TETRA TECH

CHRIS BURNS
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April 13, 2017

Mr. Brian Kelly
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Subject: **Final Removal Assessment Report**
Lake Linden Recreation Area Sediments
EPA Contract No. EP-S5-13-01
Technical Direction Document No. S05-0001-1701-010
Document Tracking No. 1468A

Dear Mr. Kelly:

Tetra Tech, Inc. (Tetra Tech) is submitting this Final Removal Assessment Report for the Lake Linden Recreation Area. This report summarizes the findings of a review of existing information and addresses your comments on the draft report submitted on March 1.

If you have any questions regarding this report, please contact me at (312) 201-7710.

Sincerely,

Chris Burns
Project Manager

Enclosure

cc: TDD File
Kevin Scott, Tetra Tech Program Manager

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FINAL REMOVAL ASSESSMENT REPORT
FOR
LAKE LINDEN RECREATION AREA SEDIMENTS
1000 HILTUNEN STREET
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

U.S. Environmental Protection Agency
Emergency Response Branch
Region 5
9311 Groh Road
Gross Ile, MI 48138-1697

Submitted by

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APPENDICES

1.0 INTRODUCTION

Under the Superfund Technical Assessment and Response Team (START) Contract No. EP-S5-13-01, U.S. Environmental Protection Agency (EPA) Region 5 tasked Tetra Tech, Inc. (Tetra Tech) to prepare a removal assessment report for sediment from Torch Lake, near 1000 Hiltunen Street in the Village of Lake Linden, Michigan. This area is referred to as the Lake Linden Recreation Area Sediments (LLRAS) site. The purpose of the removal assessment was to evaluate the potential for threats to human health and/or the environment, in order to assess the necessity for a removal action.

Under Technical Direction Document (TDD) No. S05-0001-1701-010, Tetra Tech START performed the following activities during this assessment:

- Reviewed existing analytical data and background information from multiple state and federal agencies.
- Compared existing analytical data to applicable screening levels.
- Developed a preliminary conceptual site model.
- Reviewed applicable EPA guidance for managing contaminated sediment risks.

Section 2.0 of this removal assessment report discusses the site location and site history; Section 3.0 discusses the screening levels, summarizes the existing information review findings, evaluates the data, presents a preliminary conceptual site model, and discusses EPA guidance; and Section 4.0 presents conclusions and recommendations. All references cited in this report are listed after the text. LLRAS site tables are attached, and Appendix A contains figures. Appendix B provides the EPA agreement for recovery of past response costs, and Appendix C includes the Michigan Department of Environmental Quality (MDEQ) request for EPA assistance.

2.0 SITE BACKGROUND

This section describes the LLRAS site location and summarizes its history.

2.1 SITE LOCATION

The LLRAS site is the beach and a 5-acre sediment area located near 1000 Hiltunen Street in the Village of Lake Linden, Houghton County, Michigan. The LLRAS site is situated within the Lake Linden Recreation Area, which is east of downtown Lake Linden along the shoreline of Torch Lake in a mixed residential and commercial area. The village-owned properties in the Lake Linden Recreation Area include the publicly accessible park, swimming beach, campground, marina, and sports facilities. The general location of the LLRAS site is depicted on Figure 1 in Appendix A.

The LLRAS site is part of the Torch Lake Superfund Site, which was previously (until circa late 1960s) the location of the Calumet & Hecla (C&H) Mining Company reclamation operations that included the regrinding plants No. 1 and No. 2, leaching plant, and the flotation plant. Located west, south, and adjacent to the Lake Linden Recreation Area are the ruins of the related C&H industrial complex that historically included the Calumet and Hecla stamp mills, and the C&H power plant, still house, boiler house, and assay laboratory. The waste rock, commonly referred to as stamp sand or tailings, generated by the stamping process was discharged into Torch Lake forming the deposit that fills the north end of Torch Lake and now constitutes the north and eastern portion of the Lake Linden Recreation Area. Further to the south in the community of Hubbell, C&H undertook other industrial operations, including smelting and refining. The LLRAS site layout and proximal historic C&H mining era buildings and structures are depicted on Figure 2 in Appendix A.

2.2 TORCH LAKE HISTORY

Copper mining was extensive in Houghton and Keweenaw Counties in the Upper Peninsula of Michigan and formed the backbone of the regional economy and society. Copper ore milling and smelting operations conducted from the mid-1860s to the 1960s, included the importation, reprocessing, and smelting of various scrap metals in the later years of operation. Consistent with past industrial practices, Torch Lake served as a receptor for virtually all mining industry-related waste products, including tailings, slag, mine pumpage, and various chemicals including metal-bearing wastes, leaching and flotation agents (pine oil, creosotes, and xanthates), cupric ammonium carbonate, and other mining byproducts. At least 20 percent of the Torch Lake's volume is estimated to be filled with tailings and other waste products.

After over 100 years of mining and reclamation, EPA designated Torch Lake and its western shoreline as a Superfund site in 1986 (https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0503034). Torch Lake was also designated as a Great Lakes Area of Concern (AOC) by the U.S./Canada Great Lakes Water Quality Agreement (https://www.epa.gov/torch-lake-aoc). The Torch Lake National Priorities List (NPL) Site "is comprised of several smaller sites ranging from approximately 10 acres to more than 200 acres. The sites are located around the Keweenaw Peninsula. The Torch Lake NPL Site was listed primarily because of the detrimental ecological effects of copper and mine tailings on aquatic organisms and to the surface water of Torch Lake. When it was added to the NPL, the Torch Lake NPL Site was defined to include Torch Lake, the northern portion of Portage Lake, North Entry, and tributary areas" (Weston 2007b). "The EPA's 1992 Record of Decision (ROD) divided the Torch Lake Site into three Operable Units (OUs):

- **OU 1** includes surface tailings, drums, and slag pile/beach on the western shore of Torch Lake. These tailing piles include stamp sands in Lake Linden, Hubbell/Tamarack City, and Mason, while a slag pile/beach is located in Hubbell.
- **OU 2** includes groundwater, surface water, submerged tailings and sediments in Torch Lake, Portage Lake, the Portage Canal, and other water bodies.
- **OU 3** includes tailings and slag deposits located in the north entry of Lake Superior, Michigan Smelter, Quincy Smelter, Calumet Lake, Isle-Royale, Boston Pond, and Grosse-Point.

Ultimately, the OU 1 and OU 3 remedy selected and implemented by the EPA required that stamp sands, tailings and slag piles be covered with soil and vegetation, and that use restrictions are put in place to protect the covered materials' long-term integrity. Through these measures, it was concluded that the following Remedial Actions Objectives (RAO) would be met:

- Reduce or minimize potential future risks to human health associated with the inhalation of airborne contaminants from the tailings and/or slag.
- Reduce or minimize potential future risks to human health associated with direct contact with and/or the ingestion of the tailings and/or the slag.
- Reduce or minimize the release of contaminants in tailings to the groundwater through leaching.
- Reduce or minimize the release of contaminants in tailings to the surface water and sediment by soil erosion and/or air deposition" (Weston 2016).

Starting in 1998, EPA undertook the Torch Lake Site's long-term remedy including covering 800 acres of slag piles and tailings with soil and vegetation. "This cover was designed to prevent further contamination and ecological degradation of area water bodies by reducing the ongoing transport (*i.e.*, wind erosion, surface water runoff, and shoreline erosion) and loading of mining waste metals and particulate matter. The area water bodies were then allowed to naturally recover. The remedial investigation and cleanup efforts

focused on areas along the shores of Torch Lake and the surrounding areas, where stamp sands and tailings were a concern for erosion into the waterways. Buildings and other related structures that were not shown to be a concern for erosion into surface water, were not included as part of the Torch Lake NPL Site" (Weston 2007b). The historic C&H mining-era buildings and structures proximal to the LLRAS site are depicted on Figure 3 in Appendix A.

'The EPA selected a "No Action" remedy in their 1994 ROD for OU 2. To meet the RAO, the remedy selected for OU 2 took into consideration and relied upon:

- The reduction of stamp sand loading to surface water bodies expected as a result of the remedial action taken at OU 1 and OU 3.
- Ongoing natural sedimentation and detoxification such as that which is occurring in other surface water bodies in the area.
- Institutional programs and practices controlling potential future exposure to site-affected groundwater, which are administered at the county and state level.
- The long-term monitoring and the five-year review process monitoring requirements of the remedy selected for OU 1 and OU 3 under the 1992 ROD" (Weston 2016).

In April 2002, a partial NPL delisting of the Lake Linden portion of the Torch Lake NPL Site and all of Operable Unit 2 (sediments, surface water, and groundwater) was finalized.

2.3 LLRAS HISTORY

In 2007, Lake Superior's water level, to which Torch Lake is hydrologically connected, reached near-record lows exposing mining era wastes on the lake bottom. On June 21, 2007, MDEQ representatives visited the Lake Linden Recreation Area to assess the newly exposed shoreline areas, and observed and sampled white, clay-like material on the shoreline west of the Lake Linden Beach. Analytical results of the white material showed polychlorinated biphenyl (PCB) concentrations of 12 milligrams per kilogram (mg/kg) and elevated target analyte list (TAL) metals including antimony (600 mg/kg), arsenic (45 mg/kg), barium (120,000 mg/kg), copper (81,000 mg/kg), and lead (78,000 mg/kg). Concentrations of these TAL metals exceeded MDEQ Residential and Commercial I Soil Direct Contact Criteria (RDCC) established under Part 201 of Act 451 of the Michigan Compiled Laws. The MDEQ subsequently requested EPA Emergency Response Branch (ERB) assistance to address removal of the waste material from the nearshore area. On August 3, 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 were completed on October 3, 2007. The extent of EPA's 2007

emergency removal and proximal historic C&H mining-era buildings and structures are depicted on Figure 3 in Appendix A. A detailed discussion of the EPA's 2007 removal is included in Section 3.

2.4 LLRAS WASTE PROCESS SUMMARY

The following process summary was largely excerpted from the *Agreement for Recovery of Past Response Costs at Lake Linden CERCLA Removal Site* signed by EPA on February 3, 2012 (EPA 2012a; Appendix B). C&H ran its smelting and copper milling facilities along Torch Lake in the villages of Hubbell and Lake Linden. At the mills, copper was extracted by crushing or "stamping" the rock into smaller pieces, grinding the pieces, and driving them through successively smaller meshes. Gravimetric sorting in a liquid medium separated the copper and crushed rock. The copper was sent to the C&H smelter in Hubbell. The crushed rock particles, called tailings or stamp sands, were discarded with the mill processing water, typically by pumping into Torch Lake or depositing the tailings onto property around Torch Lake. The milling process was not efficient and copper was lost in the discarded tailings.

Mining output, milling activity, and tailing production peaked in the Torch Lake area in the early 1900s to 1920. In about 1916, advances in technology allowed recovery of copper remaining in the tailings previously deposited into Torch Lake. The C&H leaching plant began operations in 1916 and the C&H flotation plant began operations in 1919. These plants were located within the current footprint of the Lake Linden Recreation Area. Dredges were used to collect the tailings, which were then screened, re-crushed, and gravity separated. An ammonia leaching process was used to recover copper and other metals from the conglomerate tailings, and the flotation process was used to extract copper from both conglomerate and amygdaloid tailings. After leaching or flotation at the reclamation plants, the chemically treated tailings were deposited in Torch Lake.

Mining activity decreased during the 1920s, though reclamation of copper from the tailings continued until the late 1960s. In the 1930s and 1940s, Torch Lake-area mills operated mainly to recover tailings in Torch Lake.

Reclamation of copper from scrap electrical materials occurred at the C&H smelter and leaching plant from about 1940 until 1968, when the mines and mills closed. According to a 1986 report, "workers in the smelter reported that electrical material that presumably contained copper was transported by ship and rail to the smelter from the lower Midwest. It was then doused with a flammable substance and burned so that all the rubber or asbestos insulation was removed leaving bare metal. The metal was brought to the smelter for extraction of copper. The resulting slag from this process was dumped out into the lake and along the shoreline...." The waste from this reclamation had large enrichments of lead, tin, zinc, and chromium.

2.5 2007 EMERGENCY RESPONSE INTERVIEW

During EPA's 2007 emergency removal activities, a former employee of C&H provided additional information to EPA about the scrap recycling that took place at C&H. He stated that C&H accepted scrap electrical equipment to reclaim the copper. This included large and small motors, car starters, generators, alternators, washing machine motors, and electric fan motors. He also said he observed employees behind C&H's smelter in the yard near Torch Lake burning off the insulation on copper wires on the large motors and the solder (60% lead and 40% tin) that held the wires to the lead and zinc bearings. The former employee said he observed C&H employees push the insulation ash and melted solder into Torch Lake behind the C&H smelter. The C&H smelter was located in Hubbell, near the current location of Koppers Performance Chemicals, which recovers copper from scrap materials.

The former employee said the large motors were then hauled to the C&H leaching plant in Lake Linden where any remaining copper was leached off the motors. Small electric motors such as car starters, generators, alternators, washing machine motors, and electric fan motors were sent directly to the C&H leaching plant where the ammonia and salt solution leached out the copper. The copper remained in the solution and was sent to the still house where the copper precipitated as an oxide. The lead solder from the scrap sank to the bottom of the leaching tanks and formed sludge. He said he knew from other employees that the sludge was washed down a trough into Torch Lake, in the location where EPA conducted the aforementioned removal action in August 2007.

The former employee also stated that during World War II, C&H reclaimed copper from 30- and 50-caliber bullets that had been rejected for various reasons and sent to scrap yards. The bullets were steel with a copper jacket on the outside and a lead core in the center. The copper was leached from the bullets in the C&H leaching plant; the lead from the core became a sludge in the leaching tanks and was washed down the trough to Torch Lake in Lake Linden. A book about the copper industry, *Red Metal - The Calumet and Hecla Story*, refers to a contract that C&H had with the Metals Reserve Company for C&H to treat the bullets, and states that the leaching plant recovered about 20,800,000 pounds of copper and 40,000 long tons of steel from small arms scrap under that contract. A letter to EPA, dated April 1992, from an attorney for Universal Oil Products Company, states that the United States Department of Commerce (as successor to the War Production Board and the Metals Reserve Company) supplied substantial quantities of scrap to C&H for copper recovery during World War II.

2.6 C&H CORPORATE HISTORY

C&H was incorporated in 1871 in Michigan as a consolidation of the Hecla, Calumet, Portland, and Scott Mining companies. C&H grew by buying and merging with neighboring copper mines and, in 1923, was renamed the Calumet & Hecla Consolidated Copper Company, which essentially controlled all the operating mines north of Hancock, Michigan.

C&H reincorporated in 1952 as Calumet & Hecla, Inc., dropping any specific reference to being a mining company. On April 30, 1968, Universal Oil Products Company merged with Calumet & Hecla, Inc., and operated it as a subsidiary named Calumet & Hecla Corp. Universal Oil Products Company closed down the operations of its Calumet Division and Universal Oil Products Company merged with Calumet & Hecla Corp. on December 31, 1969. As a successor to Universal Oil Products Company and, under agreement, Honeywell Specialty Metals (HSM) reimbursed EPA for prior removal actions at the LLRAS site, and conducted a series of remediation activities in the adjacent C&H industrial complex.

2.7 2016 – 2017 INVESTIGATION

In 2016 and 2017, the MDEQ evaluated the results of several key studies conducted at the LLRAS site between 2005 and 2015. MDEQ concluded that contamination extended outward from EPA's 2007 removal limits:

- Nearshore and offshore sediments contain concentrations of arsenic, barium, copper, lead, and total PCBs that exceed MDEQ RDCC (for soils), ecological screening criteria, and potentially hazardous toxicity values similar to the sediments removed by the EPA in 2007.
- Nearshore and offshore sediments contain concentrations of other metals and total PCBs in excess of ecological screening criteria.
- Surface water contains concentrations of metals and semivolatile organic compounds (SVOCs) in excess of ecological screening criteria.
- Surface water contains total PCBs based on analytical results from semipermeable membrane devices (SPMD).

Based on the evaluation, in a January 19, 2017, letter, the MDEQ requested EPA ERB assistance to address the contaminated sediments at the LLRAS site. The request for assistance document is included in Appendix C.

3.0 SITE SCREENING LEVELS AND EXISTING DATA EVALUATION

This section describes the selected LLRAS site screening levels and provides an evaluation of the existing analytical data. This section also includes a conceptual site model and a review of EPA guidance on managing risks for contaminated sediment, as it applies to the LLRAS site.

3.1 SITE SCREENING LEVELS

The following provides a summary of the regulatory criteria utilized for evaluating existing analytical results from sediment and surface water sampling to determine if contaminant concentrations on-site would require removal.

- EPA residential direct contact removal management levels (RMLs) (EPA 2016). EPA RMLs are modified based on target risk levels for carcinogens (TCR) and hazard quotients (HQ). EPA's generic RML tables were used with specific TCR and HQ modifiers. The EPA's RMLs were used with a criterion of 10^{-4} TCR and a HQ of 3 for non-carcinogens.
    - Sediment, since the soil criteria are considered applicable to sediments.
- Part 201 of Michigan's Natural Resources and Environmental Protection Act (NREPA), being PA 451 of 1994, as amended Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity (December 30, 2013).
    - Sediment, since the soil criteria are considered applicable to sediments.
- EPA, Resource Conservation and Recovery Act (RCRA), Identification and Listing of Hazardous Waste Criteria (40 CFR, Part 261, Subpart C) (EPA 2012b).
    - Sediment.
- EPA, Region 5, RCRA, Ecological Screening Levels (ESLs) (EPA 2003).
    - Sediment; and,
    - Surface Water.
- 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.

3.2 DATA EVALUATION

Major MDEQ and EPA studies associated with Torch Lake are available on the MDEQ's Abandoned Mining Waste Project website http://www.michigan.gov/deq/0,4561,7-135-3311_4109_9846_76560---,00.html. In development of this removal assessment report the surface water, sediment, and SPMD data from key studies selected by MDEQ were evaluated, relative to the screening levels described in Section

3.1, to assist in characterizing and delineating the extent of the impacted sediments at the LLRAS site. The following is a summary of the key documents reviewed to support preparation of the removal assessment report:

- *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake, Houghton County – March 2006. (MDEQ 2006).*
- *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan – November 2007. (Weston 2007a).*
- *A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, MDEQ Water Bureau – February 2008. (MDEQ 2008).*
- *Site Inspection (SI) Report for C&H Lake Linden Operations, Lake Linden, Michigan, 49945 – June 2014.* Prepared by the MDEQ-RRD, Superfund Section, Pre-remedial Group, Site Evaluation Unit (Pre-remedial Group). *(MDEQ 2014).*
- *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan. March 2016. (Weston 2016).*

The sample types, locations, and data sources included in the evaluation are depicted on Figure 4 in Appendix A.

3.2.1 Key Document Reviews

Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake, Houghton County – March 2006. The MDEQ contracted Great Lakes Environmental Center, Inc. to conduct a contaminant concentration study, using SPMDs, in Torch Lake, Portage Lake, 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.

The collection method provided a time-weighted exposure representative of chemical uptake through fish respiration. SPMD sample results did not provide for a direct comparison to surface water criteria, but were an indicator of contaminants in the water column. SPMDs isolate only the truly dissolved portion of PCBs from the water; the portion 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). Use of SPMDs for monitoring aqueous

residues of PCBs, as well as other low to moderate molecular weight nonpolar organic environmental contaminants, has repeatedly demonstrated results.

SPMDs were deployed at 10 locations (Sites 1-10) in Torch Lake, Portage Lake, the Keweenaw Waterway in Houghton County, and Huron Bay in Baraga County. SPMD Site 3 was located within the LLRAS site. 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 micrograms per liter (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.
- Site 10 was located 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 suggested that they 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 suggested that PCB concentrations 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) contained 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 supported. The fact that Site 1 (without stamp sands) had elevated levels of PCBs, and Site 5 (with stamp sands) had background levels of PCBs indicated 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, including the LLRAS site, contained PCBs. The sample result for the SPMD from Site 3, located within the LLRAS site, is depicted on Figure 5b in Appendix A.

Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan – November 2007. On June 21, 2007, MDEQ representatives visited the Lake Linden Recreation Area to assess the newly exposed shoreline areas, and observed and sampled white, clay-like material on the

shoreline. The MDEQ sample was collected along the shoreline west of the Lake Linden beach. The sample contained PCBs at a concentration of 12 mg/kg as well as elevated target analyte list metals that exceeded MDEQ RDCC.

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

On August 3, 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 August 6 and were completed on October 3, 2007. The emergency removal activities completed during this period included 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 August 7 and was completed on August 12, 2007. Two excavators, one standard-reach and one long-reach, were used to excavate the top 2 to 5 feet (deeper than the projected 18 inches based on visual observations and field screening) of the area contaminated with clay-like waste material. An estimated 905.5 tons of soil were removed and stockpiled for disposal.
- On August 7 and 8 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 excavation at Area 2 on August 13, and completed activities on August 15, 2007. An estimated 64.69 tons of soil was removed and stockpiled for disposal.

At the completion of the work, the excavation areas were capped with clean soil and riprap along the shoreline. Sample results for the surface water and unexcavated soil/sediment samples along with a comparison to applicable criteria are depicted on Figures 5a, 5b, and 5c in Appendix A.

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 MDEQ Water Bureau and the EPA Great Lakes National Program Office completed the investigation. At the time of the investigation,

the EPA listed Torch Lake as a Great Lakes AOC. MDHHS also restricted consumption of northern pike, smallmouth bass, and walleye caught in Torch Lake.

Previous investigations indicated that a potential source of PCBs was present within the northern portion of Torch Lake. The objective of this 2008 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 locations 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. Concentrations in LLRAS site sediments exceeded EPA RMLs, MDEQ RDCC, and ESLs.
- PCBs were detected in 16 of the 71 discrete samples, with concentrations ranging from 130 micrograms/kilogram (µg/kg) to 8,900 µg/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 within the LLRAS site. Concentrations in LLRAS site sediments exceeded EPA RMLs, MDEQ RDCC, and ESLs.
- Surficial sediments near Hubbell in Torch Lake contained low PCB concentrations (1,000 µg/kg or less). PCB concentrations in the deeper sediments, except at the very northern end of the sample area within the LLRAS site footprint, were predominantly below reporting limits.

Sediment sample results at the LLRAS site, along with a comparison to applicable criteria are depicted on Figures 5a, 5b, and 5c in Appendix A.

MDEQ Pre-remedial Group - SI Report for C&H Lake Linden Operations – 2014. Under the authority of a cooperative agreement between the MDEQ and the EPA, the MDEQ's Pre-Remedial Group conducted assessment activities in October 2011 at the C&H operations site in Lake Linden. The Site Investigation (SI) fieldwork was completed between October 10 and 13, 2011. The findings were documented in a 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; SVOCs and PCBs in waste materials; VOCs 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 removal actions. SI activities 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 C&H Lake Linden Operations site conditions. Four migration pathways of concern were discussed in the report and included groundwater, surface water, soil, and air. Most relevant to the LLRAS site were the sediment and surface water results that are discussed in the following paragraphs.

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. MDEQ noted that the topography adjacent to the C&H Lake Linden Operations site was at higher elevations that directed surface runoff across the C & H site and into surface waters. The Village of Lake Linden is immediately uphill of the C&H Lake Linden Operations site, and any surface runoff in this area flowed across village properties before flowing across the site and into Torch Lake. 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 indicated an observed release of contaminants into Torch Lake. A limited number of inorganic analytes were determined to exceed both RDWC, Groundwater Surface Water Interface Criteria (GSIC), and ESLs. No exceedances of direct contact criteria were identified.

Similar to surface water, sediment samples indicated an observed release of contaminants into Torch Lake. 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), seven exceeded MDEQ Residential Drinking Water Protection Criteria (RDWPC), and copper exceeded ESLs. Since no public water intakes are present within the 15-mile target distance limit, the exceedances of RDWPC were determined to be insignificant (MDEQ's Pre-remedial Group had identified the nearest known surface water intakes used for public drinking water supplies, which are located approximately 25 miles south of the LLRAS site). Arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, and zinc exceeded GSIPC.

The findings of the 2011 SI determined that significant quantities of waste were present at the C & H Lake Linden Operations site; and shallow and subsurface soils, groundwater, surface water, and sediments have become contaminated with heavy metals, especially arsenic, chromium, copper, and lead. Sample results for

the sediment and surface water samples located within the LLRAS site along with a comparison to the applicable criteria are depicted on Figure 5a in Appendix A.

Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan. March 2016. The MDEQ's Abandoned Mining Waste Project is addressing some of the remaining concerns in Houghton County that were not addressed by the EPA Torch Lake Superfund project. The Abandoned Mining Wastes Project concerns involve groundwater, surface water, sediments, and "upland" media within and adjacent to the entire western shoreline of Torch Lake. Known or suspected problems which are being evaluated include: an unidentified, significant in-lake and/or terrestrial source of PCBs, uncharacterized waste deposits and more than 750 uncharacterized drums on the lake bottom, slag, landfills, industrial ruins, coal storage areas, underground storage tanks (USTs), residual process materials (RPM), asbestos-containing material (ACM), and any other waste materials that may be identified during future investigations.

During 2014 and 2015, the MDEQ Remediation and Redevelopment Division (RRD) conducted SI activities and confirmed that the remaining concerns in the Abandoned Mining Wastes Project area involve groundwater, surface water, sediments, and "upland" media. Priority concerns which were evaluated and deemed to require interim response measures include: significant terrestrial sources of PCBs; ACM; RPM; abandoned mining-era containers; seeps; limited areas of soil in which there are Direct Contact Criteria (DCC) and Particulate Soil Inhalation Criteria (PSIC) exceedances; and physical hazards.

MDEQ concluded that the Lake Linden Recreation Area is generally characterized by detections of organic and inorganic contaminants in soil, groundwater, sediment, and surface water; repercussions of mining era operations in the region.

The findings of MDEQ's Lake Linden Recreation Area SI activities are summarized as follows:

- Soil analytical results exceeded GSIPC and DCC in one or both of the residential and nonresidential exposure scenarios for inorganic and SVOC contaminants. In addition, a limited number of samples analyzed for cyanide and SVOCs exceeded GSIPC, and SVOCs exceeded RDCC.
- Surface soil screening results also included measured inorganic contaminant concentrations that exceeded DCC and PSIC in both residential and non-residential exposure scenarios.
- Groundwater analytical results exceeded MDEQ Drinking Water Criteria (DWC) for both residential and nonresidential exposure scenarios and GSIC for ammonia and organic contaminants. In several samples, ammonia exceeded DWC for both residential and nonresidential exposure scenarios. Benzene exceeded DWC and GSIC in three sampling locations at the marina.

- Sediment analytical results exceeded EPA RMLs, RDCC, ESLs, TECs, and PECs for inorganic contaminants. In addition, analytical results for total PCBs also exceeded RDCC, TECs and PECs in both surficial and deep sampling locations.
- Surface water sample analytical results exceeded applicable regulatory criteria for inorganic contaminants.

In addition to the evaluation of analytical results, the following provides a summary of findings derived from the assessment of the Lake Linden Recreation Area and Torch Lake with respect to the goals and objectives for the Abandoned Mining Wastes Project:

- Significant in-lake and terrestrial sources of contamination are present in the form of metals, cyanide, VOCs, and SVOCs in the Lake Linden Recreation Area. Concentrations of total PCBs exceeding regulatory criteria were identified in 15 sediment samples indicating a significant in-lake source of PCB contamination in the Lake Linden Recreation Area.
- PCBs were identified in an SPMD sample.
- A suspected in-lake PCB-containing waste deposit was identified in sediment near the Lake Linden Village Park and the beach. Terrestrial investigation near the suspected waste deposit did not indicate that PCBs were present landward of the shoreline.
- Bulk disposal areas, including capped stamp sand deposits, are present in Lake Linden Recreation Area.
- Industrial ruins, including foundations and building floors, are present at the ground surface and have been incorporated into facilities at the Lake Linden Village Park. The ruins were investigated as part of the SI and suspect ACM and similar mining area containers, building materials, or wastes were not identified in the area.
- The MDEQ Water Resources Division (WRD) and MDHHS continues to monitor fish contaminant levels in Torch Lake and from two Lake Superior reference sites to allow comparisons of key contaminant concentrations between sites as well as temporal trend evaluations (MDEQ 2016). The most recent WRD study concluded that "Overall, the evidence indicates that total PCB concentrations in Torch Lake fish remain elevated compared to other water bodies in northern Michigan, even though levels have declined since monitoring began in 1988. Mercury concentrations in Torch Lake fish have not declined since monitoring began in 1988 and may have increased over that time; however, mercury levels are lower than in fish from other Upper Peninsula inland lakes." The report also projected continued fish consumption guidelines for Total PCBs and mercury.

Sample results for the sediment and surface water samples located within the LLRAS site, as well as a comparison to applicable criteria, are depicted on Figures 5a, 5b, and 5c in Appendix A.

3.3 CONCEPTUAL SITE MODEL

Comparing existing analytical data to applicable regulatory criteria and the relevant exposure pathways assessed in the preceding subsections indicates that contaminants are present in various environmental

media at the LLRAS site, including surface and vadose zone soils, groundwater, surface water, sediment, and wastes. These contaminated media have the potential to affect human and ecological receptors, as well as recreational users or consumers of the natural resources of Torch Lake. A summary of analytical results that exceeded the selected screening criteria are depicted on Figures 5a, 5b, and 5c in Appendix A, and presented in Tables 1 and 2.

Based on the existing information, the extent of contamination associated with the LLRAS site outward from EPA's 2007 removal limits includes:

- Nearshore and offshore sediments with concentrations of barium, copper, lead, and PCB Aroclor 1254 that exceed the EPA RML for residential soil.
- Nearshore and offshore sediments with concentrations of arsenic, barium, copper, lead, and total PCBs that exceed the MDEQ RDCC.
- Nearshore and offshore surficial and deep sediments with concentrations of metals and total PCBs that exceed ESLs, TECs, and PECs.
- Sediments, identified as ongoing in-lake sources of PCBs, contributing to the MDHHS fish consumption guideline for total PCBs in Torch Lake fish.
- Surface water with concentrations of metals and SVOCs in excess of ESLs and surface water criteria.
- Surface water with total PCBs based on SPMD analytical results.

There is potential exposure of LLRAS site contamination to human receptors that utilize the Lake Linden Recreation Area through direct contact with the contaminated sediments, particularly in areas where swimming or wading may occur, including contact with submerged sediment. There is potential exposure of LLRAS site contamination to ecological receptors, and the waste deposit in the lake extends outward from the 2007 EPA removal area. This waste serves as a continuing source of PCBs into the environment, as indicated by the SPMD sample result and the presence of PCBs in Torch Lake fish. PCBs in Torch Lake fish create an additional pathway for LLRAS site contamination to reach human receptors via ingestion of fish.

The LLRAs site preliminary conceptual site model on Figure 6 in Appendix A graphically presents the relevant exposure pathways and their relationship to the distribution of contaminants in the nearshore and offshore environment. The cross-sectional representation depicts these relationships under a recreational use scenario, the current and anticipated future use.

3.4 EPA GUIDANCE REVIEW

The February 12, 2002 OSWER Directive 9285.6-08 (EPA 2002) entitled *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* and the January 9, 2017 OLEM Directive 9200.1-130 (EPA 2017) entitled *Remediating Contaminated Sediment Sites – Clarification of Several Key Remedial Investigation / Feasibility Study and Risk Management Recommendations, and Updated Contaminated Sediment Technical Advisory Group Operating Procedures* were reviewed with regard to the LLRAS site. These documents provide recommendations for risk-based decision making using an iterative approach when evaluating contaminated sediment sites and response alternatives. Several key recommendations from these documents are discussed in the following subsections.

3.4.1 Control Sources Early

EPA 2002 suggests that "site managers should assess which continuing sources can be controlled and by what mechanisms. It may be helpful to prioritize sources according to the relative contributions to site risks." As EPA 2017 notes, "taking appropriate early actions during the site investigation is consistent with the NCP [National Contingency Plan] and existing guidance. Even before the sediment at a site is well characterized, if risk is obvious, it may be very important to begin to control significant ongoing land-based sources. It also may be appropriate to take other early or interim actions, followed by a period of monitoring, before deciding on a final remedy." Actions taken by EPA in 2007 and the current evaluation are consistent with this guidance.

3.4.2 Evaluate the Risks Associated with Exposure to Contaminated Sediments, Including Submerged Sediments

EPA 2017 states, "direct contact (dermal exposure) with sediments may be particularly important in areas where swimming or wading may occur, including contact to submerged sediment, and therefore, is an important exposure pathway to evaluate at contaminated sediments sites." This guidance directly applies to the LLRAS site, which includes a swimming beach within the area of sediment impact.

3.4.3 Use an Iterative Approach in a Risk-Based Framework

Principle number five in EPA 2002 states, "An iterative approach may also incorporate the use of phase, early, or interim actions. At complex sediment sites, site managers should consider the benefits of phasing the remediation. At some sites, an early action may be needed to quickly reduce risks or to control the ongoing spread of contamination. In some cases, it may be appropriate to take an interim action to control a source, or remove or cap a hot spot, followed by a period of monitoring in order to evaluate the effectiveness of these interim actions before addressing less contaminated areas."

3.4.4 Select Site-specific, Project-specific, and Sediment-specific Risk Management Approach that will Achieve Risk-based Goals

EPA 2002 notes, "At many sites, a combination of options will be the most effective way to manage the risk. For example, at some sites, the most appropriate remedy may be to dredge high concentrations of persistent and bioaccumulative contaminants such as PCBs or DDT [dichlorodiphenyltrichloroethane], to cap areas where dredging is not practicable or cost-effective, and then to allow natural recovery processes to achieve further recovery in net deposition areas that are less contaminated." This approach is consistent with action taken by EPA, including the 2007 removal activities and the OU 2 1994 ROD "No Action" remedy that relies upon the reduction of stamp sand loading to surface water bodies as a result of capping remedial actions taken at Operable Units 1 and 3, ongoing natural sedimentation, institutional programs and practices, and long term monitoring. The appropriate approach to the currently identified LLRAS impact is being evaluated within the context of the EPA guidance.

3.4.5 Ensure that Sediment Cleanup Levels are Clearly Tied to Risk Management Goals and Develop Risk Reduction Expectations that are Achievable by the Remedial Action

"The use of measured concentrations of PCBs in fish is suggested as the most relevant means of measuring exposures of receptors to PCBs in contaminated sediments" notes EPA 2002, while EPA 2017 states that "Until fish tissue levels are within the acceptable risk range it is important that the remedy include a fish consumption advisory to ensure that the remedy is protective in the short term and long term." Recovery through natural sedimentation (capping) with an MDHHS fish consumption guideline for total PCBs in Torch Lake fish is part of the current EPA Torch Lake Superfund Site ROD to manage risks associated with human consumption of PCB-contaminated fish.

4.0 CONCLUSION

Removal assessment activities consisted of reviewing existing analytical data and background information from multiple state and federal agencies, and comparing existing analytical data to applicable screening levels to evaluate the potential for threats to human health and/or the environment.

The surface water, sediment, and SPMD data reviewed from studies previously conducted by various state of Michigan and EPA entities included 132 (plus 8 field duplicates) sediment samples collected from 59 locations, 7 (plus 1 field duplicate) surface water samples, and 1 SPMD sample within the LLRAS site footprint. Analyses varied by study, but generally included metals, VOCs, PCBs, and SVOCs for sediment and surface water samples, and PCBs for the SPMD sample. The samples were analyzed by a combination of laboratories, including the MDEQ environmental laboratory, and MDEQ- and EPA-contracted laboratories. Analytical results that exceeded the selected screening criteria are depicted on Figures 5a, 5b,

and 5c in Appendix A and presented in Tables 1 and 2. Based on the analytical results, the extent of contamination associated with the LLRAS site extends outward from EPA's 2007 removal limits. This includes:

- Nearshore and offshore sediments with concentrations of barium, copper, lead, and PCB Aroclor 1254 that exceed the EPA RML for residential soil.
- Nearshore and offshore sediments with concentrations of arsenic, barium, copper, lead, and total PCBs that exceed the MDEQ RDCC.
- Nearshore and offshore surficial and deep sediments with concentrations of metals and total PCBs that exceed ESLs, TECs, and PECs.
- Sediments, identified as ongoing in-lake sources of PCBs, contributing to the MDHHS fish consumption guideline for total PCBs in Torch Lake fish.
- Surface water with concentrations of metals and SVOCs in excess of ESLs and surface water criteria.
- Surface water with total PCBs based on SPMD analytical results.

The LLRAS site, encompassed by the Lake Linden Recreation Area, includes the publically accessible Lake Linden Village Park, the swimming beach, campground, marina, and associated sports facilities.

There is potential exposure of LLRAS site contamination to human receptors that utilize the Lake Linden Recreation Area through direct contact with the contaminated sediments, particularly in areas where swimming or wading may occur. There is potential exposure of LLRAS site contamination to ecological receptors, and the waste deposits in the lake extend outward from the 2007 EPA removal area. This waste serves as a continuing source of PCBs into the environment, as indicated by the SPMD sample result and the presence of PCBs in Torch Lake fish. PCBs in Torch Lake fish create an additional pathway for LLRAS site contamination to reach human receptors via ingestion of fish. Potential exposure could occur through each of these migration pathways and cause imminent danger to human health and the environment. The conditions at the LLRAS site may present a threat to the public health or welfare, and the environment, and meet the criteria for a time-critical removal action as provided for in the NCP as outlined in 40 CFR § 300.415(b)(2). These criteria include, but are not limited to, the following:

Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants

Existing analytical data and background information reviewed during development of this removal assessment report documented metals and PCB-contaminated sediments at the LLRAS site. Additionally, the waste and contaminated sediments serve as a continuing source of PCBs into the environment. A

summary of analytical results that exceeded the selected screening criteria are depicted on Figures 5a, 5b, and 5c in Appendix A and presented in Tables 1 and 2. The toxicological effects of lead, arsenic, copper, barium, and PCBs have been studied by the Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological information taken directly from ATSDR documents is provided below and referenced at the end of this report.

Lead – The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in the body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage (ATSDR 2007c).

Arsenic - Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet. Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. Skin contact with inorganic arsenic may cause redness and swelling (ATSDR 2007a).

Copper - Absorption of small amounts of copper is essential for good health. However, high levels of copper can be harmful. Breathing high levels of copper can cause irritation of the nose and throat. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very high doses of copper can damage the liver and kidneys, and can even cause death (ATSDR 2004).

Barium - Background levels of barium in the environment are very low. The air that most people breathe contains about 0.0015 parts of barium per billion parts of air (ppb). The air around factories that release barium compounds into the air has about 0.33 ppb or less of barium. Most surface water and public water supplies contain on average 0.030 parts of barium per million parts of water (ppm) or less, but can average as high as 0.30 ppm in some regions of the United States. In some areas that have underground water wells, drinking water may contain more barium than the 2 ppm limit set by EPA. The highest amount measured from these water wells has been 10 ppm. The amount of barium found in soil ranges from about 15 to 3,500 ppm. Some foods, such as Brazil nuts, seaweed, fish, and certain plants, may contain high amounts of

barium. The amount of barium found in food and water usually is not high enough to be a health concern. However, information is still being collected to determine if long-term exposure to low levels of barium causes any health problems.

People with the greatest known risk of exposure to high levels of barium are those working in industries that make or use barium compounds. Most of these exposed persons breathe air that contains barium sulfate or barium carbonate. Sometimes they are exposed to one of the more harmful barium compounds (for example, barium chloride or barium hydroxide) by breathing the dust from these compounds or by getting them on their skin. Barium carbonate can be harmful if accidentally eaten because it will dissolve in the acids within the stomach unlike barium sulfate, which will not dissolve in the stomach. Many hazardous waste sites contain barium compounds, and these sites may be a source of exposure for people living and working near them. Exposure near hazardous waste sites may occur by breathing dust, eating soil or plants, or drinking water that is contaminated with barium. People near these sites may also get soil or water that contains barium on their skin (ATSDR 2007b).

PCBs – PCBs affect primarily the liver, stomach, and thyroid gland in the body. The main target for PCB toxicity is the liver in adults. Studies of long-term exposure of adult workers indicated changes in the blood and urine that may indicate liver damage. PCBs have also been shown to cause anemia and are a probable carcinogen found to cause cancer in the liver and biliary tract. Short-term exposure to high levels of PCBs by dermal contact can cause skin conditions such as acne and rashes. Women who were exposed to relatively high levels of PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women exposed to PCBs showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs (ATSDR 2014).

To address the potential exposure that could occur through each of the migration pathways and cause imminent threat to human health and the environment, a removal action to address the wastes and contaminated sediments may be appropriate. As identified by Principle 7 in EPA 2002, at many sites a combination of options may be the most effective way to manage risks. For example, the most appropriate remedy may be to dredge to reduce risks quickly. When dredging is not practicable or cost-effective, capping of sediments and/or allowing natural recovery processes to achieve further net deposition areas that are less contaminated may be acceptable.

Implementing an early/interim/iterative dredging action outward from EPA's 2007 removal limits in the nearshore (shallow water where wading and swimming may occur) may be appropriate to mitigate risks associated with contaminated sediments that contain concentrations of PCBs and metals (barium, copper, lead, and/or arsenic) that exceed the EPA RMLs and MDEQ criteria for residential soil. The sediments in this area also exceed ecological screening levels. If dredging is determined to be impractical or not cost-effective in deeper water areas of the LLRAS, an action such as capping, in-situ treatment to reduce bioavailability, and/or continued monitoring of natural sedimentation and maintaining fish consumption guidelines (as is an element of the EPA ROD) to address deeper offshore sediments could be considered to mitigate risks associated with contaminated sediments that contain concentrations of PCBs and metals that exceed the EPA RMLs and MDEQ criteria for residential soil, and ecological screening levels.

A sediment dredging effort has initially been conceptualized, with the ultimate limits of dredging subject to ongoing risk assessment, further evaluation of alternatives, and delineation of the horizontal and vertical extent of contamination. The conceptualized dredging project aligns with the area extending outward from the 2007 EPA Removal Area 1, and is intended to address lead and PCB-contaminated waste within the most highly contaminated sediments nearshore (Area A), related contaminated sediments offshore (Area B), and an area extending outward from the 2007 EPA Removal Area 2 designed to address arsenic contaminated material (Area C).

A conceptual layout of the sediment remediation project, if dredging is employed, is depicted on Figure 7 in Appendix A.

The level of expected risk reduction achieved by a remedy, expressed as the RAOs for the LLRAS site, is the following:

- Mitigate risks associated with contaminated sediments that contain concentrations of PCBs and/or metals (barium, copper, lead, and/or arsenic) that exceed the EPA RMLs and MDEQ criteria for residential soil.
- Mitigate risks associated with nearshore and offshore surficial and deep sediments with concentrations of total PCBs that exceed ESLs, TECs, and PECs.
- Mitigate risks associated with sediments, identified as ongoing in-lake sources of PCBs, contributing to the MDHHS fish consumption guideline for total PCBs in Torch Lake fish.

Conceptually, the conditions to be achieved are remediation of metals and PCBs in sediments at the LLRAS site (approximately Areas A through C) to attain conditions that no longer exceed EPA RMLs and MDEQ criteria for residential soil and no longer exceed ESLs, TECs, and PECs for PCBs. Additional delineation

and cost/benefit analysis of remedial alternatives is recommended to reduce uncertainty and aid in decision making as to an appropriate remedial approach.

As noted in EPA 2002, in addition to considering the impacts of remedial alternatives on human health and ecological risks, the short-term and long-term impacts of each alternative on societal and cultural practices should be identified and considered. For short-term impacts, a dredging alternative would likely be disruptive to users of the park, beach, and Torch Lake within the LLRAS site due to the area needed for dredging (including within the swimming area), barge off-loading, material handling, truck loading, and hauling. This could be particularly significant if remedial activities occurred during local events that bring thousands of people to the park such as the annual July 4th festivities and fireworks. However, dredging permanently removes the affected media from the site thereby fostering a strong, positive long-term impact given the popular recreational land uses at the LLRAS site. A capping remedy would likely have slightly less of a short-term impact as the area needed for material handling would be reduced but would still be disruptive and potentially have less of a long-term impact, as affected media would still be present within a swimming, fishing, and recreational area. The current OU 2 ROD remedy may present the least short-term societal impact in terms of disruption of recreational activities at the LLRAS site but also presents the longest duration for remedy implementation, by relying on natural sedimentation processes to cover the contaminated sediments.

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TABLES

TABLE 1
SUMMARY OF SEDIMENT ANALYTICAL RESULTS
THE LAKE LINDEN RECREATION AREA SEDIMENTS - RS SITE
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name						CHLL-SD12		CHLL-SD13			CHLL-SD14			CHLL-SD15		CHLL-SD16			
Sample ID	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	CHLL-SD 12-0"-6"	CHLL-SD 12-1'-2.5'	CHLL-SD 13-0"-6"	CHLL-SD 13-1'-2'	CHLL-SD 13-1'-2' dup	CHLL-SD-14-0"-6"	CHLL-SD-14-1'-3'	CHLL-SD-14-3'-4'	CHLL-SD 15-0-6"	CHLL-SD 15-1'-2.7'	CHLL-SD-16-0"-6"	CHLL-SD-16-1'-3'	CHLL-SD-16-3'-4'	CHLL-SD-16-3'-4' DUP
Lab Sample ID						1406230-09	1406230-10	1406229-11 1407121-02	1406229-12	1406229-13	1407175-02	1407175-03	1407175-04	1406229-14	1406229-15	1407175-05	1407175-06	1407175-07	1407175-08
Sample Date						6/15/2014	6/15/2014	6/15/2014	6/15/2014	6/15/2014	7/11/2014	7/11/2014	7/11/2014	6/16/2014	6/16/2014	7/11/2014	7/11/2014	7/11/2014	7/11/2014
Sample Type										Field Duplicate									Field Duplicate
Inorganics - Metals (mg/kg)																			
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	**7,700**	--	--	**15,000**	--	--	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	--	--	<0.6 U	--	--	**15**	--	--	--	--	--	--	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	--	--	**1.9**	--	--	**16**	--	--	--	--	--	--	--	--
BARIUM	NA	NA	NA	37,000	46,000	--	--	**26**	--	--	**2,300 J**	--	--	--	--	--	--	--	--
BERYLLIUM	NA	NA	NA	410	470	--	--	**0.8**	--	--	**1.3**	--	--	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	<0.2 U	--	--	**3.6**	--	--	--	--	--	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	**19**	--	--	**42**	--	--	--	--	--	--	--	--
COBALT	50	NA	NA	2,600	70	--	--	**8.8**	--	--	**19**	--	--	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	--	--	**550**	--	--	**9,800**	--	--	--	--	--	--	--	--
IRON	NA	NA	NA	160,000	160,000	--	--	**14,000**	--	--	**31,000**	--	--	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	--	--	**4.3**	--	--	**2,200**	--	--	--	--	--	--	--	--
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	**270 J**	--	--	**420**	--	--	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	<0.07 U	--	--	**0.3**	--	--	--	--	--	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	**25**	--	--	**52**	--	--	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	<0.4 U	--	--	**1.6**	--	--	--	--	--	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	--	--	**1.7**	--	--	**26**	--	--	--	--	--	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	--	--	**61**	--	--	**430**	--	--	--	--	--	--	--	--
Inorganics - Cyanide (mg/kg)																			
CYANIDE	0.0001	NA	NA	12	69	--	--	<0.14 U	--	--	<0.23 U	--	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																			
AROCLOR-1242	NA	NA	NA	NA	23,000	<140 U	<130 U	<140 U	<130 U	<130 U	**340 J**	<300 U	<290 U	<240 UJ	<210 U	**340 J**	<300 U	<300 U	<290 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<140 U	<130 U	<140 U	<130 U	<130 U	<340 UJ	<300 U	<290 U	**230 J**	<210 U	<430 UJ	<300 U	<300 U	<290 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<140 U	<130 U	<140 U	<130 U	<130 U	**390 J**	<300 U	<290 U	**270 J**	<180 U	**220 J**	<300 U	<300 U	<290 U
AROCLOR-1262	NA	NA	NA	NA	NA	<140 U	<130 U	<140 U	<130 U	<130 U	<230 UJ	<300 U	<290 U	<170 UJ	**290**	<430 UJ	<300 U	<300 U	<290 U
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	ND	ND	ND	**730 J**	ND	ND	**500 J**	**290**	**560 J**	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																			
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																			
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	<280 UJ	--	--	<1100 U	--	--	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	<280 UJ	--	--	<1100 U	--	--	--	--	--	--	--	--
DRO/ORO (ug/kg)																			
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.

EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

TABLE 1
SUMMARY OF SEDIMENT ANALYTICAL RESULTS
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LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	CHLL-SD17			CHLL-SD18		CHLL-SD19		CHLL-SD20		CHLL-SD21	CHLL-SD22		
Sample ID						CHLL-SD 17-0"-6"	CHLL-SD 17-1'-3'	CHLL-SD 17-3'-5'	CHLL-SD 18-0"-6"	CHLL-SD 18-1'-2.7'	CHLL-SD 19-0"-6"	CHLL-SD-19-1'-2.4'	CHLL-SD 20-0-6"	CHLL-SD 20-1'-2'	CHLL-SD21-0"-6"	CHLL-SD 22-0-6"	CHLL-SD 22-1'-1.5'	CHLL-SD 22-0-6" dup
Lab Sample ID						1407166-15 1502020-02	1407166-16	1407166-17	1407166-18	1407166-19	1407166-20	1407175-11	1406229-16	1406229-17	1407176-09	1406229-18	1406229-20	1406229-19
Sample Date						7/12/2014	7/12/2014	7/12/2014	7/12/2014	7/12/2014	7/12/2014	7/12/2014	6/16/2014	6/16/2014	7/10/2014	6/16/2014	6/16/2014	6/16/2014
Sample Type																		Field Duplicate
Inorganics - Metals (mg/kg)																		
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	**4,800**	**3,200**	**4,400**	**3,800**	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	--	--	--	<0.3 U	**17**	<0.3 U	<0.3 U	--	--	--	--	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	--	--	--	**1.7**	**2.3**	**1.2**	**1.4**	--	--	--	--	--	--
BARIUM	NA	NA	NA	37,000	46,000	--	--	--	**78 J**	**2700 J**	**31 J**	**20 J**	--	--	--	--	--	--
BERYLLIUM	NA	NA	NA	410	470	--	--	--	**0.5**	**1**	**0.4**	**0.3**	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	--	<0.2 U	**3.1**	<0.2 U	<0.2 U	--	--	--	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	--	**9**	**13**	**8.5**	**8.5**	--	--	--	--	--	--
COBALT	50	NA	NA	2,600	70	--	--	--	**4.5**	**6.4**	**4.5**	**4.5**	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	--	--	--	**130**	**4,400**	**89**	**140**	--	--	--	--	--	--
IRON	NA	NA	NA	160,000	160,000	--	--	--	**12,000**	**9,900**	**10,000**	**9,000**	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	--	--	--	**27**	**1,600**	**5.6**	**5.4**	--	--	--	--	--	--
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	**160**	**120**	**130**	**110**	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	--	<0.07 U	**0.1**	<0.08 U	<0.07 U	--	--	--	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	**12**	**17**	**12**	**12**	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	--	<0.2 U	**1.1**	<0.2 U	<0.2 U	--	--	--	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	--	--	--	**0.3**	**13**	<0.1 U	**0.2**	--	--	--	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	--	--	--	**24**	**220**	**23**	**25**	--	--	--	--	--	--
Inorganics - Cyanide (mg/kg)																		
CYANIDE	0.0001	NA	NA	12	69	--	--	--	<0.14 U	<0.12 U	<0.15 U	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																		
AROCLOR-1242	NA	NA	NA	NA	23,000	**760 J**	<300 U	<150 U	<140 U	**360 J**	<150 U	<130 U	<150 U	<120 U	<260 U	<120 U	<110 U	<110 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<790 UJ	<300 U	<150 U	<140 U	<370 UJ	<150 U	<130 U	<150 U	<120 U	<260 U	<120 U	<110 U	<110 U
AROCLOR-1254	NA	NA	NA	NA	3,500	**890 J**	<300 U	<150 U	<140 U	**360 J**	<150 U	<130 U	<150 U	<120 U	<260 U	<120 U	<110 U	<110 U
AROCLOR-1262	NA	NA	NA	NA	NA	<420 UJ	<300 U	<150 U	<140 U	<120 UJ	<150 U	<130 U	<150 U	<120 U	<260 U	<120 U	<110 U	<110 U
TOTAL PCBS	59.8	59.8	676	1,000	NA	**1,650 J**	ND	ND	ND	**720 J**	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	**132**	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																		
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																		
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	<700 U	<620 U	<750 U	<660 U	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	<700 U	<620 U	<750 U	<660 U	--	--	--	--	--	--
DRO/ORO (ug/kg)																		
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

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[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.
EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

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Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	CHLL-SD23		CHLL-SD73				CHLL-SD74			CHLL-SD75		
Sample ID						CHLL-SD23-0"-6"	CHLL-SD-23-1'-1.5'	CHLL-SD-73 0'-6"	CHLL-SD-73 1'-3'	CHLL-SD-73 1'-3' DUP	CHLL-SD-73 3'-4.9'	CHLL-SD-74 0'-6"	CHLL-SD-74 1'-3'	CHLL-SD-74 3'-5'	CHLL-SD-75 0'-6"	CHLL-SD-75 1'-3'	CHLL-SD-75 3'-5'
Lab Sample ID						1407176-10	1407175-01	1506001-10	1506001-11	1506001-16	1506001-12	1506001-07	1506001-08	1506001-09	1506001-13	1506001-14	1506001-15
Sample Date						7/10/2014	7/10/2014	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015
Sample Type										Field Duplicate							
Inorganics - Metals (mg/kg)																	
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	**7,100**	--	--	--	**11,000**	--	--	**5,000**	--	--
ANTIMONY	NA	NA	NA	180	94	--	--	**13**	--	--	--	**7.5**	--	--	<0.3 U	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	--	--	**4.8**	--	--	--	**12**	--	--	**1.3**	--	--
BARIUM	NA	NA	NA	37,000	46,000	--	--	**2,300**	--	--	--	**570**	--	--	**17**	--	--
BERYLLIUM	NA	NA	NA	410	470	--	--	**0.8**	--	--	--	<2 U	--	--	**0.4**	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	**2.7**	--	--	--	**2.6**	--	--	<0.2 U	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	**19**	--	--	--	**30**	--	--	**12**	--	--
COBALT	50	NA	NA	2,600	70	--	--	**8.9**	--	--	--	**13**	--	--	**6.2**	--	--
COPPER	31.6	31.6	149	20,000	9,400	--	--	**3,800**	--	--	--	**4,000**	--	--	**480**	--	--
IRON	NA	NA	NA	160,000	160,000	--	--	**12,000**	--	--	--	**20,000**	--	--	**7,200**	--	--
LEAD	35.8	35.8	128	400	400	--	--	**1,900**	--	--	--	**1,100**	--	--	**8.2**	--	--
LITHIUM	NA	NA	NA	4,200	470	--	--	**6.8**	--	--	--	**10**	--	--	**3.4**	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	**6,000**	--	--	--	**8,600**	--	--	**4,900**	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	**190**	--	--	--	**320**	--	--	**150**	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	**0.1**	--	--	--	**0.2**	--	--	<0.06 U	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	**27**	--	--	--	**43**	--	--	**17**	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	**0.4**	--	--	--	<2 U	--	--	<0.2 U	--	--
SILVER	0.5	NA	NA	2,500	1,200	--	--	**13**	--	--	--	**7.8**	--	--	**1.7**	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	--	--	**290**	--	--	--	**440**	--	--	**40**	--	--
Inorganics - Cyanide (mg/kg)																	
CYANIDE	0.0001	NA	NA	12	69	--	--	<0.2 U	--	--	--	<0.23 U	--	--	<0.13 U	--	--
Organics - PCBs (ug/kg)																	
AROCLOR-1242	NA	NA	NA	NA	23,000	<320 U	<150 U	<400 UJ	<330 UJ	<320 UJ	<300 U	<450 UJ	<300 U	<260 U	<250 U	<110 U	<120 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<320 U	<150 U	<400 UJ	<330 UJ	<320 UJ	<300 U	<450 UJ	<300 U	<260 U	<250 U	<110 U	<120 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<320 U	<150 U	**180 J**	**250 J**	**230 J**	<300 U	**210 J**	<300 U	<260 U	<250 U	<110 U	<120 U
AROCLOR-1262	NA	NA	NA	NA	NA	<320 U	<150 U	<400 UJ	<330 UJ	<320 UJ	<300 U	**160 J**	<300 U	<260 U	<250 U	<110 U	<120 U
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	**180 J**	**250 J**	**230 J**	ND	**370 J**	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																	
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																	
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	**940 J**	**1,200**	--	--	<740 U	--	--	<230 U	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	**700 J**	**890**	--	--	<740 U	--	--	<230 U	--
DRO/ORO (ug/kg)																	
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

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EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

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Sample ID						CHLL-SD-76 0-6"	CHLL-SD-76 1'-3'	CHLL-SD-76 1'-3' DUP	CHLL-SD-76 3'-5'	CHLL-SD-77 0-6"	CHLL-SD-77 1'-3'	CHLL-SD-77 3'-5'	CHLL-SD-78 0-6"	CHLL-SD-78 1'-3'	CHLL-SD-78 3'-5'	CHLL-SD-79 0-6"	CHLL-SD-79 1'-3'	CHLL-SD-79 1'-3' DUP	CHLL-SD-79 3'-4.75'
Lab Sample ID						1506002-07	1506002-08	1506002-09	1506002-10	1506002-01	1506002-02	1506002-03	1506002-04	1506002-05	1506002-06	1506002-11	1506002-12	1506002-13	1506002-14
Sample Date						5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015	5/28/2015
Sample Type								Field Duplicate										Field Duplicate	
Inorganics - Metals (mg/kg)																			
ALUMINUM	NA	NA	NA	50,000	230,000	**7,400**	--	--	--	**6,600**	--	--	**12,000**	--	--	**17,000**	--	--	--
ANTIMONY	NA	NA	NA	180	94	<0.3 U	--	--	--	<0.3 U	--	--	**1.5**	--	--	**14**	--	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	**1.8**	--	--	--	**1.5**	--	--	**10**	--	--	**14**	--	--	--
BARIUM	NA	NA	NA	37,000	46,000	**20**	--	--	--	**32**	--	--	**77**	--	--	**1,000**	--	--	--
BERYLLIUM	NA	NA	NA	410	470	**0.7**	--	--	--	**0.7**	--	--	<2 U	--	--	**1.2**	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	<0.2 U	--	--	--	<0.2 U	--	--	**0.6**	--	--	**3.8**	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	**18**	--	--	--	**17**	--	--	**32**	--	--	**40**	--	--	--
COBALT	50	NA	NA	2,600	70	**9.4**	--	--	--	**9.3**	--	--	**17**	--	--	**21**	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	**490**	--	--	--	**490**	--	--	**1,900**	--	--	**11,000**	--	--	--
IRON	NA	NA	NA	160,000	160,000	**11,000**	--	--	--	**10,000**	--	--	**23,000**	--	--	**27,000**	--	--	--
LEAD	35.8	35.8	128	400	400	**16**	--	--	--	**3.7**	--	--	**330**	--	--	**2,800**	--	--	--
LITHIUM	NA	NA	NA	4,200	470	**5**	--	--	--	**4.7**	--	--	**7.5**	--	--	**15**	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	**7,900**	--	--	--	**7,800**	--	--	**12,000**	--	--	**16,000**	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	**240**	--	--	--	**230**	--	--	**410**	--	--	**480**	--	--	--
MERCURY	0.174	0.18	1.06	160	33	<0.06 U	--	--	--	<0.07 U	--	--	**0.1**	--	--	**0.2**	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	**25**	--	--	--	**24**	--	--	**46**	--	--	**53**	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	<0.2 U	--	--	--	<0.2 U	--	--	<2 U	--	--	**0.5**	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	**3**	--	--	--	**2.2**	--	--	**5.5**	--	--	**28**	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	**68**	--	--	--	**65**	--	--	**150**	--	--	**330**	--	--	--
Inorganics - Cyanide (mg/kg)																			
CYANIDE	0.0001	NA	NA	12	69	<0.13 U	--	--	--	<0.14 U	--	--	<0.18 U	--	--	<0.22 U	--	--	--
Organics - PCBs (ug/kg)																			
AROCLOR-1242	NA	NA	NA	NA	23,000	<130 U	<120 U	<120 U	<120 U	<140 U	<130 U	<280 UJ	<350 U	<290 U	<290 U	<440 UJ	<290 U	<300 U	<300 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<130 U	<120 U	<120 U	<120 U	<140 U	<130 U	<280 UJ	<350 U	<290 U	<290 U	<440 UJ	<290 U	<300 U	<300 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<130 U	<120 U	<120 U	<120 U	<140 U	<130 U	**88 J**	<350 U	<290 U	<290 U	**140 J**	<290 U	<300 U	<300 U
AROCLOR-1262	NA	NA	NA	NA	NA	<130 U	<120 U	<120 U	<120 U	<140 U	<130 U	<280 UJ	<350 U	<290 U	<290 U	<440 UJ	<290 U	<300 U	<300 U
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	ND	ND	ND	ND	**88 J**	ND	ND	ND	**140 J**	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																			
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																			
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	<230 U	<250 U	--	--	<260 U	--	--	<720 U	--	--	<740 U	<740 U	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	<230 U	<250 U	--	--	<260 U	--	--	<720 U	--	--	<740 U	<740 U	--
DRO/ORO (ug/kg)																			
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.

EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

TABLE 1
SUMMARY OF SEDIMENT ANALYTICAL RESULTS
THE LAKE LINDEN RECREATION AREA SEDIMENTS - RS SITE
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name						CHLL-SD80			CHLL-SD81			CHLL-SD82			CHLL-SD101		
Sample ID	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	CHLL-SD-80 0'-6"	CHLL-SD-80 1'-3'	CHLL-SD-80 3'-4.75'	CHLL-SD-81 0'-6"	CHLL-SD-81 1'-3'	CHLL-SD-81 3'-4'	CHLL-SD-82-0"-6"	CHLL-SD-82 1'-3'	CHLL-SD-82 3'-4.75'	CHLL-SD-101-0-6"	CHLL-SD-101-1-3'	CHLL-SD-101-3-4.75'
Lab Sample ID						1506001-01	1506001-02	1506001-03	1506001-04	1506001-05	1506001-06	1508147-01 1506002-15	1506002-16	1506002-17	1507172-08	1507172-09	1507172-10
Sample Date						5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/27/2015	5/28/2015	5/28/2015	5/28/2015	7/12/2015	7/12/2015	7/12/2015
Sample Type																	
Inorganics - Metals (mg/kg)																	
ALUMINUM	NA	NA	NA	50,000	230,000	**15,000**	--	--	**10,000**	--	--	**10,000**	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	**11**	--	--	**12**	--	--	**0.9**	--	--	--	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	**14**	--	--	**6.8**	--	--	**2.2**	--	--	--	--	--
BARIUM	NA	NA	NA	37,000	46,000	**660**	--	--	**800**	--	--	**160**	--	--	--	--	--
BERYLLIUM	NA	NA	NA	410	470	<2 U	--	--	**1.3**	--	--	**0.7**	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	**2.7**	--	--	**2.9**	--	--	**0.4**	--	--	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	**40**	--	--	**23**	--	--	**15**	--	--	--	--	--
COBALT	50	NA	NA	2,600	70	**19**	--	--	**13**	--	--	**7.4**	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	**6,700**	--	--	**9,900**	--	--	**110**	--	--	--	--	--
IRON	NA	NA	NA	160,000	160,000	**23,000**	--	--	**18,000**	--	--	**15,000**	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	**1,800**	--	--	**1,700**	--	--	**85**	--	--	--	--	--
LITHIUM	NA	NA	NA	4,200	470	**15**	--	--	**21**	--	--	**13**	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	**12,000**	--	--	**11,000**	--	--	**5,300**	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	**450**	--	--	**340**	--	--	**230**	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	**0.3**	--	--	**0.3**	--	--	<0.1 UJ	--	--	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	**51**	--	--	**33**	--	--	**18**	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	<2 U	--	--	**0.6**	--	--	**0.3**	--	--	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	**16**	--	--	**20**	--	--	**1.5**	--	--	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	**310**	--	--	**290**	--	--	**210**	--	--	--	--	--
Inorganics - Cyanide (mg/kg)																	
CYANIDE	0.0001	NA	NA	12	69	<0.27 U	--	--	<0.18 U	--	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																	
AROCLOR-1242	NA	NA	NA	NA	23,000	<550 UJ	<300 U	<300 U	<360 UJ	<290 U	<290 U	<430 U	<410 UJ	<120 U	<490 U	<300 U	<290 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<550 UJ	<300 U	<300 U	<360 UJ	<290 U	<290 U	<430 U	**400 J**	<120 U	<490 U	<300 U	<290 U
AROCLOR-1254	NA	NA	NA	NA	3,500	**210 J**	<300 U	<300 U	**130 J**	<290 U	<290 U	<430 U	**500 J**	<120 U	<490 U	<300 U	<290 U
AROCLOR-1262	NA	NA	NA	NA	NA	<550 UJ	<300 U	<300 U	<360 UJ	<290 U	<290 U	<430 U	<320 UJ	<120 U	<490 U	<300 U	<290 U
TOTAL PCBS	59.8	59.8	676	1,000	NA	**210 J**	ND	ND	**130 J**	ND	ND	ND	**900 J**	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																	
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																	
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	<750 U	--	--	<720 U	--	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	<750 U	--	--	<720 U	--	--	--	--	--	--	--
DRO/ORO (ug/kg)																	
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.

EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

TABLE 1
SUMMARY OF SEDIMENT ANALYTICAL RESULTS
THE LAKE LINDEN RECREATION AREA SEDIMENTS - RS SITE
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	CHLL-SD102			LLV-1		LLV-3		LLV-4		LLV-5		LLV-6	
Sample ID						CHLL-SD-102-0-6"	CHLL-SD-102-1-3'	CHLL-SD-102-3-5'	LLV-1A	LLV-1B	LLV-3A	LLV-3B	LLV-4A	LLV-4B	LLV-5A	LLV-5B	LLV-6A	LLV-6B
Lab Sample ID						1507172-05	1507172-06	1507172-07	07070929-001	07070929-002	07070929-005	07070929-006	07070929-007	07070929-008	07070929-009	07070929-010	07070929-011	07070929-012
Sample Date						7/12/2015	7/12/2015	7/12/2015	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007
Sample Type																		
Inorganics - Metals (mg/kg)																		
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	--	--	--	<2.5 UJ	**3.1**	<2.6 UJ	<2.6 UJ	<2.5 UJ	<2.4 UJ	<2.6 UJ	<2.4 UJ	<2.6 UJ	<2.3 UJ
ARSENIC	9.79	9.79	33.0	7.6	68	--	--	--	**2.6**	**2.1**	**6.5**	**7**	**1.5**	**1.7**	**1.7**	**1.4**	**2.4**	**2.3**
BARIUM	NA	NA	NA	37,000	46,000	--	--	--	**20**	**21**	**12**	**10**	**21**	**19**	**17**	**16**	**14**	**11**
BERYLLIUM	NA	NA	NA	410	470	--	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	--	--	--	--	--	--	--	--	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
COBALT	50	NA	NA	2,600	70	--	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	--	--	--	**1,900**	**7,100**	**810**	**1,200**	**770**	**1,500**	**6,400**	**1,300**	**2,600**	**3,900**
IRON	NA	NA	NA	160,000	160,000	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	**160**	--	--	**23**	**40**	**19**	**14**	**16**	**8.3**	**20**	**20**	**35**	**13**
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Cyanide (mg/kg)																		
CYANIDE	0.0001	NA	NA	12	69	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																		
AROCLOR-1242	NA	NA	NA	NA	23,000	<360 U	<310 U	<290 U	<100 U	<100 U	<110 U	<100 U	<100 U	<100 U	<110 U	<100 U	<100 U	<94 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<360 U	<310 U	<290 U	<100 U	<100 U	<110 U	<100 U	<100 U	<100 U	<110 U	<100 U	<100 U	<94 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<360 U	<310 U	<290 U	<100 U	<100 U	<110 U	<100 U	<100 U	<100 U	<110 U	<100 U	<100 U	<94 U
AROCLOR-1262	NA	NA	NA	NA	NA	<360 U	**920**	<290 U	--	--	--	--	--	--	--	--	--	--
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	**920**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																		
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																		
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	--	--	--	--	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	--	--	--	--	--	--	--	--	--	--
DRO/ORO (ug/kg)																		
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	**75,000**	**60,000**	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	**420,000**	**370,000**	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.
EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

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LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	LLV-7				LLV-8		LLV-9		LLV-10		LLV-11	
Sample ID						LLV-7A	LLV-7A DUP	LLV-7B	LLV-7B DUP	LLV-8A	LLV-8B	LLV-9A	LLV-9B	LLV-10A	LLV-10B	LLV-11A	LLV-11B
Lab Sample ID						07070929-013	07070929-016	07070929-014	07070929-015	07080010-001	07080010-002	07080010-003	07080010-004	07080010-007	07080010-008	07080010-009	07080010-010
Sample Date						7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007
Sample Type							Field Duplicate		Field Duplicate								
Inorganics - Metals (mg/kg)																	
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	<2.5 UJ	<2.4 UJ	<2.6 UJ	<2.4 UJ	<2.2 UJ	<2.3 UJ	<2.1 UJ	<2.4 UJ	<2.5 UJ	<2.3 UJ	<2.2 UJ	<2.4 UJ
ARSENIC	9.79	9.79	33.0	7.6	68	**3**	**3.1**	**1.8**	**1.6**	<1.1 UJ	<1.2 UJ	**1.6**	**1.6**	**2.2**	<1.2 UJ	**2.7**	**1.3**
BARIUM	NA	NA	NA	37,000	46,000	**16**	**14**	**11**	**9.3**	**7.2**	**7.4**	**11**	**12**	**14**	**8**	**43**	**41**
BERYLLIUM	NA	NA	NA	410	470	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	--	--	--	--	--	--	--	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	--	--	--	--	--	--	--	--	--	--
COBALT	50	NA	NA	2,600	70	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	**1,000**	**1,100**	**560**	**470**	**1,500**	**1,000**	**1,700**	**2,200**	**910**	**970**	**800**	**780**
IRON	NA	NA	NA	160,000	160,000	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	**27**	**25**	**22**	**18**	**11**	**14**	**59**	**36**	**74**	**18**	**79**	**16**
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	--	--	--	--	--	--	--	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	--	--	--	--	--	--	--	--	--	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Cyanide (mg/kg)																	
CYANIDE	0.0001	NA	NA	12	69	--	--	--	--	--	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																	
AROCLOR-1242	NA	NA	NA	NA	23,000	<100 U	<98 U	<110 U	<100 U	<95 U	<97 U	<92 U	<97 U	<100 U	<96 U	<92 U	<94 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<100 U	<98 U	<110 U	<100 U	<95 U	<97 U	<92 U	<97 U	<100 U	<96 U	<92 U	<94 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<100 U	<98 U	<110 U	<100 U	<95 U	<97 U	<92 U	<97 U	<100 U	<96 U	<92 U	<94 U
AROCLOR-1262	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																	
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																	
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	--	--	--	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	--	--	--	--	--	--	--	--	--
DRO/ORO (ug/kg)																	
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.
EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

TABLE 1
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THE LAKE LINDEN RECREATION AREA SEDIMENTS - RS SITE
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	LLV-13				LLV-14		LLV-15				LLV-16	
Sample ID						LLV-13A	LLV-13A DUP	LLV-13B	LLV-13B DUP	LLV-14A	LLV-14B	LLV-15A	LLV-15A DUP	LLV-15B	LLV-15B DUP	LLV-16A	LLV-16B
Lab Sample ID						07080010-011	07080010-013	07080010-012	07080010-014	07080011-001	07080011-002	07080011-003	07080011-005	07080011-004	07080011-006	07080011-007	07080011-008
Sample Date						7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007
Sample Type							Field Duplicate		Field Duplicate				Field Duplicate		Field Duplicate		
Inorganics - Metals (mg/kg)																	
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	<2.5 UJ	<2.6 UJ	<2.6 UJ	<2.6 UJ	<2.4 UJ	<2.3 UJ	<2.3 UJ	<2.3 UJ	<2.4 UJ	<2.4 UJ	<2.3 UJ	<2.5 UJ
ARSENIC	9.79	9.79	33.0	7.6	68	**1.7**	**1.7**	**3.2**	**2**	<1.2 UJ	**11**	<1.2 UJ	<1.2 UJ	**2.6**	**3.1**	<1.2 UJ	**1.6**
BARIUM	NA	NA	NA	37,000	46,000	**54**	**49**	**100**	**41**	**19**	**110**	**15**	**13**	**21**	**22**	**14**	**23**
BERYLLIUM	NA	NA	NA	410	470	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	--	--	--	--	--	--	--	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	--	--	--	--	--	--	--	--	--	--
COBALT	50	NA	NA	2,600	70	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	**300**	**440**	**1,100**	**300**	**72**	**1,500**	**130**	**130**	**590**	**550**	**160**	**380**
IRON	NA	NA	NA	160,000	160,000	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	**23**	**20**	**49**	**20**	**4.5**	**470**	**2.5**	**2.4**	**20**	**27**	**2.7**	**16**
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	--	--	--	--	--	--	--	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	--	--	--	--	--	--	--	--	--	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Cyanide (mg/kg)																	
CYANIDE	0.0001	NA	NA	12	69	--	--	--	--	--	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																	
AROCLOR-1242	NA	NA	NA	NA	23,000	<100 U	<110 U	<100 U	<110 U	<97 U	<100 U	<96 U	<94 U	<100 U	<99 U	<95 U	<96 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<100 U	<110 U	<100 U	<110 U	<97 U	<100 U	<96 U	<94 U	<100 U	<99 U	<95 U	<96 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<100 U	<110 U	<100 U	<110 U	<97 U	<100 U	<96 U	<94 U	<100 U	<99 U	<95 U	<96 U
AROCLOR-1262	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																	
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																	
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	--	--	--	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	--	--	--	--	--	--	--	--	--
DRO/ORO (ug/kg)																	
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.

EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

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LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	LLV-17		LLV-18		LLV-19		LLV-20		LLV-21		LLV-22			
Sample ID						LLV-17A	LLV-17B	LLV-18A	LLV-18B	LLV-19A	LLV-19B	LLV-20A	LLV-20B	LLV-21A	LLV-21B	LLV-22A	LLV-22A DUP	LLV-22B	LLV-22B DUP
Lab Sample ID						07080013-009	07080013-010	07080013-005	07080013-006	07080013-007	07080013-008	07080010-023	07080010-024	07080010-025	07080010-026	07080010-015	07080010-017	07080010-016	07080010-018
Sample Date						7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007	7/30/2007
Sample Type																	Field Duplicate		Field Duplicate
Inorganics - Metals (mg/kg)																			
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	<2.4 UJ	<2.5 UJ	<2.2 UJ	<2.4 UJ	<2.3 UJ	<2.7 UJ	<2.5 UJ	<2.4 UJ	<2.3 UJ	<2.5 UJ	<2.3 UJ	<2.4 UJ	<2.4 UJ	<2.3 UJ
ARSENIC	9.79	9.79	33.0	7.6	68	**2.2**	**2.2**	**2**	**1.2**	**2.8**	**2.1**	**3.9**	**1.5**	**10**	**5**	**2.3**	**1.9**	**1.7**	**1.6**
BARIUM	NA	NA	NA	37,000	46,000	**21**	**40**	**17**	**20**	**19**	**25**	**28**	**23**	**57**	**49**	**22**	**21**	**22**	**18**
BERYLLIUM	NA	NA	NA	410	470	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COBALT	50	NA	NA	2,600	70	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	**390**	**440**	**290**	**930**	**440**	**930**	**410**	**850**	**3,200**	**760**	**580**	**720**	**580**	**570**
IRON	NA	NA	NA	160,000	160,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	**10**	**49**	**9.4**	**13**	**4.7**	**39**	**9.7**	**4**	**10**	**9.6**	**8.5**	**3.9**	**2.5**	**2.2**
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SILVER	0.5	NA	NA	2,500	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Cyanide (mg/kg)																			
CYANIDE	0.0001	NA	NA	12	69	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																			
AROCLOR-1242	NA	NA	NA	NA	23,000	<100 U	<100 U	<87 U	<98 U	<95 U	<100 U	<100 U	<99 U	<100 U	<100 U	<99 U	<100 U	<95 U	<98 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<100 U	<100 U	<87 U	<98 U	<95 U	<100 U	<100 U	<99 U	<100 U	<100 U	<99 U	<100 U	<95 U	<98 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<100 U	<100 U	<87 U	<98 U	<95 U	<100 U	<100 U	<99 U	<100 U	<100 U	<99 U	<100 U	<95 U	<98 U
AROCLOR-1262	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																			
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																			
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DRO/ORO (ug/kg)																			
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

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EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

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Sample ID						LLV-23A	LLV-23B	LLV-24A	LLV-24B	LLV-MP3-01	LLV-MP4-01	LLV-MP5-01	LLV-MP6-01	LLV-MP7-01	LLV-MP8-01	SD-03	SD-03D	TL07-01 0-6	TL07-01 6-24
Lab Sample ID						07080010-027	07080010-028	07080010-029	07080010-030	07080254-003	07080254-004	07080254-005	07080254-006	07080254-007	07080254-008	C4208-16 350425918	C4208-17 350425919	AB02294	AB02295
Sample Date						7/30/2007	7/30/2007	7/30/2007	7/30/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	10/12/2011	10/12/2011	8/7/2007	8/7/2007
Sample Type																	Field Duplicate		
Inorganics - Metals (mg/kg)																			
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	--	--	--	--	--	--	--	**2,060**	**2,140**	--	--
ANTIMONY	NA	NA	NA	180	94	<2.6 UJ	<2.2 UJ	<2.5 UJ	<2.3 UJ	<4.7 UJ	<5.2 UJ	<4.8 UJ	<6.2 UJ	<5 UJ	<7.4 UJ	**0.27 J**	**0.34 J**	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	**5**	**1.6**	**4.6**	**2.1**	<2.3 UJ	<2.6 UJ	<2.4 UJ	<3.1 UJ	<2.5 UJ	**4.1**	<1 UJ	**1.4 J-**	**1**	**1.3**
BARIUM	NA	NA	NA	37,000	46,000	**66**	**27**	**80**	**23**	**29**	**25**	**170**	**120**	**32**	**150**	**20.7 J**	**26.5**	**22**	**52**
BERYLLIUM	NA	NA	NA	410	470	--	--	--	--	--	--	--	--	--	--	**0.28 J**	**0.33 J**	--	--
CADMIUM	0.99	0.99	4.98	550	210	--	--	--	--	--	--	--	--	--	--	**0.51 J**	**0.56**	<0.2 U	<0.2 U
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	**1,630**	**1,600**	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	--	--	--	--	--	--	--	--	--	--	**8.4**	**7.9**	**9.5**	**11**
COBALT	50	NA	NA	2,600	70	--	--	--	--	--	--	--	--	--	--	**3.2 J**	**2.8 J**	--	--
COPPER	31.6	31.6	149	20,000	9,400	**630**	**880**	**750**	**570**	**200**	**340**	**310**	**330**	**100**	**540**	**164**	**97.7**	**140**	**430**
IRON	NA	NA	NA	160,000	160,000	--	--	--	--	--	--	--	--	--	--	**8,430**	**9,320**	--	--
LEAD	35.8	35.8	128	400	400	**15**	**3**	**5.6**	**3.7**	**40**	**21**	**130**	**110**	**11**	**68**	**7.6**	**8.5**	**9.2**	**110**
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	**1,910**	**1,680**	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	--	--	--	--	--	--	--	**101**	**107**	--	--
MERCURY	0.174	0.18	1.06	160	33	--	--	--	--	--	--	--	--	--	--	<0.1 U	<0.1 U	<0.05 U	<0.05 U
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	--	--	--	--	--	--	--	**8.6**	**7.3**	--	--
SELENIUM	NA	NA	NA	2,600	1,200	--	--	--	--	--	--	--	--	--	--	<3.5 U	<3.5 U	<0.2 U	<0.2 U
SILVER	0.5	NA	NA	2,500	1,200	--	--	--	--	--	--	--	--	--	--	<1 U	<1 U	**0.22**	**1.3**
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	**313 J**	**145 J**	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	**15.6**	**18.4**	--	--
ZINC	121	121	459	170,000	70,000	--	--	--	--	--	--	--	--	--	--	**28.4**	**26**	**23**	**40**
Inorganics - Cyanide (mg/kg)																			
CYANIDE	0.0001	NA	NA	12	69	--	--	--	--	--	--	--	--	--	--	<0.5 UJ	<0.5 UJ	--	--
Organics - PCBs (ug/kg)																			
AROCLOR-1242	NA	NA	NA	NA	23,000	<100 U	<100 U	<110 U	<100 U	<100 U	<110 U	<100 U	<130 U	<110 U	<150 U	<48 U	<45 U	<130 U	<120 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<100 U	<100 U	<110 U	<100 U	<100 U	<110 U	<100 U	<130 U	<110 U	<150 U	<48 U	<45 U	<130 U	<120 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<100 U	<100 U	<110 U	<100 U	<100 U	<110 U	<100 U	<130 U	<110 U	<150 U	<48 U	<45 U	<130 U	<120 U
AROCLOR-1262	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	<48 U	<45 U	<130 U	<120 U
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																			
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																			
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	**130 J**	<170 U	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	--	--	--	--	--	--	--	<170 UJ	<170 UJ	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	--	--	--	--	--	--	--	<170 U	<170 UJ	--	--
DRO/ORO (ug/kg)																			
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.
EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

TABLE 1
SUMMARY OF SEDIMENT ANALYTICAL RESULTS
THE LAKE LINDEN RECREATION AREA SEDIMENTS - RS SITE
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	TL07-01		TL07-02			TL07-03			TL07-04			
Sample ID						TL07-01 24-43	TL07-01 43-64	TL07-02 0-28	TL07-02 28-48	TL07-02 48-64	TL07-03 0-21	TL07-03 21-41	TL07-03 41-70	TL07-04 0-6	TL07-04 6-26	TL07-04 36-60	TL07-04 60-95
Lab Sample ID						AB02296	AB02297	AB02298	AB02299	AB02300	AB02301	AB02302	AB02303	AB02304	AB02305	AB02306	AB02307
Sample Date						8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007	8/7/2007
Sample Type																	
Inorganics - Metals (mg/kg)																	
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	--	--	--	--	--	--	--	--	--	--	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	2.7	**49**	2.3	**38**	8.2	1.6	**55**	5.6	**26**	5.7	5.8	4.7
BARIUM	NA	NA	NA	37,000	46,000	220	**130,000**	310	**84,000**	4,100	150	**99,000**	620	12,000	410	88	71
BERYLLIUM	NA	NA	NA	410	470	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	0.33	85	0.27	38	3.6	<0.2 U	37	0.59	<0.2 U	0.6	<0.2 U	<0.2 U
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	15	200	13	130	38	8.7	120	44	51	45	44	44
COBALT	50	NA	NA	2,600	70	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	670	**120,000**	370	**78,000**	8,600	160	**120,000**	3,500	**28,000**	3,900	3,400	3,000
IRON	NA	NA	NA	160,000	160,000	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	150	**75,000**	100	**44,000**	**2,500**	19	**42,000**	300	**7,800**	400	39	23
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	0.09	1.5	<0.05 U	1.7	0.3	<0.05 U	2.6	0.12	0.6	0.13	0.07	0.07
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	0.27	20	0.27	18	2.6	<0.2 U	23	0.31	5	0.4	<0.2 U	<0.2 U
SILVER	0.5	NA	NA	2,500	1,200	1.2	450	0.87	290	39	0.31	380	9.3	80	11	6.1	5.4
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	80	6,800	54	3,500	430	38	4,100	140	1,000	180	110	110
Inorganics - Cyanide (mg/kg)																	
CYANIDE	0.0001	NA	NA	12	69	--	--	--	--	--	--	--	--	--	--	--	--
Organics - PCBs (ug/kg)																	
AROCLOR-1242	NA	NA	NA	NA	23,000	<170 U	**5,100**	<180 U	**3,000**	<140 U	<140 U	**3,200**	<130 U	**460**	<140 U	<140 U	<140 U
AROCLOR-1248	NA	NA	NA	NA	23,000	<170 U	<5200 U	<180 U	<3100 U	130	<140 U	<3200 U	<130 U	<470 UJ	<140 U	<140 U	<140 U
AROCLOR-1254	NA	NA	NA	NA	3,500	<170 U	**3,800**	<180 U	**2,800**	150	<140 U	**2,900**	<130 U	450	180	<140 U	<140 U
AROCLOR-1262	NA	NA	NA	NA	NA	<170 U	<1000 U	<180 U	<970 U	<140 U	<140 U	<1000 U	<130 U	<210 U	<140 U	<140 U	50
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	**8,900**	ND	**5,800**	280	ND	**6,100**	ND	910	180	ND	50
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--	--	--	--	--	--	--
Organics - VOCs (ug/kg)																	
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)																	
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	--	--	--	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	--	--	--	--	--	--	--	--	--
DRO/ORO (ug/kg)																	
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.
EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

TABLE 1
SUMMARY OF SEDIMENT ANALYTICAL RESULTS
THE LAKE LINDEN RECREATION AREA SEDIMENTS - RS SITE
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	EPA Region 5 Ecological Screening Level (ESL)[a]	Threshold Effect Concentration (TEC)[b]	Probable Effect Concentration (PEC)[b]	MDEQ Part 201 Residential Direct Contact Criteria (RDCC) for Soil[c]	EPA Residential Regional Removal Management Level (RML) for Soil[d]	TL07-13					TL08-080
Sample ID						TL07-13 0-6	TL07-13 6-26	TL07-13 26-40	TL07-13 40-66	TL07-13 40-66 D	TL08-080
Lab Sample ID						AB02335	AB02336	AB02337	AB02338	AB02339	E44P6
Sample Date						8/8/2007	8/8/2007	8/8/2007	8/8/2007	8/8/2007	8/28/2008
Sample Type										Field Duplicate	
Inorganics - Metals (mg/kg)											
ALUMINUM	NA	NA	NA	50,000	230,000	--	--	--	--	--	--
ANTIMONY	NA	NA	NA	180	94	--	--	--	--	--	--
ARSENIC	9.79	9.79	33.0	7.6	68	**7.5**	**8.7**	**18**	**3.8**	**2.6**	--
BARIUM	NA	NA	NA	37,000	46,000	**15**	**19**	**21**	**17**	**15**	--
BERYLLIUM	NA	NA	NA	410	470	--	--	--	--	--	--
CADMIUM	0.99	0.99	4.98	550	210	<0.2 U	**0.22**	**0.27**	<0.2 U	<0.2 U	--
CALCIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--
CHROMIUM	43.4	43.4	111	790,000	NA	**28**	**27**	**32**	**20**	**18**	--
COBALT	50	NA	NA	2,600	70	--	--	--	--	--	--
COPPER	31.6	31.6	149	20,000	9,400	**800**	**1,300**	**2,400**	**7,100**	**5,800**	--
IRON	NA	NA	NA	160,000	160,000	--	--	--	--	--	--
LEAD	35.8	35.8	128	400	400	**34**	**70**	**72**	**10**	**7.8**	--
LITHIUM	NA	NA	NA	4,200	470	--	--	--	--	--	--
MAGNESIUM	NA	NA	NA	1,000,000	NM	--	--	--	--	--	--
MANGANESE	NA	NA	NA	25,000	5,500	--	--	--	--	--	--
MERCURY	0.174	0.18	1.06	160	33	<0.05 U	**0.09**	**0.12**	**0.07**	<0.05 U	--
NICKEL	22.7	22.7	48.6	40,000	4,600	--	--	--	--	--	--
SELENIUM	NA	NA	NA	2,600	1,200	<0.2 U	<0.2 U	<0.2 U	<0.2 U	**0.21**	--
SILVER	0.5	NA	NA	2,500	1,200	**3.3**	**4**	**8.1**	**8**	**6.9**	--
SODIUM	NA	NA	NA	NA	NA	--	--	--	--	--	--
VANADIUM	NA	NA	NA	750	1,200	--	--	--	--	--	--
ZINC	121	121	459	170,000	70,000	**98**	**120**	**120**	**78**	**65**	--
Inorganics - Cyanide (mg/kg)											
CYANIDE	0.0001	NA	NA	12	69	--	--	--	--	--	--
Organics - PCBs (ug/kg)											
AROCLOR-1242	NA	NA	NA	NA	23,000	<130 U	<130 U	<130 U	<130 U	<130 U	
AROCLOR-1248	NA	NA	NA	NA	23,000	<130 U	<130 U	<130 U	<130 U	<130 U	
AROCLOR-1254	NA	NA	NA	NA	3,500	<130 U	<130 U	<130 U	<130 U	<130 U	
AROCLOR-1262	NA	NA	NA	NA	NA	<130 U	<130 U	<130 U	<130 U	<130 U	
TOTAL PCBS	59.8	59.8	676	1,000	NA	ND	ND	ND	ND	ND	ND
TOTAL PCB CONGENERS	NA	NA	NA	1,000	NA	--	--	--	--	--	--
Organics - VOCs (ug/kg)											
VOCs (all)	--	--	--	--	--	--	--	--	--	--	--
Organics - SVOCs (ug/kg)											
ACETOPHENONE	NA	NA	NA	47,000,000	23,000,000	--	--	--	--	--	--
FLUORANTHENE	423	423	2,230	46,000,000	7,200,000	--	--	--	--	--	--
PYRENE	195	195	1,520	29,000,000	5,400,000	--	--	--	--	--	--
DRO/ORO (ug/kg)											
Diesel Range Organics (C10-C20)	NA	NA	NA	NA	NA	--	--	--	--	--	--
Oil Range Organics (C20-C34)	NA	NA	NA	NA	NA	--	--	--	--	--	--

Note: Only detected analytes are shown

[a] EPA Region 5 Ecological Screening Levels (ESLs) dated August 2003.

[b] Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), from MacDonald, et al, 2000

[c] MDEQ Part 201 Residential Direct Contact Cleanup Criteria (RDCC) for Response Activity dated December 30, 2013

[d] EPA Removal Management Levels for Chemicals (RMLs), dated May 2016.

EPA RML using 10-4 risk level for carcinogens or a Hazard Quotient (HQ) of 3 for non-carcinogens

Bold values indicated detected concentrations

- Shaded values exceed the EPA RML

- Bold borders indicate values exceed MDEQ Part 201 Residential Direct Contact Criteria for Soil

-- = Not analyzed

J = estimated result

mg/kg = milligrams per kilogram

NA = criteria is not available

U = not detected above the reported sample reporting limit

ug/kg = micrograms per kilograms

TABLE 2
SUMMARY OF SURFACE WATER AND SPMD ANALYTICAL RESULTS
THE LAKE LINDEN RECREATION AREA SEDIMENTS - RS SITE
LAKE LINDEN, HOUGHTON COUNTY, MICHIGAN

Station Name	CASNumber	EPA Region 5 Ecological Screening Level (ESL)[a]	MDEQ Rule 57 Values[b]			CHLL-SW01	CHLL-SW02	CHLL-SW03	CHLL-SW04	LLV-Beach1	LLV-Creek1	SPMD Site #3	SW-03	
Field Sample ID			Human Cancer Value (HCV) Drinking Water Source	Human Non-Cancer Value (HNV) Drinking Water Source	Wildlife Value (WV)	CHLL-SW01- 6.7-7.7'	CHLL-SW02-12.5-13.5'	CHLL-SW03-18.4-19.4'	CHLL-SW04-11.5-12.5'	LLV Beach 1	LLV Creek 1	SPMD Site #3	SW-03	SW-03D
Sample Date						5/27/2015	5/27/2015	5/28/2015	5/28/2015	7/26/2007	7/26/2007	11/18/2005	10/12/2011	10/12/2011
Sample Interval						6.7 - 7.7 ft	12.5 - 13.5 ft	18.4 - 19.4 ft	11.5 - 12.5 ft	0 - 0 ft	0 - 0 ft	3 - 3 ft	0 - 6 in	0 - 6 in
Inorganics - Metals (ug/l)														**Field Duplicate**
ALUMINUM	7429-90-5	NA	NA	NA	NA	--	--	--	--	**3100**	**3900**	--	**16.7 J**	**22.6 J**
ANTIMONY	7440-36-0	80	NA	1.7	NA	--	--	--	--	<2 U	**3.0**	--	<60 U	<60 U
ARSENIC	7440-38-2	148	10	10	NA	--	--	--	--	**9.0**	**20**	--	<10 U	<10 U
BARIUM	7440-39-3	220	NA	1,900	NA	--	--	--	--	**270**	**530**	--	**44.1 J**	**39.6 J**
CADMIUM	7440-43-9	0.15	NA	2.5	NA	--	--	--	--	<1 U	**1.2**	--	<5 U	<5 U
CALCIUM	7440-70-2	NA	NA	NA	NA	--	--	--	--	**57000**	**33000**	--	**17300**	**16900**
CHROMIUM	7440-47-3	42	NA	120	NA	--	--	--	--	<10 U	**14**	--	**1.1 J**	<10 U
COPPER	7440-50-8	1.58	NA	470	na	--	--	--	--	**240**	**990**	--	**19.6 J**	**28.2**
IRON	7439-89-6	NA	NA	NA	NA	--	--	--	--	**2800**	**14000**	--	<100 U	**110**
LEAD	7439-92-1	1.17	NA	14	NA	--	--	--	--	**44**	**550**	--	**1.5 J**	<10 U
MAGNESIUM	7439-95-4	NA	NA	NA	NA	--	--	--	--	**5000**	**7000**	--	**1220 J**	**2330 J**
MANGANESE	7439-96-5	NA	NA	1,300	NA	--	--	--	--	**180**	**720**	--	**5.5 J**	**11.5 J**
NICKEL	7440-02-0	28.9	NA	2,600	NA	--	--	--	--	<20 U	<20 U	--	**1.8 J**	**1.3 J**
POTASSIUM	7440-09-7	NA	NA	NA	NA	--	--	--	--	**1600**	**3800**	--	<5000 U	<5000 U
SILVER	7440-22-4	0.12	NA	130	NA	--	--	--	--	**0.88**	**4.6**	--	<10 U	<10 U
SODIUM	7440-23-5	NA	NA	NA	NA	--	--	--	--	**7700**	**14000**	--	**3610000**	**1700000**
VANADIUM	7440-62-2	12	NA	53	NA	--	--	--	--	**7.0**	**20**	--	<50 U	<50 U
ZINC	7440-66-6	65.7	NA	3,300	NA	--	--	--	--	<50 U	**110**	--	<60 U	<60 U
Inorganics - Cyanide (ug/l)														
CYANIDE	57-12-5	5.2	NA	600	NA	--	--	--	--	<5 U	<5 U	--	**20.7 J**	<10 UJ
Organics - PCBs (ug/l)														
TOTAL PCBS (congeners)	TPCB	0.00012	0.000026	NLS	0.00012	ND	ND	ND	ND	<0.2 U	<0.2 U	**74**	<1 U	<1 U
Organics - SVOCs (ug/l)														
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	0.3	25	120	NA	--	--	--	--	<5.0 U	<5.0 U	--	<5 U	**3.6 J**
Organics - VOCs (ug/l)														
1,4-DICHLOROBENZENE	106-46-7	9.4	24	1,100	NA	--	--	--	--	<5.0 U	<5.0 U	--	**0.12 J**	<5 U

Surface Water Table Footnotes:

[a] EPA Region 5 Ecological Screening Levels (ESLs) from August 2003.

[b] MDEQ Rule 57 values derived from the Michigan Department of Environmental Quality, Water Bureau, Water Resources Protection, filed with the Secretary of State on January 13, 2006. Part 4 Water Quality Standards, Rule 323.1057 Toxic Substances, as amended. Updated on February 27, 2014.

- Only detected analytes are listed
- **Bold** values are concentrations detected above the reporting limit.
- **Shaded values exceed the EPA Region 5 Ecological Screening Level**
- **Bold borders** indicate values exceed one or more MDEQ Rule 57 values
- SPMD results are not compared to surface water criteria.

-- = Not analyzed/Not reported
EPA = United States Environmental Protection Agency
ESL = Ecological Screening Level
ft = feet
in = Inches
MDEQ = Michigan Department of Environmental Quality
PCBs = Polychlorindated biphenyls
RCRA = Resource Conservation and Recovery Act
SPMD = Semi-permeable membrane device
SVOC = Semi-volatile organic compound
ug/l = Micrograms per liter
VOC = Volatile organic compound

Criteria Footnotes:

NA = a criterion or value is not available
NLS = no literature search has been conducted

Laboratory Footnotes:

J = estimated result
ND = not detected
U = analyte analyzed for but not detected above the reported sample reporting limit.

APPENDIX A

FIGURES

Base Map Source: ESRI USA Topo Maps map service

EPA Contract No.: EP-S5-13-01

TDD No.: 0001/S05-0001-1701-010

Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 1

Site Location

TETRA TECH

Prepared For: USEPA

Prepared By: KRB - MSG

File Path: C:\temp\Projects\T1130057\mxds\Fig01_Site_Location_v20170207.mxd

Date Saved: 2/8/2017

Coordinate System: NAD_1983_StatePlane_Michigan_North_FIPS_2111_Feet_Intl

Legend

Mining Era Buildings and Structures

Source of Aerial Photograph: MIS - Public Imagery and ESRI World Imagery (NAIP 2014)

EPA Contract No.: EP-S5-13-01

TDD No.: 0001/S05-0001-1701-010

N

0 450 900

Feet

Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 2

Site Layout

TETRA TECH

Prepared For: USEPA

Prepared By: KRB - MSG

Coordinate System: NAD_1983_StatePlane_Michigan_North_FIPS_2111_Feet_Intl

File Path: C:\temp\Projects\T113057\mxds\Fig02_Site_Layout_v.20170227.mxd

Date Saved: 2/27/2017

C&H Flotation Plant

Lake Linden Village Park

Lake Linden Beach

C&H Leaching Plant

Area 1
Extent of EPA's 2007 Emergency Response Removal to address lead and PCB contaminated soil and sediment

C&H Regrinding Plant No. 2

Sub-Station

C&H Regrinding Plant No. 1

Area 2
Extent of EPA's 2007 Emergency Response Removal to address arsenic contaminated soil and sediment

0 200 Feet

VILLAGE OF LAKE LINDEN

C&H Flotation Plant

Capped Stampsands

Campground

Calumet Stamp Mill

Still House

Assay Laboratory

Marina

C&H Power Plant

Hecla Stamp Mill

C&H Boiler House

Coal Dock Sub-Station

Mineral House

C&H Smelting & Refining

Electric Shop

C&H Smelter Power Plant

Electrolytic Plant

Acid Treating Plant

HUBBELL

Legend

2007 EPA Excavation Extent

Mining Era Buildings and Structures

Source of Aerial Photograph: MIS - Public Imagery

EPA Contract No.: EP-S5-13-01

TDD No.: 0001/S05-0001-1701-010

N

0 450 900

Feet

Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 3

2007 EPA Removal

TETRA TECH

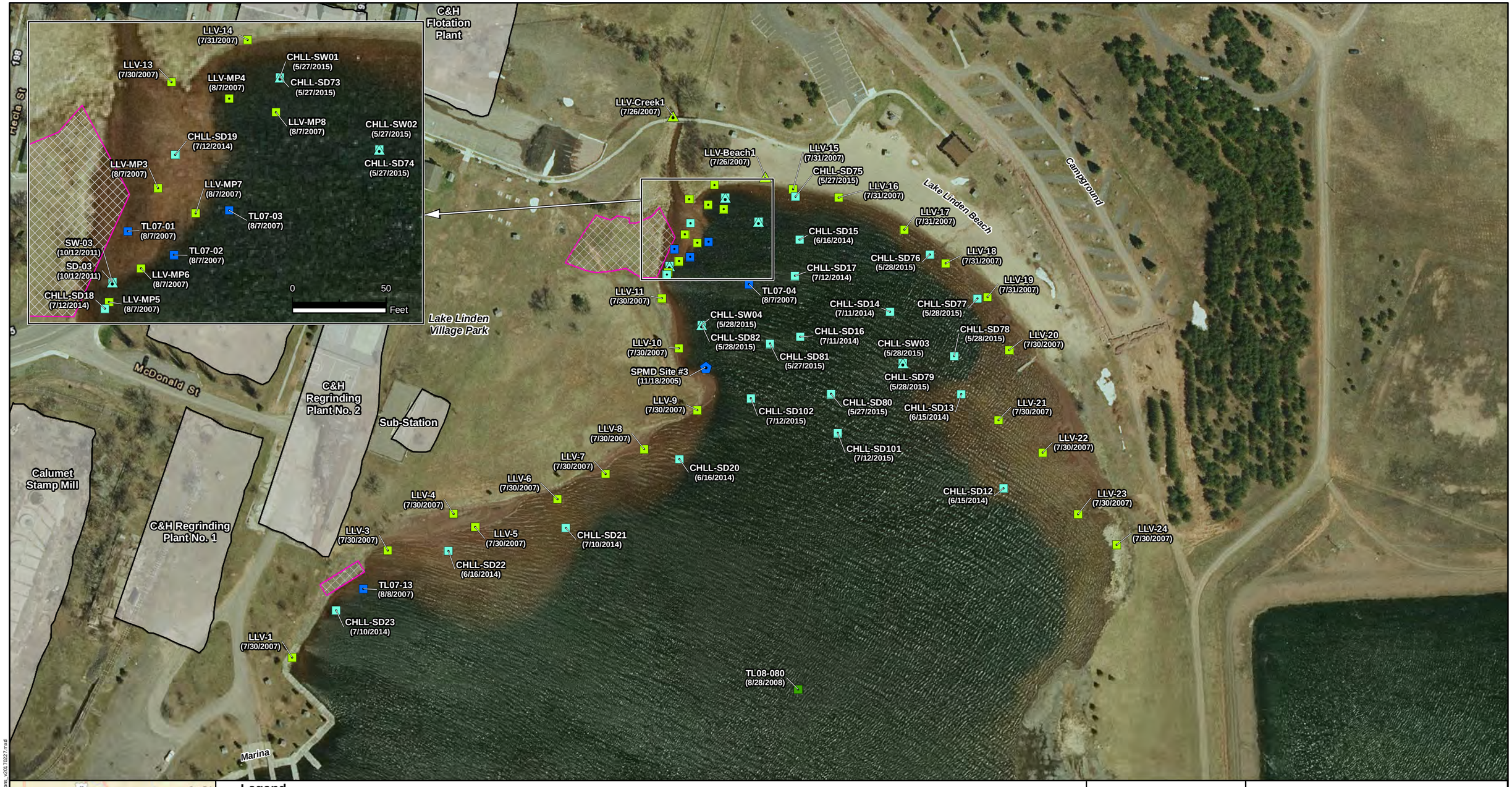
Prepared For: USEPA

Prepared By: KRB - MSG

Coordinate System: NAD_1983_StatePlane_Michigan_North_FIPS_2111_Feet_Intl

File Path: C:\temp\Projects\T113005.7\mxds\Fig03_2007_EPA_Removal_v2017b227.mxd

Date Saved: 2/27/2017



Legend

Sample Type / Source

- Surface Water (MDEQ - RRD)
- Surface Water (USEPA)
- SPMD (MDEQ - Water Bureau)
- Sediment (MDEQ - RRD)
- Sediment (MDEQ - Water Bureau)
- Sediment (USEPA)
- Sediment (USEPA - GLNPO)
- Mining Era Buildings and Structures
- 2007 EPA Excavation Extent

Source of Aerial Photograph: MIS - Public Imagery

EPA Contract No.: EP-S5-13-01

TDD No.: 0001/S05-0001-1701-010

N

0 75 150

Feet

Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 4

Sample Locations

TETRA TECH

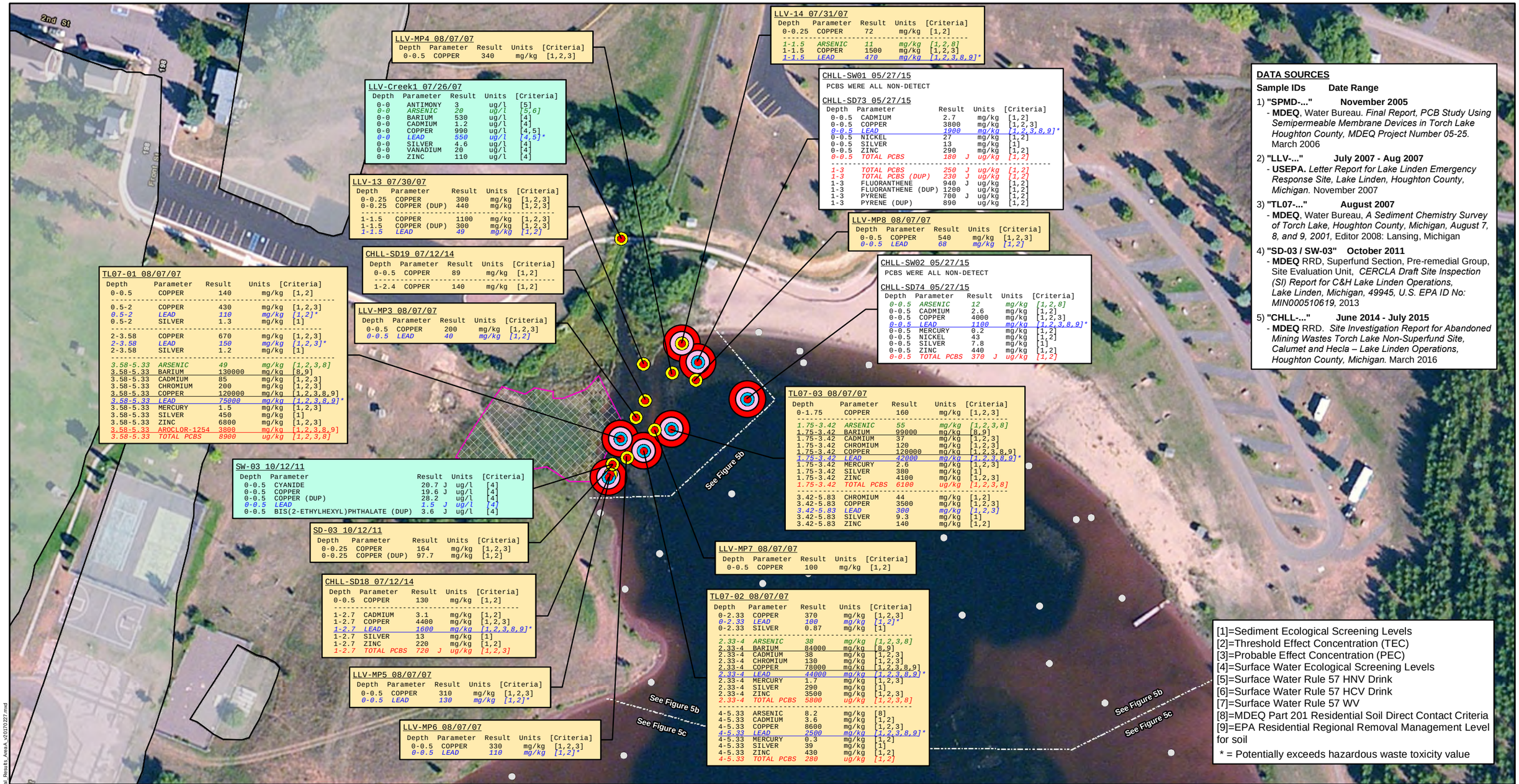
Prepared For: USEPA

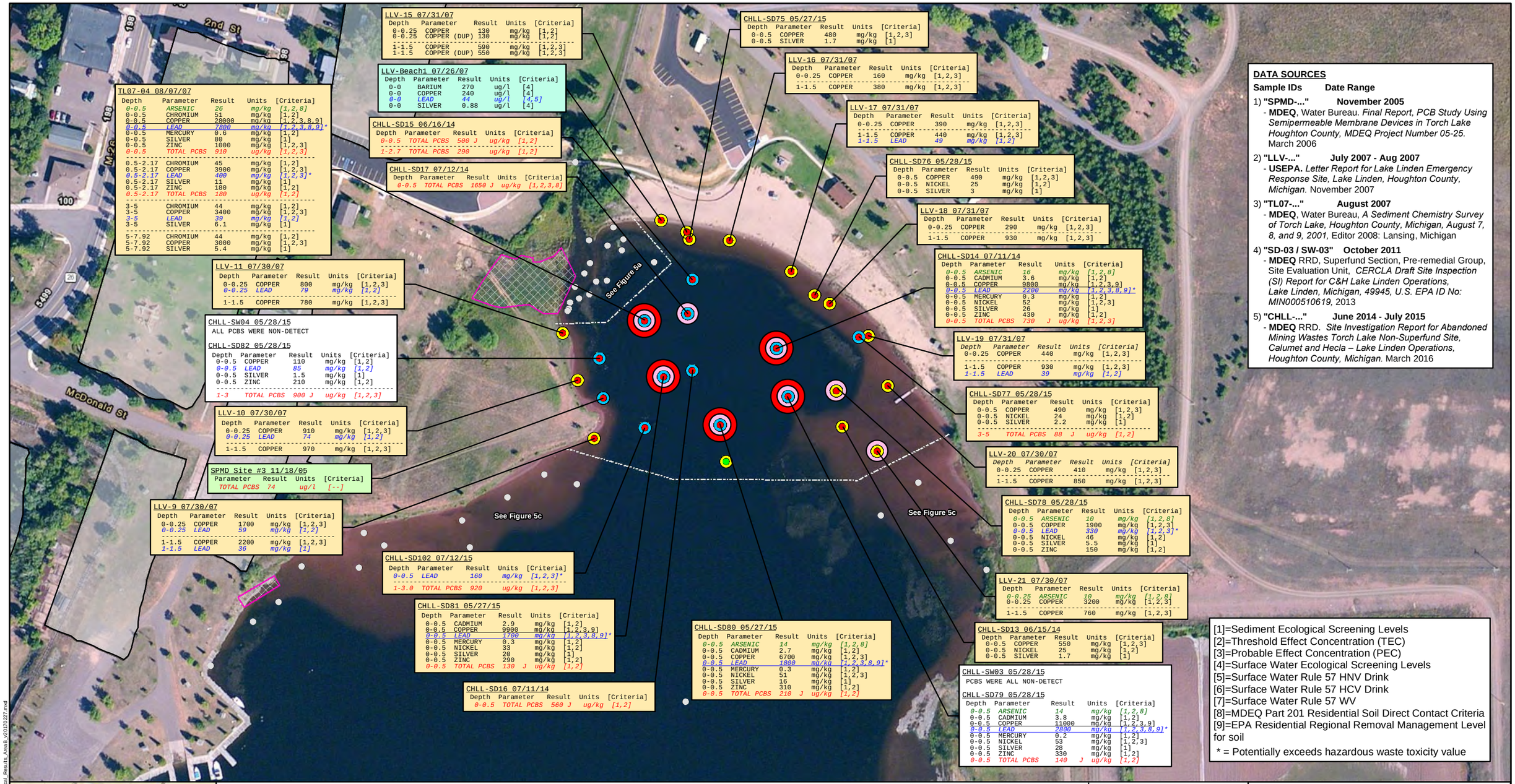
Prepared By: KRB - MSG

File Path: C:\temp\Projects\T113005.7mxds\Fig04_Sample_Locations_v20170227.mxd

Date Saved: 2/27/2017

Coordinate System: NAD_1983_StatePlane_Michigan_North_FIPS_2111_Feet_Intl


2nd St
Front St
LLV-MP4 08/07/07
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 340 mg/kg [1,2,3]
LLV-Creek1 07/26/07
Depth Parameter Result Units [Criteria]
0-0 ANTIMONY 3 ug/l [5]
0-0 ARSENIC 20 ug/l [5,6]
0-0 BARIUM 530 ug/l [4]
0-0 CADMIUM 1.2 ug/l [4]
0-0 COPPER 990 ug/l [4,5]
0-0 LEAD 550 ug/l [4,5]*
0-0 SILVER 4.6 ug/l [4]
0-0 VANADIUM 20 ug/l [4]
0-0 ZINC 110 ug/l [4]
LLV-13 07/30/07
Depth Parameter Result Units [Criteria]
0-0.25 COPPER 300 mg/kg [1,2,3]
0-0.25 COPPER (DUP) 440 mg/kg [1,2,3]
1-1.5 COPPER 1100 mg/kg [1,2,3]
1-1.5 COPPER (DUP) 300 mg/kg [1,2,3]
1-1.5 LEAD 49 mg/kg [1,2]
CHLL-SD19 07/12/14
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 89 mg/kg [1,2]
1-2.4 COPPER 140 mg/kg [1,2]
LLV-MP3 08/07/07
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 200 mg/kg [1,2,3]
0-0.5 LEAD 40 mg/kg [1,2]
TL07-01 08/07/07
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 140 mg/kg [1,2]
0.5-2 COPPER 430 mg/kg [1,2,3]
0.5-2 LEAD 110 mg/kg [1,2]*
0.5-2 SILVER 1.3 mg/kg [1]
2-3.58 COPPER 670 mg/kg [1,2,3]
2-3.58 LEAD 150 mg/kg [1,2,3]*
2-3.58 SILVER 1.2 mg/kg [1]
3.58-5.33 ARSENIC 49 mg/kg [1,2,3,8]
3.58-5.33 BARIUM 130000 mg/kg [8,9]
3.58-5.33 CADMIUM 85 mg/kg [1,2,3]
3.58-5.33 CHROMIUM 200 mg/kg [1,2,3]
3.58-5.33 COPPER 120000 mg/kg [1,2,3,8,9]
3.58-5.33 LEAD 75000 mg/kg [1,2,3,8,9]*
3.58-5.33 MERCURY 1.5 mg/kg [1,2,3]
3.58-5.33 SILVER 450 mg/kg [1]
3.58-5.33 ZINC 6800 mg/kg [1,2,3]
3.58-5.33 AROCLOR-1254 3800 mg/kg [1,2,3,8,9]
3.58-5.33 TOTAL PCBS 8900 ug/kg [1,2,3,8]
SW-03 10/12/11
Depth Parameter Result Units [Criteria]
0-0.5 CYANIDE 20.7 J ug/l [4]
0-0.5 COPPER 19.6 J ug/l [4]
0-0.5 COPPER (DUP) 28.2 ug/l [4]
0-0.5 LEAD 1.5 J ug/l [4]
0-0.5 BIS(2-ETHYLHEXYL)PHTHALATE (DUP) 3.6 J ug/l [4]
SD-03 10/12/11
Depth Parameter Result Units [Criteria]
0-0.25 COPPER 164 mg/kg [1,2,3]
0-0.25 COPPER (DUP) 97.7 mg/kg [1,2]
CHLL-SD18 07/12/14
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 130 mg/kg [1,2]
1-2.7 CADMIUM 3.1 mg/kg [1,2]
1-2.7 COPPER 4400 mg/kg [1,2,3]
1-2.7 LEAD 1600 mg/kg [1,2,3,8,9]*
1-2.7 SILVER 13 mg/kg [1]
1-2.7 ZINC 220 mg/kg [1,2]
1-2.7 TOTAL PCBS 720 J ug/kg [1,2,3]
LLV-MP5 08/07/07
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 310 mg/kg [1,2,3]
0-0.5 LEAD 130 mg/kg [1,2]*
LLV-MP6 08/07/07
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 330 mg/kg [1,2,3]
0-0.5 LEAD 110 mg/kg [1,2]*
LLV-14 07/31/07
Depth Parameter Result Units [Criteria]
0-0.25 COPPER 72 mg/kg [1,2]
1-1.5 ARSENIC 11 mg/kg [1,2,8]
1-1.5 COPPER 1500 mg/kg [1,2,3]
1-1.5 LEAD 470 mg/kg [1,2,3,8,9]*
CHLL-SW01 05/27/15
PCBS WERE ALL NON-DETECT
CHLL-SD73 05/27/15
Depth Parameter Result Units [Criteria]
0-0.5 CADMIUM 2.7 mg/kg [1,2]
0-0.5 COPPER 3800 mg/kg [1,2,3]
0-0.5 LEAD 1900 mg/kg [1,2,3,8,9]*
0-0.5 NICKEL 27 mg/kg [1,2]
0-0.5 SILVER 13 mg/kg [1]
0-0.5 ZINC 290 mg/kg [1,2]
0-0.5 TOTAL PCBS 180 J ug/kg [1,2]
1-3 TOTAL PCBS 250 J ug/kg [1,2]
1-3 TOTAL PCBS (DUP) 230 J ug/kg [1,2]
1-3 FLUORANTHENE 940 J ug/kg [1,2]
1-3 FLUORANTHENE (DUP) 1200 ug/kg [1,2]
1-3 PYRENE 700 J ug/kg [1,2]
1-3 PYRENE (DUP) 890 ug/kg [1,2]
LLV-MP8 08/07/07
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 540 mg/kg [1,2,3]
0-0.5 LEAD 68 mg/kg [1,2]
CHLL-SW02 05/27/15
PCBS WERE ALL NON-DETECT
CHLL-SD74 05/27/15
Depth Parameter Result Units [Criteria]
0-0.5 ARSENIC 12 mg/kg [1,2,8]
0-0.5 CADMIUM 2.6 mg/kg [1,2]
0-0.5 COPPER 4000 mg/kg [1,2,3]
0-0.5 LEAD 1100 mg/kg [1,2,3,8,9]*
0-0.5 MERCURY 0.2 mg/kg [1,2]
0-0.5 NICKEL 43 mg/kg [1,2]
0-0.5 SILVER 7.8 mg/kg [1]
0-0.5 ZINC 440 mg/kg [1,2]
0-0.5 TOTAL PCBS 370 J ug/kg [1,2]
TL07-03 08/07/07
Depth Parameter Result Units [Criteria]
0-1.75 COPPER 160 mg/kg [1,2,3]
1.75-3.42 ARSENIC 55 mg/kg [1,2,3,8]
1.75-3.42 BARIUM 99000 mg/kg [8,9]
1.75-3.42 CADMIUM 37 mg/kg [1,2,3]
1.75-3.42 CHROMIUM 120 mg/kg [1,2,3]
1.75-3.42 COPPER 120000 mg/kg [1,2,3,8,9]
1.75-3.42 LEAD 42000 mg/kg [1,2,3,8,9]*
1.75-3.42 MERCURY 2.6 mg/kg [1,2,3]
1.75-3.42 SILVER 380 mg/kg [1]
1.75-3.42 ZINC 4100 mg/kg [1,2,3]
1.75-3.42 TOTAL PCBS 6100 ug/kg [1,2,3,8]
3.42-5.83 CHROMIUM 44 mg/kg [1,2]
3.42-5.83 COPPER 3500 mg/kg [1,2,3]
3.42-5.83 LEAD 300 mg/kg [1,2,3]
3.42-5.83 SILVER 9.3 mg/kg [1]
3.42-5.83 ZINC 140 mg/kg [1,2]
LLV-MP7 08/07/07
Depth Parameter Result Units [Criteria]
0-0.5 COPPER 100 mg/kg [1,2]
TL07-02 08/07/07
Depth Parameter Result Units [Criteria]
0-2.33 COPPER 370 mg/kg [1,2,3]
0-2.33 LEAD 100 mg/kg [1,2]*
0-2.33 SILVER 0.87 mg/kg [1]
2.33-4 ARSENIC 38 mg/kg [1,2,3,8]
2.33-4 BARIUM 84000 mg/kg [8,9]
2.33-4 CADMIUM 38 mg/kg [1,2,3]
2.33-4 CHROMIUM 130 mg/kg [1,2,3]
2.33-4 COPPER 78000 mg/kg [1,2,3,8,9]
2.33-4 LEAD 44000 mg/kg [1,2,3,8,9]*
2.33-4 MERCURY 1.7 mg/kg [1,2,3]
2.33-4 SILVER 290 mg/kg [1]
2.33-4 ZINC 3500 mg/kg [1,2,3]
2.33-4 TOTAL PCBS 5800 ug/kg [1,2,3,8]
4-5.33 ARSENIC 8.2 mg/kg [8]
4-5.33 CADMIUM 3.6 mg/kg [1,2]
4-5.33 COPPER 8600 mg/kg [1,2,3]
4-5.33 LEAD 2500 mg/kg [1,2,3,8,9]*
4-5.33 MERCURY 0.3 mg/kg [1,2]
4-5.33 SILVER 39 mg/kg [1]
4-5.33 ZINC 430 mg/kg [1,2]
4-5.33 TOTAL PCBS 280 ug/kg [1,2]
See Figure 5b
See Figure 5c
See Figure 5b
See Figure 5c
DATA SOURCES
Sample IDs Date Range
1) "SPMD-..." November 2005
- MDEQ, Water Bureau. Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake Houghton County, MDEQ Project Number 05-25. March 2006
2) "LLV-..." July 2007 - Aug 2007
- USEPA. Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan. November 2007
3) "TL07-..." August 2007
- MDEQ, Water Bureau, A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2001, Editor 2008: Lansing, Michigan
4) "SD-03 / SW-03" October 2011
- MDEQ RRD, Superfund Section, Pre-remedial Group, Site Evaluation Unit, CERCLA Draft Site Inspection (SI) Report for C&H Lake Linden Operations, Lake Linden, Michigan, 49945, U.S. EPA ID No: MIN000510619, 2013
5) "CHLL-..." June 2014 - July 2015
- MDEQ RRD. Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan. March 2016
[1]=Sediment Ecological Screening Levels
[2]=Threshold Effect Concentration (TEC)
[3]=Probable Effect Concentration (PEC)
[4]=Surface Water Ecological Screening Levels
[5]=Surface Water Rule 57 HNV Drink
[6]=Surface Water Rule 57 HCV Drink
[7]=Surface Water Rule 57 WV
[8]=MDEQ Part 201 Residential Soil Direct Contact Criteria
[9]=EPA Residential Regional Removal Management Level for soil
* = Potentially exceeds hazardous waste toxicity value
Lake Linden
Map Extent
Schoolcraft Twp
Hubbell
Torch Lake
Legend
Sampling locations with at least one exceedance
Sampling locations with no exceedances
Locations are included on a different figure
Locations Analyzed for PCBs
No Detections
At Least One Detection
Mining Era Buildings and Structures
Sediment Exceeds MDEQ Part 201 Residential Soil Direct Contact Criteria
Sediment Exceeds EPA Residential Regional Removal Management Level
2007 EPA Excavation Extent
- mg/kg = milligrams per kilogram
- ug/kg = micrograms per kilogram
- ug/l = micrograms per liter
- Sample depths shown in feet below ground surface
- Only results greater than criteria are shown
- RED text indicates Total PCBs
- BLUE text indicates Lead
- GREEN text indicates Arsenic
- Underlined text indicates RML exceedance
N
0 50 100
Feet
EPA Contract No.: EP-S5-13-01
TDD No.: 0001/S05-0001-1701-010
Source of Aerial Photograph: ESRI World Imagery (NAIP 2014)
Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan
Figure 5a
Sample Analytical Results - Area A
TETRA TECH
Prepared For: USEPA
Prepared By: KRB - MSG
Coordinate System: NAD_1983_Michigan_GeoRef_Meters
File Path: C:\temp\Projects\T113005.7\mxds\Fig05a_Sample_Analytical_Results_AreaA_v20170227.mxd
Date Saved: 2/27/2017



LLV-15 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	130	mg/kg	[1,2]
0-0.25	COPPER (DUP)	130	mg/kg	[1,2]
1-1.5	COPPER	590	mg/kg	[1,2,3]
1-1.5	COPPER (DUP)	550	mg/kg	[1,2,3]

LLV-Beach1 07/26/07

Depth	Parameter	Result	Units	[Criteria]
0-0	BARIUM	270	ug/l	[4]
0-0	COPPER	240	ug/l	[4]
0-0	LEAD	44	ug/l	[4,5]
0-0	SILVER	0.88	ug/l	[4]

CHLL-SD15 06/16/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	TOTAL PCBS	500 J	ug/kg	[1,2]
1-2.7	TOTAL PCBS	290	ug/kg	[1,2]

CHLL-SD17 07/12/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	TOTAL PCBS	1650 J	ug/kg	[1,2,3,8]

TL07-04 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	ARSENIC	26	mg/kg	[1,2,8]
0-0.5	CHROMIUM	51	mg/kg	[1,2]
0-0.5	COPPER	28000	mg/kg	[1,2,3,8,9]
0-0.5	LEAD	7800	mg/kg	[1,2,3,8,9]*
0-0.5	MERCURY	0.6	mg/kg	[1,2]
0-0.5	SILVER	80	mg/kg	[1]
0-0.5	ZINC	1000	mg/kg	[1,2,3]
0-0.5	TOTAL PCBS	910	ug/kg	[1,2,3]
0.5-2.17	CHROMIUM	45	mg/kg	[1,2]
0.5-2.17	COPPER	3900	mg/kg	[1,2,3]
0.5-2.17	LEAD	400	mg/kg	[1,2,3]*
0.5-2.17	SILVER	11	mg/kg	[1]
0.5-2.17	ZINC	180	mg/kg	[1,2]
0.5-2.17	TOTAL PCBS	180	ug/kg	[1,2]
3-5	CHROMIUM	44	mg/kg	[1,2]
3-5	COPPER	3400	mg/kg	[1,2,3]
3-5	LEAD	39	mg/kg	[1,2]
3-5	SILVER	6.1	mg/kg	[1]
5-7.92	CHROMIUM	44	mg/kg	[1,2]
5-7.92	COPPER	3000	mg/kg	[1,2,3]
5-7.92	SILVER	5.4	mg/kg	[1]

LLV-11 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	800	mg/kg	[1,2,3]
0-0.25	LEAD	79	mg/kg	[1,2]
1-1.5	COPPER	780	mg/kg	[1,2,3]

CHLL-SW04 05/28/15

ALL PCBS WERE NON-DETECT

CHLL-SD82 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	110	mg/kg	[1,2]
0-0.5	LEAD	85	mg/kg	[1,2]
0-0.5	SILVER	1.5	mg/kg	[1]
0-0.5	ZINC	210	mg/kg	[1,2]
1-3	TOTAL PCBS	900 J	ug/kg	[1,2,3]

LLV-10 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	910	mg/kg	[1,2,3]
0-0.25	LEAD	74	mg/kg	[1,2]
1-1.5	COPPER	970	mg/kg	[1,2,3]

SPMD Site #3 11/18/05

Parameter	Result	Units	[Criteria]
TOTAL PCBS	74	ug/l	[--]

LLV-9 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1700	mg/kg	[1,2,3]
0-0.25	LEAD	59	mg/kg	[1,2]
1-1.5	COPPER	2200	mg/kg	[1,2,3]
1-1.5	LEAD	36	mg/kg	[1]

CHLL-SD102 07/12/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	LEAD	160	mg/kg	[1,2,3]*
1-3.0	TOTAL PCBS	920	ug/kg	[1,2,3]

CHLL-SD81 05/27/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	CADMIUM	2.9	mg/kg	[1,2]
0-0.5	COPPER	9900	mg/kg	[1,2,3,9]
0-0.5	LEAD	1700	mg/kg	[1,2,3,8,9]*
0-0.5	MERCURY	0.3	mg/kg	[1,2]
0-0.5	NICKEL	33	mg/kg	[1,2]
0-0.5	SILVER	20	mg/kg	[1]
0-0.5	ZINC	290	mg/kg	[1,2]
0-0.5	TOTAL PCBS	130 J	ug/kg	[1,2]

CHLL-SD16 07/11/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	TOTAL PCBS	560 J	ug/kg	[1,2]

CHLL-SD75 05/27/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	480	mg/kg	[1,2,3]
0-0.5	SILVER	1.7	mg/kg	[1]

LLV-16 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	160	mg/kg	[1,2,3]
1-1.5	COPPER	380	mg/kg	[1,2,3]

LLV-17 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	390	mg/kg	[1,2,3]
1-1.5	COPPER	440	mg/kg	[1,2,3]
1-1.5	LEAD	49	mg/kg	[1,2]

CHLL-SD76 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	490	mg/kg	[1,2,3]
0-0.5	NICKEL	25	mg/kg	[1,2]
0-0.5	SILVER	3	mg/kg	[1]

LLV-18 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	290	mg/kg	[1,2,3]
1-1.5	COPPER	930	mg/kg	[1,2,3]

CHLL-SD14 07/11/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	ARSENIC	16	mg/kg	[1,2,8]
0-0.5	CADMIUM	3.6	mg/kg	[1,2]
0-0.5	COPPER	9800	mg/kg	[1,2,3,9]
0-0.5	LEAD	2200	mg/kg	[1,2,3,8,9]*
0-0.5	MERCURY	0.3	mg/kg	[1,2]
0-0.5	NICKEL	52	mg/kg	[1,2,3]
0-0.5	SILVER	26	mg/kg	[1]
0-0.5	ZINC	430	mg/kg	[1,2]
0-0.5	TOTAL PCBS	730 J	ug/kg	[1,2,3]

LLV-19 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	440	mg/kg	[1,2,3]
1-1.5	COPPER	930	mg/kg	[1,2,3]
1-1.5	LEAD	39	mg/kg	[1,2]

CHLL-SD77 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	490	mg/kg	[1,2,3]
0-0.5	NICKEL	24	mg/kg	[1,2]
0-0.5	SILVER	2.2	mg/kg	[1]
3-5	TOTAL PCBS	88 J	ug/kg	[1,2]

LLV-20 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	410	mg/kg	[1,2,3]
1-1.5	COPPER	850	mg/kg	[1,2,3]

CHLL-SD78 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	ARSENIC	10	mg/kg	[1,2,8]
0-0.5	COPPER	1900	mg/kg	[1,2,3]
0-0.5	LEAD	330	mg/kg	[1,2,3]*
0-0.5	NICKEL	46	mg/kg	[1,2]
0-0.5	SILVER	5.5	mg/kg	[1]
0-0.5	ZINC	150	mg/kg	[1,2]

LLV-21 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	ARSENIC	10	mg/kg	[1,2,8]
0-0.25	COPPER	3200	mg/kg	[1,2,3]
1-1.5	COPPER	760	mg/kg	[1,2,3]

CHLL-SD13 06/15/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	550	mg/kg	[1,2,3]
0-0.5	NICKEL	25	mg/kg	[1,2]
0-0.5	SILVER	1.7	mg/kg	[1]

CHLL-SD80 05/27/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	ARSENIC	14	mg/kg	[1,2,8]
0-0.5	CADMIUM	2.7	mg/kg	[1,2]
0-0.5	COPPER	6700	mg/kg	[1,2,3]
0-0.5	LEAD	1800	mg/kg	[1,2,3,8,9]*
0-0.5	MERCURY	0.3	mg/kg	[1,2]
0-0.5	NICKEL	51	mg/kg	[1,2,3]
0-0.5	SILVER	16	mg/kg	[1]
0-0.5	ZINC	310	mg/kg	[1,2]
0-0.5	TOTAL PCBS	210 J	ug/kg	[1,2]

CHLL-SW03 05/28/15

PCBS WERE ALL NON-DETECT

CHLL-SD79 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	ARSENIC	14	mg/kg	[1,2,8]
0-0.5	CADMIUM	3.8	mg/kg	[1,2]
0-0.5	COPPER	11000	mg/kg	[1,2,3,9]
0-0.5	LEAD	2800	mg/kg	[1,2,3,8,9]*
0-0.5	MERCURY	0.2	mg/kg	[1,2]
0-0.5	NICKEL	53	mg/kg	[1,2,3]
0-0.5	SILVER	28	mg/kg	[1]
0-0.5	ZINC	330	mg/kg	[1,2]
0-0.5	TOTAL PCBS	140 J	ug/kg	[1,2]

DATA SOURCES

Sample IDs **Date Range**

1) **"SPMD-..."** **November 2005**
- **MDEQ**, Water Bureau. *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake Houghton County, MDEQ Project Number 05-25.* March 2006

2) **"LLV-..."** **July 2007 - Aug 2007**
- **USEPA.** *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan.* November 2007

3) **"TL07-..."** **August 2007**
- **MDEQ**, Water Bureau, *A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2001*, Editor 2008: Lansing, Michigan

4) **"SD-03 / SW-03"** **October 2011**
- **MDEQ** RRD, Superfund Section, Pre-remedial Group, Site Evaluation Unit, *CERCLA Draft Site Inspection (SI) Report for C&H Lake Linden Operations, Lake Linden, Michigan, 49945, U.S. EPA ID No: MIN000510619,* 2013

5) **"CHLL-..."** **June 2014 - July 2015**
- **MDEQ** RRD. *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan.* March 2016

[1]=Sediment Ecological Screening Levels
[2]=Threshold Effect Concentration (TEC)
[3]=Probable Effect Concentration (PEC)
[4]=Surface Water Ecological Screening Levels
[5]=Surface Water Rule 57 HNV Drink
[6]=Surface Water Rule 57 HCV Drink
[7]=Surface Water Rule 57 WV
[8]=MDEQ Part 201 Residential Soil Direct Contact Criteria
[9]=EPA Residential Regional Removal Management Level for soil
* = Potentially exceeds hazardous waste toxicity value

Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included on a different figure

Locations Analyzed for PCBs

- No Detections
- At Least One Detection
- Mining Era Buildings and Structures

- Sediment Exceeds MDEQ Part 201 Residential Soil Direct Contact Criteria
- Sediment Exceeds EPA Residential Regional Removal Management Level for Soil
- 2007 EPA Excavation Extent

- mg/kg = milligrams per kilogram
- ug/kg = micrograms per kilogram
- ug/l = micrograms per liter
- Sample depths shown in feet below ground surface
- Only results greater than criteria are shown
- ***RED*** text indicates Total PCBs
- ***BLUE*** text indicates Lead
- ***GREEN*** text indicates Arsenic
- Underlined text indicates RML exceedance

N

0 80 160

Feet

EPA Contract No.: EP-S5-13-01
TDD No.: 0001/S05-0001-1701-010

Source of Aerial Photograph: ESRI World Imagery (NAIP 2014)

Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 5b

Sample Analytical Results - Area B

TETRA TECH

Prepared For: USEPA Prepared By: KRB - MSG

Coordinate System: NAD_1983_Michigan_GeoRef_Meters

File Path: C:\temp\Projects\T113005.7\mxd\Fig05b_Sample_Analytical_Results_Area B_20170227.mxd

Date Saved: 2/27/2017

DATA SOURCES

Sample IDs Date Range

1) **"SPMD-..." November 2005**
- **MDEQ**, Water Bureau. *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake Houghton County, MDEQ Project Number 05-25.* March 2006

2) **"LLV-..." July 2007 - Aug 2007**
- **USEPA.** *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan.* November 2007

3) **"TL07-..." August 2007**
- **MDEQ**, Water Bureau, *A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2001*, Editor 2008: Lansing, Michigan

4) **"SD-03 / SW-03" October 2011**
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5) **"CHLL-..." June 2014 - July 2015**
- **MDEQ** RRD. *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan.* March 2016

See Figure 5a

See Figure 5b

LLV-8 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1500	mg/kg	[1,2,3]
1-1.5	COPPER	1000	mg/kg	[1,2,3]

LLV-7 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1000	mg/kg	[1,2,3]
0-0.25	COPPER (DUP)	1100	mg/kg	[1,2,3]
1-1.5	COPPER	560	mg/kg	[1,2,3]
1-1.5	COPPER (DUP)	470	mg/kg	[1,2,3]

LLV-4 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	770	mg/kg	[1,2,3]
1-1.5	COPPER	1500	mg/kg	[1,2,3]

TL07-13 08/08/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	800	mg/kg	[1,2,3]
0-0.5	SILVER	3.3	mg/kg	[1]
0.5-2.17	*ARSENIC*	*8.7*	*mg/kg*	*[8]*
0.5-2.17	COPPER	1300	mg/kg	[1,2,3]
0.5-2.17	*LEAD*	*70*	*mg/kg*	*[1,2]*
0.5-2.17	SILVER	4	mg/kg	[1]
2.17-3.33	*ARSENIC*	*18*	*mg/kg*	*[1,2,8]*
2.17-3.33	COPPER	2400	mg/kg	[1,2,3]
2.17-3.33	*LEAD*	*72*	*mg/kg*	*[1,2]*
2.17-3.33	SILVER	8.1	mg/kg	[1]
3.33-5.5	COPPER	7100	mg/kg	[1,2,3]
3.33-5.5	COPPER (DUP)	5800	mg/kg	[1,2,3]
3.33-5.5	SILVER	8	mg/kg	[1]
3.33-5.5	SILVER (DUP)	6.9	mg/kg	[1]

LLV-6 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	2600	mg/kg	[1,2,3]
1-1.5	COPPER	3900	mg/kg	[1,2,3]

LLV-5 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	6400	mg/kg	[1,2,3]
1-1.5	COPPER	1300	mg/kg	[1,2,3]

LLV-3 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	810	mg/kg	[1,2,3]
1-1.5	COPPER	1200	mg/kg	[1,2,3]

LLV-1 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1900	mg/kg	[1,2,3]
1-1.5	COPPER	7100	mg/kg	[1,2,3]
1-1.5	*LEAD*	*40*	*mg/kg*	*[1,2]*

LLV-22 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	580	mg/kg	[1,2,3]
0-0.25	COPPER (DUP)	720	mg/kg	[1,2,3]
1-1.5	COPPER	580	mg/kg	[1,2,3]
1-1.5	COPPER (DUP)	570	mg/kg	[1,2,3]

LLV-23 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	630	mg/kg	[1,2,3]
1-1.5	COPPER	880	mg/kg	[1,2,3]

LLV-24 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	750	mg/kg	[1,2,3]
1-1.5	COPPER	570	mg/kg	[1,2,3]

[1]=Sediment Ecological Screening Levels
[2]=Threshold Effect Concentration (TEC)
[3]=Probable Effect Concentration (PEC)
[4]=Surface Water Ecological Screening Levels
[5]=Surface Water Rule 57 HNV Drink
[6]=Surface Water Rule 57 HCV Drink
[7]=Surface Water Rule 57 WV
[8]=MDEQ Part 201 Residential Soil Direct Contact Criteria
[9]=EPA Residential Regional Removal Management Level for soil
* = Potentially exceeds hazardous waste toxicity value

Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included on a different figure

Locations Analyzed for PCBs

- No Detections
- At Least One Detection
- Mining Era Buildings and Structures

- Sediment Exceeds MDEQ Part 201 Residential Soil Direct Contact Criteria
- Sediment Exceeds EPA Residential Regional Removal Management Level for Soil
- 2007 EPA Excavation Extent

- mg/kg = milligrams per kilogram
- ug/kg = micrograms per kilogram
- ug/l = micrograms per liter
- Sample depths shown in feet below ground surface
- Only results greater than criteria are shown
- ***RED*** text indicates Total PCBs
- ***BLUE*** text indicates Lead
- ***GREEN*** text indicates Arsenic
- Underlined text indicates RML exceedance

N

0 75 150

Feet

EPA Contract No.: EP-S5-13-01
TDD No.: 0001/S05-0001-1701-010

Source of Aerial Photograph: ESRI World Imagery (NAIP 2014)

Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 5c

Sample Analytical Results - Area C

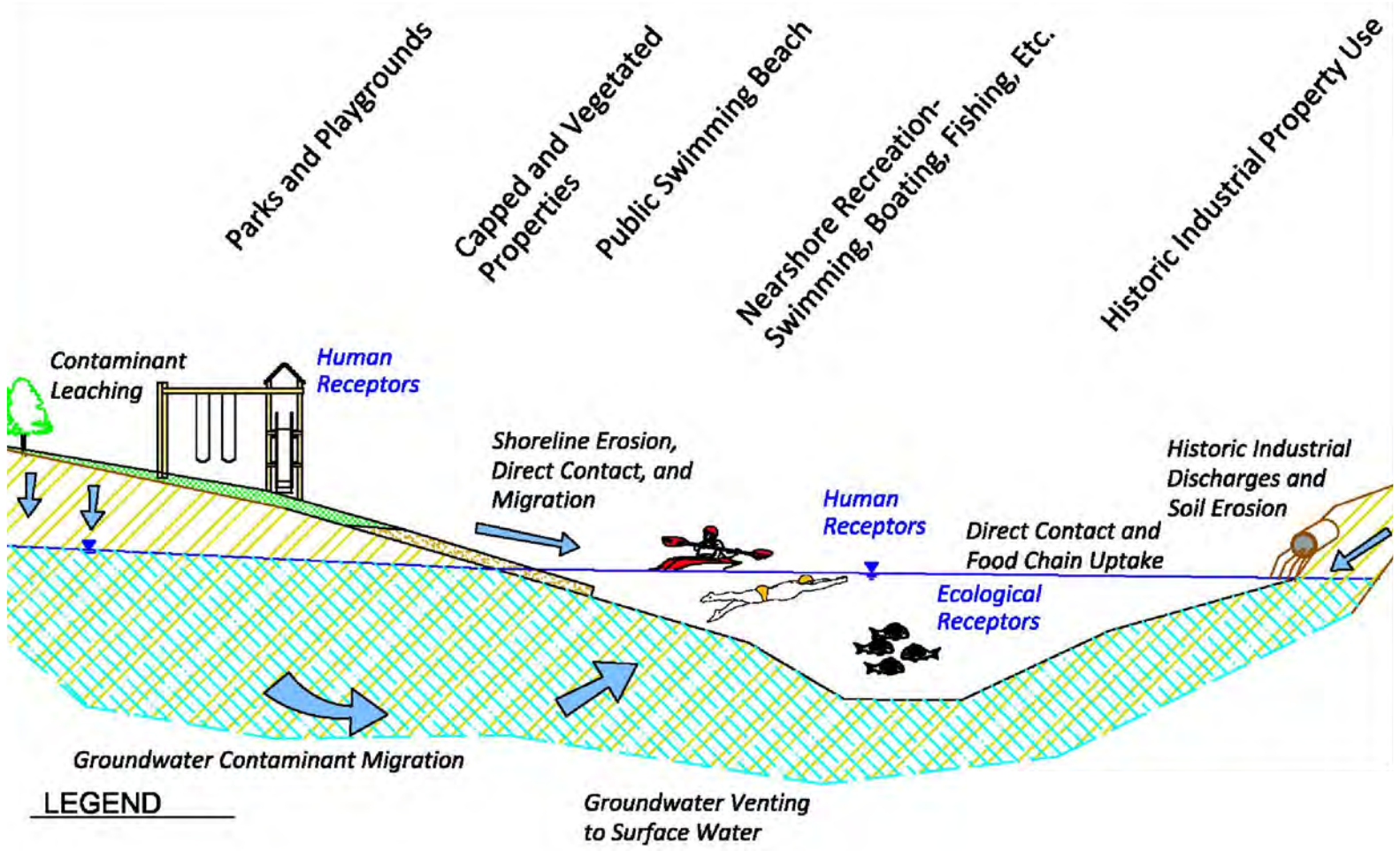
TETRA TECH

Prepared For: USEPA Prepared By: KRB - MSG

Coordinate System: NAD_1983_Michigan_GeoRef_Meters

File Path: C:\temp\Projects\T113057\mxds\Fig05c_Sample_Analytical_Results_AreaC_v20170227.mxd

Date Saved: 2/27/2017



Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 6

Conceptual Site Model

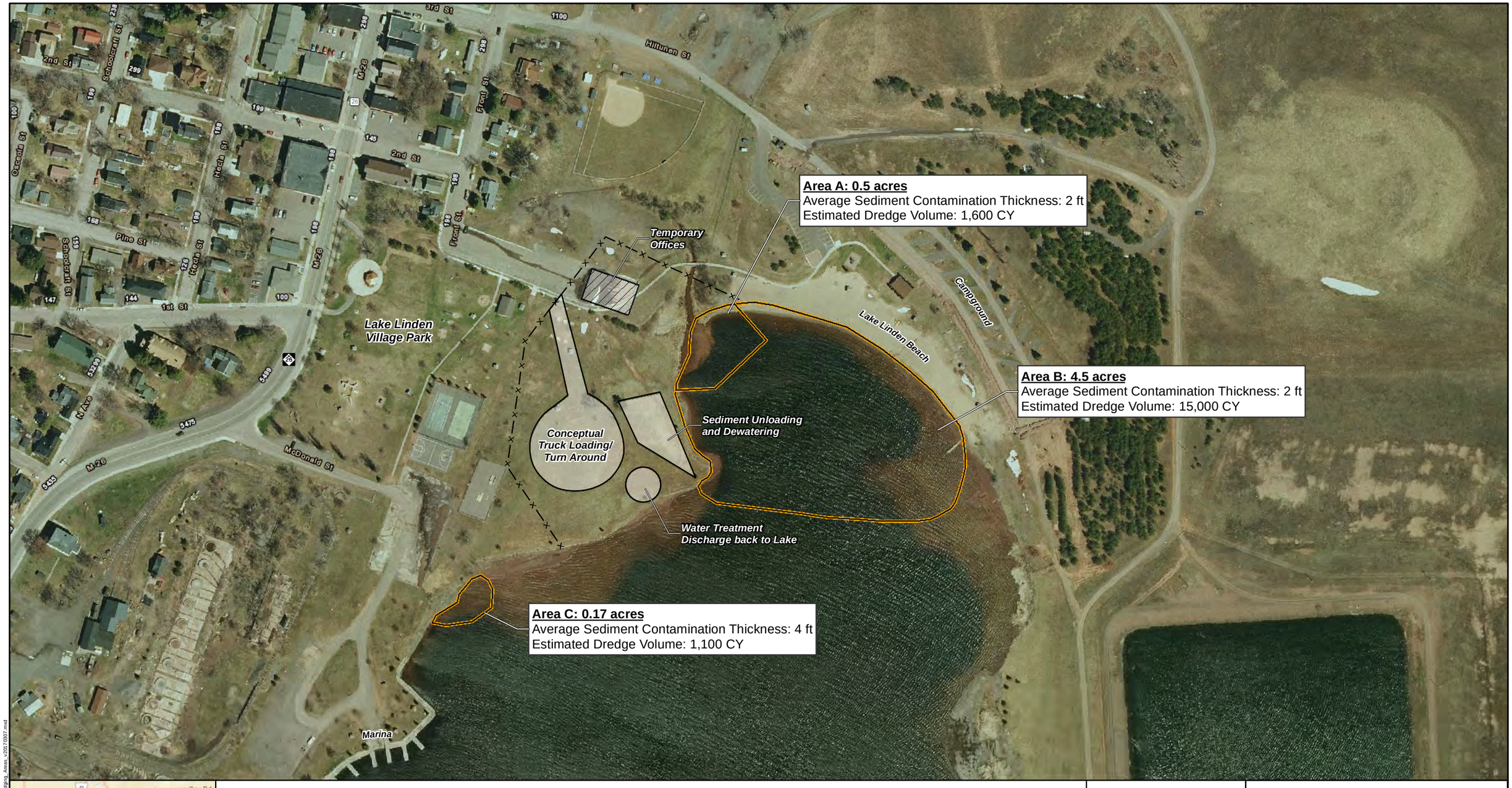
TETRA TECH

Prepared For: USEPA	Prepared By: KRB - MSG

EPA Contract No.: EP-S5-13-01
TDD No.: 0001/S05-0001-1701-010

File Path: C:\temp\Projects\T1130057\mxds\Fig06_RecCSM_v20170308.mxd

Date Saved: 3/8/2017



Legend

× — × — Conceptual Fence

Proposed Dredging Areas

Source of Aerial Photograph: MIS - Public Imagery

EPA Contract No.: EP-S5-13-01

TDD No.: 0001/S05-0001-1701-010

N

0 100 200

Feet

Lake Linden Recreation Area Sediments - RS Site
Lake Linden, Michigan

Figure 7

Proposed Dredging Areas

TETRA TECH

Prepared For: USEPA

Prepared By: KRB - MSG

Coordinate System:

File Path: C:\temp\Projects\7113005\7mxds\Fig07_Proposed_Dredging_Areas_v20170307.mxd

Date Saved: 3/7/2017

APPENDIX B

AGREEMENT FOR RECOVERY OF PAST RESPONSE COSTS AT

LAKE LINDEN CERCLA REMOVAL SITE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF

C-14J

MEMORANDUM

SUBJECT: Agreement for Recovery of Past Response Costs at Lake Linden CERCLA Removal Site

FROM: Larry Kyte, Deputy Branch Chief
Office of Regional Counsel

TO: Richard Karl, Director
Superfund Division

Attached hereto is a final agreement for settlement of past response costs at the Lake Linden Removal Site, located near the Torch Lake CERCLA Site in the upper peninsula of Michigan. The Respondent is agreeing to pay $357,149.47, which represents 99% of EPA's costs plus interest. This needs to be put out for public notice and comment before you sign it. I recommend that you sign the agreement once the notice and comment process has been completed.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF

C-14J

MEMORANDUM

SUBJECT: Agreement for Recovery of Past Response Costs at Lake Linden CERCLA Removal Site

FROM: Larry L. Johnson, Assistant Regional Counsel

TO: Richard Karl, Director
Superfund Division

I. PURPOSE

The purpose of this memorandum is to recommend that you sign the attached Administrative Order on Consent for the Lake Linden CERCLA Removal Site (Site). The AOC requires payment of $357,149.47, which represents 99% of all costs expended and all interest accrued through the date of settlement.

Since total costs at the Site are less than $500,000, the Agreement does not require Department of Justice review or EPA Headquarters approval. A public comment period and a response to comments are required prior to signature.

II. EXECUTIVE SUMMARY

This Agreement concerns the Lake Linden Site located in Lake Linden, Houghton County, Michigan. EPA alleges that the Site is a "facility" as defined by Section 101(9) of CERCLA, 42 U.S.C. § 9601(9). In response to the release or threatened release of hazardous substances at or from the Site, EPA undertook response actions at the Site in 2007 pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604, which are described in the General Notice and Demand Letter sent to Honeywell International Inc. on June 4, 2010. As detailed in the General Notice and Demand Letter, in performing the response actions, EPA incurred response costs at or in connection with the Site totaling $355,743.90. EPA alleges that Honeywell Specialty Materials, Inc. (HSM), a corporate successor to Universal Oil Product Company, is a responsible party pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), and is liable for response costs incurred at or in connection with the Site. EPA has determined that the total past and projected response costs of the United States at or in connection with the Site will not exceed $500,000, excluding interest.

III. BACKGROUND

A. Site History

The Site is located on Torch Lake within Lake Linden Recreation Park, whose address is 1000 Hiltunen Street in the Village of Lake Linden in Houghton County in the Upper Peninsula of Michigan. The park has campsites, picnic and sports areas, a boat launch, several docks, a playground, and a swimming beach and is in a mixed residential and commercial area and, as explained at more length below, the park was the previous location of an ammonia leaching facility and other processing facilities operated by Calumet & Hecla Mining Company (C&H). C&H used Torch Lake as a dump for waste materials. Because of the near historic drop in lake levels in 2007, previously submerged stamp sand from C&H's operations became exposed, as did a clay-like material unrelated to the stamp sands.

In June 2007, the Michigan Department of Environmental Quality (MDEQ) sampled surface sludge along the shoreline of the park. Analytical results revealed the presence of lead above direct contact levels and polychlorinated biphenyls (PCBs). On July 25, 2007, MDEQ, the Michigan Department of Community Health, and Western Upper Peninsula District Health Department requested EPA's assistance in assessing the area of contamination.

In a sampling event between July 26, 2007, and August 1, 2007, EPA found two areas of contamination. Area 1, in a small inlet southwest of the swimming beach, had lead-contaminated sludge, which failed the Toxicity Characteristic Leaching Procedure. Area 2, adjacent to the boat dock, contained soil contaminated with arsenic, which EPA determined was above Michigan Part 201 direct contact criteria. No PCBs were found during this sampling event. Between August 2 and August 12, 2007, EPA conducted an emergency response action at the Site to eliminate the direct contact threats. EPA removed 905.5 tons of lead-contaminated soil and 64.69 tons of arsenic-contaminated soil. Area 1 was backfilled with clean soil; in Area 2 EPA installed geotextile and rip-rap. Between September 24 and October 3, 2007, EPA completed transportation and disposal of contaminated soil, and site restoration.

The Site is on the Keweenaw Peninsula in Upper Michigan where several copper mines, smelters, and mills operated from the 1860s to the late 1960s. The history of mining operations that occurred in the Lake Linden area is extensive; this section will limit its discussion largely to the operations that resulted in the generation of the lead-containing sludge.
C&H was incorporated in 1871 in Michigan as a consolidation of the Hecla, Calumet, Portland and Scott Mining companies. C&H grew by buying and merging with neighboring copper mines and in 1923 was renamed the Calumet & Hecla Consolidated Copper Company, which essentially controlled all the operating mines north of Hancock, Michigan.

C&H had its smelting and copper milling facilities along Torch Lake in the villages of Hubbell and Lake Linden. At the mills, copper was extracted by crushing or "stamping" the rock into smaller pieces, grinding the pieces, and driving them through successively smaller meshes. The copper and crushed rock were separated by gravimetric sorting in a liquid medium. The copper was sent to the smelter. The crushed rock particles, called tailings or stamp sands, were discarded with the mill processing water, typically by pumping into the lake or depositing the

tailings on property around Torch Lake. The milling process was not efficient and copper was lost in the discarded tailings.

Mining output, milling activity, and tailings production peaked in the Torch Lake area in the early 1900s to 1920. In about 1916, advances in technology allowed recovery of copper remaining in the tailings previously deposited into Torch Lake. An ammonia leaching plant began operations in 1916 (where the Lake Linden park now exists), and the north flotation plant began operations in 1919. Dredges were used to collect the tailings, which were then screened, recrushed, and gravity separated. The ammonia leaching process was used to recover copper and other metals from the conglomerate tailings, and the flotation process was used to extract copper from both conglomerate and amygdaloid tailings. After leaching or flotation at the reclamation plants, the chemically treated tailings were returned to Torch Lake.

Mining activity decreased during the 1920s, though reclamation of copper from the tailings continued until the late 1960s. In the 1930s and 1940s, Torch Lake mills operated mainly to recover tailings in Torch Lake.

Reclamation of copper from scrap electrical materials occurred at the smelter and leaching plant from about 1940 until 1968, when the mines and mills closed. According to a 1986 report, "workers in the smelter reported that electrical material that presumably contained copper was shipped by ship and rail to the smelter from the lower Midwest. It was then doused with a flammable substance and burned so that all the rubber or asbestos insulation was removed leaving bare metal. The metal was brought to the smelter for extraction of copper. The resulting slag from this process was dumped out into the lake and along the shoreline...." The waste from this reclamation had large enrichments of lead, tin, zinc, and chromium.

In October 2007, a former employee of C&H provided additional information to EPA about the scrap recycling that took place at C&H during that time. He stated that C&H accepted scrap electrical equipment to reclaim the copper. This included large and small motors, car starters, generators, and alternators, washing machine motors, and electric fan motors. He said he observed employees behind C&H's smelter in the yard near Torch Lake burning off the insulation on copper wires on the large motors and also the solder (60% lead and 40% tin) that held the wires to the lead and zinc bearings. The former employee said he observed C&H employees push the insulation ash and melted solder into Torch Lake behind the smelter. The smelter was in Hubbell where Peninsula Copper Industries now operates.

The former employee said the large motors were then hauled to the leaching plant in Lake Linden where any remaining copper was leached off the motors. Small electric motors such as car starters, generators, and alternators; washing machine motors; and electric fan motors were sent directly to the leaching plant where the ammonia and salt solution leached out the cooper. The copper remained in solution and was sent to the still house where the copper precipitated as an oxide. The lead solder from the scrap sank to the bottom of the leaching tanks and formed

sludge. He said he knew from other employees that the sludge was washed down a trough into Torch Lake where EPA conducted the removal action in August 2007.

The former employee also stated that during World War II, C&H also reclaimed copper from 30- and 50-caliber bullets that had been rejected for various reasons and sent to scrap yards. The bullets were steel with a copper jacket on the outside and a lead core in the center. The copper was leached from the bullets in the leaching plant; the lead from the core became a sludge in the leaching tanks and was washed down the trough to Torch Lake in Lake Linden. A book well-known in "Copper Country," *Red Metal – The Calumet and Hecla Story,* refers to a contract that C&H had with the Metals Reserve Company for C&H to treat the bullets, and states that the leaching plant recovered from small-arms scrap some 20,800,000 pounds of copper and 40,000 long tons of steel on that contract. A letter to EPA, dated April 1992, from an attorney for Universal Oil Products Company, states that the United States Department of Commerce (as successor to the War Production Board and the Metals Reserve Company) supplied substantial quantities of scrap to C&H for copper recovery during World War II.

Because C&H engaged in a variety of pursuits after WWII, it reincorporated in 1952 as Calumet & Hecla, Inc., dropping any specific reference to being a mining company. On April 30, 1968, Universal Oil Products Company merged with Calumet & Hecla, Inc., and operated it as a subsidiary named Calumet & Hecla Corp. Rather than deal with labor problems, Universal Oil Products Company closed down the operations of its Calumet Division. Universal Oil Products Company merged with Calumet & Hecla Corp. on December 31, 1969. Respondent HSM is a successor to Universal Oil Products Company.

In the 1970s, environmental concerns developed regarding the deposition of tailings into Torch Lake for 100 years, resulting in environmental investigations. EPA's involvement began in 1984 when the Torch Lake Superfund Site, which included several areas on the Keweenaw Peninsula, was proposed for inclusion on the National Priorities List.

B. Litigation History

No litigation has evolved from this matter.

C. Settlement History

EPA issued a General Notice and Demand for Payment of Past Response Costs on June 4, 2010.

IV. SETTLEMENT TERMS

The AOC is consistent with the Model AOC in all respects. Respondent will pay 99% of EPA's response costs, plus interest, through the date of agreement.

V. ANALYSIS OF SETTLEMENT CRITERIA

1. Volume of Waste Contributed to the Facility

Respondent's corporate predecessor C&H operated the facility and is responsible for all of the waste contributed to the facility.

2. Nature of Waste

The waste contributed to this facility consists primarily of lead-contaminated sludge and soil contaminated with arsenic.

3. Strength of Evidence linking Respondent to the Facility

During negotiations Respondent acknowledged being the corporate successor to C&H and there exists ample evidence of the fact of C&H's long-term operations at the Site.

4. Ability to Pay

No known reason exists to doubt Respondent's ability to pay.

5. Litigative Risks of Proceeding to Trial

a. Admissibility of EPA's evidence

Other than the normal risks involved in any trial, there is no known reason to believe that EPA's evidence would not be admissible at trial. Much of this evidence is contained in official County records or written statements by Respondent's corporate predecessors.

b. Adequacy of EPA's evidence

EPA possesses evidence that C&H disposed of hazardous substances during its past ownership of and operations at the facility. In addition, EPA possesses evidence of Respondent's successor liability for C&H.

c. Availability of Defenses

Respondent has no known defenses.

6. Public Interest Considerations

Although the area of disposal is a public beach, all known contamination has been removed and 99% of EPA's response costs and interest will be recovered. Thus there is little basis for any future public interest at this Site.

7. Precedential Value

None known.

8. Value in Obtaining a Sum Certain

99% of all costs are being recovered.

9. Inequities and Aggravating Factors

None known.

10. Nature of Case that Remains After "Settlement"

No case remains after settlement. No further effort will be made to recover any remaining Past Costs and this matter will be closed out.

VI. RECOMMENDATION

For the reasons set forth above, and based on an evaluation of the terms of the proposed settlement, it is our recommendation that EPA execute the AOC. We believe it represents the best interest of Superfund under all of the present circumstances.

IN THE MATTER OF:	)	AGREEMENT FOR RECOVERY OF PAST RESPONSE COSTS
Lake Linden Superfund Site Lake Linden, Houghton County, Michigan	)	EPA Region 5 CERCLA Docket No. ____
Honeywell Specialty Materials, LLC, SETTLING PARTY	)	PROCEEDING UNDER SECTION 122(h)(1) OF CERCLA 42 U.S.C. § 9622(h)(1)

V-W-11-C-988

I. JURISDICTION

1. This Agreement is entered into pursuant to the authority vested in the Administrator of the U.S. Environmental Protection Agency ("EPA") by Section 122(h)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. § 9622(h)(1), which authority has been delegated to the Regional Administrators of the EPA by EPA Delegation No. 14-14-D and redelegated to the Director, Superfund Division, by Region 5 Delegation 14-14-D.

2. This Agreement is made and entered into by EPA and Honeywell Specialty Materials, LLC ("HSM" or "the Settling Party"). HSM consents to and will not contest EPA's authority to enter into this Agreement or to implement or enforce its terms.

II. BACKGROUND

3. This Agreement concerns the Lake Linden Site ("the Site") located in Lake Linden, Houghton County, Michigan. EPA alleges that the Site is a "facility" as defined by Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

4. In response to the release or threatened release of hazardous substances at or from the Site, EPA undertook response actions at the Site pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604, which are described in the General Notice and Demand Letter sent to Honeywell International Inc. on June 4, 2010 ("Response Actions").

5. As detailed in the General Notice and Demand Letter, in performing the Response Actions, EPA incurred response costs at or in connection with the Site totaling $355,743.90.

6. EPA alleges that HSM is a responsible party pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), and is liable for response costs incurred at or in connection with the Site.

7. EPA has determined that the total past and projected response costs of the United States at or in connection with the Site will not exceed $500,000, excluding interest.

8. EPA and HSM recognize that this Agreement has been negotiated in good faith and is entered into without the admission or adjudication of any issue of fact or law.

III. PARTIES BOUND

9. This Agreement shall be binding upon EPA and HSM and its successors and assigns. Any change in ownership or corporate or other legal status of the Settling Party, including, but not limited to, any transfer of assets or real or personal property, shall in no way alter its responsibilities under this Agreement. By signing this Agreement, HSM's representative certifies that he or she is authorized to enter into the terms and conditions of this Agreement and to legally bind HSM.

IV. DEFINITIONS

10. Unless otherwise expressly provided herein, terms used in this Agreement that are defined in CERCLA or in regulations promulgated under CERCLA shall have the meanings assigned to them in CERCLA or in such regulations. Whenever terms listed below are used in this Agreement or in any appendix attached hereto, the following definitions shall apply:

a. "Agreement" shall mean this Agreement. In the event of conflict between this Agreement and any appendix, the Agreement shall control.

b. "CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq.*

c. "Day" shall mean a calendar day. In computing any period of time under this Agreement, where the last day would fall on a Saturday, Sunday, or federal holiday, the period shall run until the close of business of the next working day.

d. "EPA" shall mean the United States Environmental Protection Agency and any successor departments, agencies or instrumentalities of the United States.

e. "Interest" shall mean interest at the rate specified for interest on investments of the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, compounded annually on October 1 of each year, in accordance with 42 U.S.C. § 9607(a). The applicable rate of interest shall be the rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year.

f. "Paragraph" shall mean a portion of this Agreement identified by an Arabic numeral or a lower case letter.

g. "Parties" shall mean EPA and Honeywell Specialty Materials, LLC.

h. "Past Response Costs" shall mean all costs, including but not limited to direct and indirect costs, that EPA or the U.S. Department of Justice on behalf of EPA has paid at or in connection with the Site through May 2, 2011.

i. "Section" shall mean a portion of this Agreement identified by a Roman numeral.

j. "Settling Party" shall mean Honeywell Specialty Materials, LLC.

k. "Site" shall mean the Lake Linden Superfund Site, located in and adjacent to a public beach on Torch Lake in Lake Linden, Houghton County, Michigan, and generally shown on the map included in Appendix A.

l. "United States" shall mean the United States of America, including its departments, agencies and instrumentalities.

V. PAYMENT OF RESPONSE COSTS

11. Within 30 days of the Effective Date of this Settlement Agreement, HSM shall pay to EPA $357,149.47, which includes updated costs and interest incurred since the demand letter.

12. Payment shall be made to EPA by Electronic Funds Transfer ("EFT") with a Fedwire message in accordance with current EFT procedures that EPA Region 5 will provide HSM, and shall be accompanied by a statement identifying the name and address of the party making payment, the Site name, the EPA Region 5 and Site/Spill ID Number B5KY. EFT Payments shall be sent to:

Federal Reserve Bank of New York
ABA No. 021030004
Account No. 68010727
33 Liberty Street
New York, NY 10045
Field Tag 4200 of the Fedwire message should read "D68010727 Environmental Protection Agency

13. At the time of payment, HSM shall also send notice that payment has been made to EPA in accordance with Section XII (Notices and Submissions). Such notice shall reference EPA Region 5, the Site/Spill ID Number B5KY, and the EPA docket number for this action.

14. The total amount to be paid by HSM pursuant to Paragraph 11 shall be deposited in the EPA Hazardous Substance Superfund.

VI. FAILURE TO COMPLY WITH AGREEMENT

15. Interest on Late Payments. If the Settling Party fails to make any payment required by Paragraph 11 by the required due date, Interest shall continue to accrue on the unpaid balance through the date of payment.

16. Stipulated Penalty.

a. If any amounts due to EPA under Paragraph 11 are not paid by the required date, HSM shall be in violation of this Agreement and shall pay to EPA, as a stipulated penalty, in addition to the Interest required by Paragraph 15, $100 per violation per day that such payment is late.

b. Stipulated penalties are due and payable within 30 days of the date of demand for payment of the penalties by EPA. All payments to EPA under this Paragraph shall be identified as "stipulated penalties" and shall be made payable to "EPA Hazardous Substance Superfund." A check, or a letter accompanying the check, shall reference the name and address of the party making payment, the Site name, the EPA Region and Site Spill ID Number, and the EPA Docket Number for this action. HSM shall send the check (and any accompanying letter) to:

U.S. Environmental Protection Agency
Superfund Payments
Cincinnati Finance Center
P.O. Box 979076
St. Louis, Missouri 63197-9000

Payments made by wire transfer (Electronic Funds Transfer or EFT) shall be sent with a Fedwire message to:

Federal Reserve Bank of New York
ABA No. 021030004
Account No. 68010727
33 Liberty Street
New York, New York 10045
Field Tag 4200 of the Fedwire message should read "D68010727 Environmental Protection Agency"

c. At the time of each payment, the Settling Party shall also send notice that payment has been made to EPA in accordance with Section XII (Notices and Submissions). Such

notice shall identify EPA Region 5 and Site Spill ID Number B5KY and the EPA Docket Number for this action.

d. Penalties shall accrue as provided in this Paragraph regardless of whether EPA has notified the Settling Party of the violation or made a demand for payment, but need only be paid upon demand. All penalties shall begin to accrue on the day after payment is due, and shall continue to accrue through the date of payment. Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Agreement.

17. In addition to the Interest and Stipulated Penalty payments required by this Section and any other remedies or sanctions available to EPA by virtue of Settling Party's failure to comply with the requirements of this Agreement, if the Settling Party fails or refuses to comply with the requirements of this Agreement, it shall be subject to enforcement action pursuant to Section 122(h)(3) of CERCLA, 42 U.S.C. § 9622(h)(3). If the United States, on behalf of EPA, brings an action to enforce this Agreement, the Settling Party shall reimburse the United States for all costs of such action, including but not limited to costs of attorney time.

18. Notwithstanding any other provision of this Section, EPA may, in its unreviewable discretion, waive payment of any portion of the stipulated penalties that have accrued pursuant to this Agreement. Payment of stipulated penalties shall not excuse the Settling Party from payment as required by Section V or from performance of any other requirements of this Agreement.

VII. COVENANT NOT TO SUE BY EPA

19. Covenant Not to Sue by EPA. Except as specifically provided in Section VIII (Reservations of Rights by EPA), EPA covenants not to sue or take administrative action against HSM, pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), to recover Past Response Costs. This covenant shall take effect upon receipt by EPA of all amounts required by Section V (Payment of Response Costs) and any amounts due under Section VI (Failure to Comply with Agreement). This covenant not to sue is conditioned upon the satisfactory performance by HSM of its obligations under this Agreement. This covenant not to sue extends only to HSM and does not extend to any other person.

VIII. RESERVATIONS OF RIGHTS BY EPA

20. EPA reserves, and this Agreement is without prejudice to, all rights against HSM with respect to all matters not expressly included within the Covenant Not to Sue by EPA in Paragraph 19. Notwithstanding any other provision of this Agreement, EPA reserves all rights against HSM with respect to:

a. liability for failure of HSM to meet a requirement of this Agreement;

b. liability for costs incurred or to be incurred by the United States that are not within the definition of Past Response Costs;

c. liability for injunctive relief or administrative order enforcement under Section 106 of CERCLA, 42 U.S.C. § 9606;

d. criminal liability; and

e. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments.

21. Nothing in this Agreement is intended to be nor shall it be construed as a release, covenant not to sue, or compromise of any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or in equity, which the United States may have against any person, firm, corporation or other entity not a signatory to this Agreement.

IX. COVENANT NOT TO SUE BY SETTLING PARTY

22. HSM covenants not to sue and agrees not to assert any claims or causes of action against the United States, or its contractors or employees, with respect to Past Response Costs or this Agreement, including but not limited to:

a. any direct or indirect claim for reimbursement from the EPA Hazardous Substance Superfund based on Sections 106(b)(2), 107, 111, 112, or 113 of CERCLA, 42 U.S.C. §§ 9606(b)(2), 9607, 9611, 9612, or 9613, or any other provision of law;

b. any claims arising out of the response actions at the Site for which the Past Response Costs were incurred, including any claim under the United States Constitution, the Constitution of the State of Michigan, the Tucker Act, 28 U.S.C. § 1491, the Equal Access to Justice Act, 28 U.S.C. § 2412, as amended, or at common law; and

c. any claim against the United States pursuant to Sections 107 and 113 of CERCLA, 42 U.S.C. §§ 9607 and 9613, relating to Past Response Costs.

23. Nothing in this Agreement shall be deemed to constitute approval or preauthorization of a claim within the meaning of Section 111 of CERCLA, 42 U.S.C. § 9611, or 40 C.F.R. 300.700(d).

24. HSM agrees not to assert any claims and to waive all claims or causes of action that it may have for all matters relating to the Site, including for contribution, against any person where the person's liability to HSM with respect to the Site is based solely on having arranged for disposal or treatment, or for transport for disposal or treatment, of hazardous substances at the

Site, or having accepted for transport for disposal or treatment of hazardous substances at the Site, if all or part of the disposal, treatment, or transport occurred before April 1, 2001, and the total amount of material containing hazardous substances contributed by such person to the Site was less than 110 gallons of liquid materials or 200 pounds of solid materials.

25. The waiver in Paragraph 24 shall not apply with respect to any defense, claim, or cause of action that HSM may have against any person meeting the above criteria if such person asserts a claim or cause of action relating to the Site against HSM. This waiver also shall not apply to any claim or cause of action against any person meeting the above criteria if EPA determines:

a. that such person has failed to comply with any EPA requests for information or administrative subpoenas issued pursuant to Section 104(e) or 122(e) of CERCLA, 42 U.S.C. § 9604(e) or 9622(e), or Section 3007 of the Solid Waste Disposal Act (also known as the Resource Conservation and Recovery Act or "RCRA"), 42 U.S.C. § 6972, or has impeded or is impeding, through action or inaction, the performance of a response action or natural resource restoration with respect to the Site, or has been convicted of a criminal violation for the conduct to which this waiver would apply and that conviction has not been vitiated on appeal or otherwise; or

b. that the materials containing hazardous substances contributed to the Site by such person have contributed significantly, or could contribute significantly, either individually or in the aggregate, to the cost of response action or natural resource restoration at the Site.

X. EFFECT OF SETTLEMENT/CONTRIBUTION PROTECTION

26. Nothing in this Agreement shall be construed to create any rights in, or grant any cause of action to, any person not a Party to this Agreement. The Parties expressly reserve any and all rights (including, but not limited to, any right to contribution), defenses, claims, demands, and causes of action that they may have with respect to any matter, transaction, or occurrence relating in any way to the Site against any person not a Party hereto.

27. EPA and HSM agree that the actions undertaken by HSM in accordance with this Agreement do not constitute an admission of any liability by HSM. HSM does not admit, and retains the right to controvert in any subsequent proceedings other than proceedings to implement or enforce this Agreement, the validity of the facts or allegations contained in Section II of this Agreement.

28. The Parties agree that HSM is entitled, as of the effective date of this Agreement, to protection from contribution actions or claims as provided by Sections 113(f)(2) and 122(h)(4) of CERCLA, 42 U.S.C. §§ 9613(f)(2) and 9622(h)(4), for "matters addressed" in this Agreement. The "matters addressed" in this Agreement are Past Response Costs.

29. HSM agrees that with respect to any suit or claim for contribution brought by it for matters related to this Agreement, it will notify EPA in writing no later than 60 days prior to the initiation of such suit or claim. HSM agrees that, with respect to any suit or claim for contribution brought against it for matters related to this Agreement, it will notify EPA in writing within 10 days of service of the complaint or claim upon it. In addition, HSM shall notify EPA within 10 days of service or receipt of any Motion for Summary Judgment, and within 10 days of receipt of any order from a court setting a case for trial, for matters related to this Agreement.

30. In any subsequent administrative or judicial proceeding initiated by EPA, or by the United States on behalf of EPA, for injunctive relief, recovery of response costs, or other relief relating to the Site, HSM shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, *res judicata*, collateral estoppel, issue preclusion, claim-splitting, or other defenses based upon any contention that the claims raised in the subsequent proceeding were or should have been brought in the instant case; provided, however, that nothing in this Paragraph affects the enforceability of the covenant not to sue by EPA set forth in Section VII.

31. Notwithstanding any provision of this Agreement, EPA retains all of its access authorities and rights, as well as all of its rights to require land/water use restrictions, including enforcement authorities related thereto, under CERCLA, RCRA, and any other applicable statute or regulations.

XI. RETENTION OF RECORDS

32. Until 3 years after the Effective Date of this Agreement, HSM shall preserve and retain all records now in its possession or control, or which come into its possession or control, that relate in any manner to response actions taken at the Site or to the liability of any person under CERCLA with respect to the Site, regardless of any corporate retention policy to the contrary.

33. After the conclusion of the 3-year document retention period in the preceding paragraph, HSM shall notify EPA at least 90 days prior to the destruction of any such records and, upon request by EPA, HSM shall deliver any such records to EPA. HSM may assert that certain records are privileged under the attorney-client privilege or any other privilege recognized by federal law. If HSM asserts such a privilege, they shall provide EPA with the following: 1) the title of the record; 2) the date of the record; 3) the name, title, affiliation (*e.g.*, company or firm), and address of the author of the record; 4) the name and title of each addressee and recipient; 5) a description of the subject of the record; and 6) the privilege asserted. If a claim of privilege applies only to a portion of a record, the record shall be provided to EPA in redacted form to mask the privileged information only. HSM shall retain all records that it claims to be privileged until EPA has had a reasonable opportunity to dispute the privilege claim and any such dispute has been resolved in HSM's favor. However, no records created or generated pursuant to the

requirements of this or any other settlement with the EPA pertaining to the Site shall be withheld on the grounds that they are privileged.

34. HSM hereby certifies individually that, to the best of its knowledge and belief, after thorough inquiry, it has not altered, mutilated, discarded, destroyed or otherwise disposed of any records, reports, or information relating to its potential liability regarding the Site since notification of potential liability by the United States or the State or the filing of suit against it regarding the Site and that it has fully complied with any and all EPA requests for information pursuant to Sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e), and Section 3007 of RCRA, 42 U.S.C. § 6927

XII. NOTICES AND SUBMISSIONS

35. Whenever, under the terms of this Agreement, notice is required to be given or a document is required to be sent by one Party to another, it shall be directed to the individuals at the addresses specified below, unless those individuals or their successors give notice of a change to the other Parties in writing. Written notice as specified herein shall constitute complete satisfaction of any written notice requirement of this Agreement with respect to EPA and HSM.

As to EPA:

Larry L. Johnson
Associate Regional Counsel
U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard, C-14J
Chicago, Illinois 60604

Richard Hackley
Comptroller's Branch
U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard, M-10J
Chicago, Illinois 60604

As to HSM:

Tom Byrne
Honeywell International Inc.
101 Columbia Road.
Morristown, New Jersey 07962

XIII. INTEGRATION/APPENDICES

36. This Agreement and its appendix constitute the final, complete, and exclusive agreement and understanding among the Parties with respect to the settlement embodied in this Agreement. The Parties acknowledge that there are no representations, agreements, or understandings relating to the settlement other than those expressly contained in this Agreement. The following appendices are attached to and incorporated into this Agreement: "Appendix A" is a map of the Site.

XIV. PUBLIC COMMENT

37. This Agreement shall be subject to a public comment period of not less than 30 days pursuant to Section 122(i) of CERCLA, 42 U.S.C. § 9622(i). In accordance with Section 122(i)(3) of CERCLA, EPA may modify or withdraw its consent to this Agreement if comments received disclose facts or considerations which indicate that this Agreement is inappropriate, improper or inadequate.

XV. EFFECTIVE DATE

38. The effective date of this Agreement shall be the date upon which EPA issues written notice that the public comment period pursuant to Paragraph 37 has closed and that comments received, if any, do not require modification of or EPA withdrawal from this Agreement.

[Remainder of page left blank]

THE UNDERSIGNED SETTLING PARTY enters into this Agreement in the matter of the Lake Linden Superfund Site, EPA docket number _____

FOR SETTLING PARTY: Chuck Geadelmann
[print] Name

Corporate Remediation Manager
[print] Title

1985 Douglas Drive Golden Valley, MN 55422
[print} Address

By: Chuck Geadelmann 11/18/2011
Signature Date

IT IS SO AGREED:

U.S. Environmental Protection Agency

By: _____ 2/3/2012
Richard C. Karl
Director, Superfund Division Date

APPENDIX C

MDEQ REQUEST FOR EPA ERB ASSISTANCE AT THE LLRAS SITE

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
UPPER PENINSULA DISTRICT OFFICE

RICK SNYDER
GOVERNOR

C. HEIDI GRETHER
DIRECTOR

January 19, 2017

Mr. Brian Kelly
U.S. Environmental Protection Agency
Region V - Emergency Response Branch
9311 Groh Road
Grosse Ile, Michigan 48138

Dear Mr. Kelly:

SUBJECT: Lake Linden Recreation Area – Contaminated Sediments
Request for Assistance
Lake Linden, Houghton County, Michigan
DEQ Site ID 31000078

As we have discussed during the past few weeks, please find enclosed the figures which include the data from samples collected in Torch Lake, extending out from the Emergency Removal Action you conducted in Lake Linden in 2007.

As you know, since the time of your 2007 removal action, further evaluation of the conditions in the lake has been conducted due to an apparent on-going source of PCBs in or into Torch Lake, preventing the fish consumption advisory from being removed. The data from all studies in and along Torch Lake are linked to our Abandoned Mining Wastes (AMW) project website. An attachment to this letter describes some of the findings of those studies and provides the link to the documents and the AMW website where additional information can be found.

Our review of the compiled data from 2005 – 2015 in Torch Lake, extending out from the 2007 Lake Linden Emergency Removal action addressing lead, arsenic and associated polychlorinated biphenyls (PCBs) indicates that concentrations exceeding residential soil direct contact criteria, ecological screening levels and potentially the hazardous waste toxicity values concentrations are present in very near shore as well as off shore samples collected from an approximate 5 acre area we refer to as the Lake Linden Recreation Area- Contaminated Sediments.

All the data collected or compiled by the AMW project has been shared with the property owner, the Michigan Department of Health & Human Services (MDHHS), the local health department, state and federal agencies, and the community. MDHHS is currently finalizing their updated evaluation of this data as part of their Public Health Assessment which was initiated in approximately 2008.

Given that the concentrations of contaminants in sediments extending out from the 2007 Emergency Response Branch (ERB) Emergency Removal Action exceed several applicable criteria, including residential direct contact criteria, which is considered by the

MDHHS as applicable, and since the Department of Environmental Quality, Remediation and Redevelopment Division does not have the resources to address the contaminated sediments in the Lake Linden Recreation Area, I am requesting EPA ERB assistance to address the sediments lake-ward of the 2007 Lake Linden Emergency Response action. Please let me know if the EPA ERB can be of assistance in this effort. If you have any questions, please contact Ms. Amy Keranen, Project Manager, at DEQ RRD, 55195 U.S. 41, Calumet, MI 49913, or at keranena@michigan.gov, or 906-337-0389.

Sincerely,

Chris Austin for Clif Clark

Clifton Clark
District Supervisor
Remediation and Redevelopment Division
Upper Peninsula District Office
906-228-4516
Clarkc8@michigan.gov

Enclosures

cc: Ms. Sue Leeming, DEQ
Ms. Kathleen Shirey, DEQ
Mr. Dennis Eagle, DEQ
Ms. Amy Keranen, DEQ

Image Source: MIS - Public Imagery

C&H Flotation Plant

C&H Leaching Plant

C&H Regrinding Plant No. 2

Sub-Station

Calumet Stamp Mill

C&H Regrinding Plant No. 1

Extent of EPA's 2007 Emergency Response Removal to address lead and PCB contaminated soil and sediment

See Figure 2b

See Figure 2a

See Figure 2c

Approximate Limits of Remaining PCB, Lead, and Arsenic Contaminated Sediment
(see Figures 2a - 2c for summary of analytical results)

Extent of EPA's 2007 Emergency Response Removal to address arsenic contaminated soil and sediment

Lake Linden Recreation Area

- Approximate 5-acre area extending outward from limits of EPA's 2007 Emergency Response to Address Lead and PCB Contamination Removal Limits
- PCB concentrations greater than criteria range from 88 – 8900 ug/kg
- Lead concentrations greater than criteria range from 39 – 75,000 mg/kg
- Lead concentrations in some locations potentially exceed the Hazardous Waste Toxicity Values as did the materials removed from this area during 2007 by the EPA
- Arsenic concentrations greater than criteria range from 10 to 55 mg/kg
- Other metals also present in concentrations greater than criteria
- Contaminated sediment depths ranging from approximately .5 ft to 5.33 ft
- Overlying water depth ranges from approximately .5 to 24 ft
- No drums or other significant debris observed on lake bottom via side scan sonar

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances

Locations Analyzed for PCBs

- No Detections
- At Least One Detection

- Sediment Exceeds MDEQ Part 201 Residential Soil Direct Contact Criteria
- Approximate Area of PCBs, Lead, and Arsenic above Criteria
- Excavation Extent (EPA's 2007 ER)
- Mining Era Buildings and Structures

N

0 150 Ft

Coordinate System: MIGeoRef(m)

Prepared for:
Michigan Department of Environmental Quality

Mannik Smith GROUP
TECHNICAL SKILL. CREATIVE SPIRIT.
www.MannikSmithGroup.com

DRAFT

Figure 1

Approximate Limits of Subject Area PCB, Lead and Arsenic Contaminated Sediments
Lake Linden Recreation Area
Lake Linden, Houghton County, Michigan

FILE: C:\temp\Projects\MDEQ0070\GIS\mxds\Planning\20161130-TorchLake_Removal_Planning\LkLindenRecArea_DraftLLR_Fig01_ApproxLimits_v20170113.mxd 1/13/2017 KBrown

Image Source: ESRI World Imagery (NAIP 2014)

LLV-15 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	130	mg/kg	[1,2]
0-0.25	COPPER (DUP)	130	mg/kg	[1,2]
1-1.5	COPPER	590	mg/kg	[1,2,3]
1-1.5	COPPER (DUP)	550	mg/kg	[1,2,3]

LLV-Beach1 07/26/07

Depth	Parameter	Result	Units	[Criteria]
0-0	BARIUM	270	ug/l	[4]
0-0	COPPER	240	ug/l	[4]
0-0	*LEAD*	*44*	*ug/l*	*[4,5]*
0-0	SILVER	0.88	ug/l	[4]

CHLL-SD15 06/16/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*TOTAL PCBS*	*500 J*	*ug/kg*	*[1,2]*
1-2.7	*TOTAL PCBS*	*290*	*ug/kg*	*[1,2]*

CHLL-SD17 07/12/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*TOTAL PCBS*	*1650 J*	*ug/kg*	*[1,2,3,8]*

TL07-04 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*ARSENIC*	*26*	*mg/kg*	*[1,2,8]*
0-0.5	CHROMIUM	51	mg/kg	[1,2]
0-0.5	COPPER	28000	mg/kg	[1,2,3,8]
0-0.5	*LEAD*	*7800*	*mg/kg*	*[1,2,3,8]**
0-0.5	MERCURY	0.6	mg/kg	[1,2]
0-0.5	SILVER	80	mg/kg	[1]
0-0.5	ZINC	1000	mg/kg	[1,2,3]
0-0.5	*TOTAL PCBS*	*910*	*ug/kg*	*[1,2,3]*
0.5-2.17	CHROMIUM	45	mg/kg	[1,2]
0.5-2.17	COPPER	3900	mg/kg	[1,2,3]
0.5-2.17	*LEAD*	*400*	*mg/kg*	*[1,2,3]**
0.5-2.17	SILVER	11	mg/kg	[1]
0.5-2.17	ZINC	180	mg/kg	[1,2]
0.5-2.17	*TOTAL PCBS*	*180*	*ug/kg*	*[1,2]*
3-5	CHROMIUM	44	mg/kg	[1,2]
3-5	COPPER	3400	mg/kg	[1,2,3]
3-5	*LEAD*	*39*	*mg/kg*	*[1,2]*
3-5	SILVER	6.1	mg/kg	[1]
5-7.92	CHROMIUM	44	mg/kg	[1,2]
5-7.92	COPPER	3000	mg/kg	[1,2,3]
5-7.92	SILVER	5.4	mg/kg	[1]

LLV-11 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	800	mg/kg	[1,2,3]
0-0.25	*LEAD*	*79*	*mg/kg*	*[1,2]*
1-1.5	COPPER	780	mg/kg	[1,2,3]

CHLL-SW04 05/28/15

ALL PCBS WERE NON-DETECT

CHLL-SD82 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	110	mg/kg	[1,2]
0-0.5	*LEAD*	*85*	*mg/kg*	*[1,2]*
0-0.5	SILVER	1.5	mg/kg	[1]
0-0.5	ZINC	210	mg/kg	[1,2]
1-3	*TOTAL PCBS*	*900 J*	*ug/kg*	*[1,2,3]*

LLV-10 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	910	mg/kg	[1,2,3]
0-0.25	*LEAD*	*74*	*mg/kg*	*[1,2]*
1-1.5	COPPER	970	mg/kg	[1,2,3]

SPMD Site #3 11/18/05

Parameter	Result	Units	[Criteria]
TOTAL PCBS	*74*	*ug/l*	*[--]*

LLV-9 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1700	mg/kg	[1,2,3]
0-0.25	*LEAD*	*59*	*mg/kg*	*[1,2]*
1-1.5	COPPER	2200	mg/kg	[1,2,3]
1-1.5	*LEAD*	*36*	*mg/kg*	*[1]*

CHLL-SD102 07/12/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*LEAD*	*160*	*mg/kg*	*[1,2,3]**
1-3.0	*TOTAL PCBS*	*920*	*ug/kg*	*[1,2,3]*

CHLL-SD81 05/27/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	CADMIUM	2.9	mg/kg	[1,2]
0-0.5	COPPER	9900	mg/kg	[1,2,3]
0-0.5	*LEAD*	*1700*	*mg/kg*	*[1,2,3,8]**
0-0.5	MERCURY	0.3	mg/kg	[1,2]
0-0.5	NICKEL	33	mg/kg	[1,2]
0-0.5	SILVER	20	mg/kg	[1]
0-0.5	ZINC	290	mg/kg	[1,2]
0-0.5	*TOTAL PCBS*	*130 J*	*ug/kg*	*[1,2]*

CHLL-SD16 07/11/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*TOTAL PCBS*	*560 J*	*ug/kg*	*[1,2]*

CHLL-SD75 05/27/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	480	mg/kg	[1,2,3]
0-0.5	SILVER	1.7	mg/kg	[1]

LLV-16 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	160	mg/kg	[1,2,3]
1-1.5	COPPER	380	mg/kg	[1,2,3]

LLV-17 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	390	mg/kg	[1,2,3]
1-1.5	COPPER	440	mg/kg	[1,2,3]
1-1.5	*LEAD*	*49*	*mg/kg*	*[1,2]*

CHLL-SD76 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	490	mg/kg	[1,2,3]
0-0.5	NICKEL	25	mg/kg	[1,2]
0-0.5	SILVER	3	mg/kg	[1]

LLV-18 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	290	mg/kg	[1,2,3]
1-1.5	COPPER	930	mg/kg	[1,2,3]

CHLL-SD14 07/11/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*ARSENIC*	*16*	*mg/kg*	*[1,2,8]*
0-0.5	CADMIUM	3.6	mg/kg	[1,2]
0-0.5	COPPER	9800	mg/kg	[1,2,3]
0-0.5	*LEAD*	*2200*	*mg/kg*	*[1,2,3,8]**
0-0.5	MERCURY	0.3	mg/kg	[1,2]
0-0.5	NICKEL	52	mg/kg	[1,2,3]
0-0.5	SILVER	26	mg/kg	[1]
0-0.5	ZINC	430	mg/kg	[1,2]
0-0.5	*TOTAL PCBS*	*730 J*	*ug/kg*	*[1,2,3]*

LLV-19 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	440	mg/kg	[1,2,3]
1-1.5	COPPER	930	mg/kg	[1,2,3]
1-1.5	*LEAD*	*39*	*mg/kg*	*[1,2]*

CHLL-SD77 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	490	mg/kg	[1,2,3]
0-0.5	NICKEL	24	mg/kg	[1,2]
0-0.5	SILVER	2.2	mg/kg	[1]
3-5	*TOTAL PCBS*	*88 J*	*ug/kg*	*[1,2]*

LLV-20 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	410	mg/kg	[1,2,3]
1-1.5	COPPER	850	mg/kg	[1,2,3]

CHLL-SD78 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*ARSENIC*	*10*	*mg/kg*	*[1,2,8]*
0-0.5	COPPER	1900	mg/kg	[1,2,3]
0-0.5	*LEAD*	*330*	*mg/kg*	*[1,2,3]**
0-0.5	NICKEL	46	mg/kg	[1,2]
0-0.5	SILVER	5.5	mg/kg	[1]
0-0.5	ZINC	150	mg/kg	[1,2]

LLV-21 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	*ARSENIC*	*10*	*mg/kg*	*[1,2,8]*
0-0.25	COPPER	3200	mg/kg	[1,2,3]
1-1.5	COPPER	760	mg/kg	[1,2,3]

CHLL-SD13 06/15/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	550	mg/kg	[1,2,3]
0-0.5	NICKEL	25	mg/kg	[1,2]
0-0.5	SILVER	1.7	mg/kg	[1]

CHLL-SW03 05/28/15

PCBS WERE ALL NON-DETECT

CHLL-SD79 05/28/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*ARSENIC*	*14*	*mg/kg*	*[1,2,8]*
0-0.5	CADMIUM	3.8	mg/kg	[1,2]
0-0.5	COPPER	11000	mg/kg	[1,2,3]
0-0.5	*LEAD*	*2800*	*mg/kg*	*[1,2,3,8]**
0-0.5	MERCURY	0.2	mg/kg	[1,2]
0-0.5	NICKEL	53	mg/kg	[1,2,3]
0-0.5	SILVER	28	mg/kg	[1]
0-0.5	ZINC	330	mg/kg	[1,2]
0-0.5	*TOTAL PCBS*	*140 J*	*ug/kg*	*[1,2]*

See Figure 2b

See Figure 2c

See Figure 2c

DATA SOURCES

Sample IDs **Date Range**

1) **"SPMD-..."** **November 2005**
- **MDEQ**, Water Bureau. *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake Houghton County, MDEQ Project Number 05-25.* March 2006

2) **"LLV-..."** **July 2007 - Aug 2007**
- **USEPA.** *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan.* November 2007

3) **"TL07-..."** **August 2007**
- **MDEQ**, Water Bureau, *A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2001*, Editor 2008: Lansing, Michigan

4) **"SD-03 / SW-03"** **October 2011**
- **MDEQ** RRD, Superfund Section, Pre-remedial Group, Site Evaluation Unit, *CERCLA Draft Site Inspection (SI) Report for C&H Lake Linden Operations, Lake Linden, Michigan, 49945, U.S. EPA ID No: MIN000510619,* 2013

5) **"CHLL-..."** **June 2014 - July 2015**
- **MDEQ** RRD. *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan.* March 2016

MDEQ Part 201 Cleanup Criteria for Response Action
[1]=Sediment Ecological Screening Levels
[2]=Threshold Effect Concentration (TEC)
[3]=Probable Effect Concentration (PEC)
[4]=Surface Water Ecological Screening Levels
[5]=Surface Water Rule 57 HNV Drink
[6]=Surface Water Rule 57 HCV Drink
[7]=Surface Water Rule 57 WV
[8]=Residential Soil Direct Contact Criteria
* = Potentially exceeds hazardous waste toxicity value

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included on a different figure

Locations Analyzed for PCBs
- No Detections
- At Least One Detection

- Sediment Exceeds MDEQ Part 201 Residential Soil Direct Contact Criteria
- Approximate Subject Area of PCBs, Lead, and Arsenic above Criteria
- Excavation Extent (EPA's 2007 ER)
- Mining Era Buildings and Structures

- ***RED*** text indicates Total PCBs
- ***BLUE*** text indicates Lead
- ***GREEN*** text indicates Arsenic

- mg/kg = milligrams per kilogram
- ug/kg = micrograms per kilogram
- ug/l = micrograms per liter
- Sample depths shown in feet below ground surface
- Only results greater than criteria are shown

0 150 Ft

N

Coordinate System: MIGeoRef(m)

Prepared for:
Michigan Department of Environmental Quality

Mannik Smith GROUP
TECHNICAL SKILL. CREATIVE SPIRIT.
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Figure 2a

Sample Analytical Result Map
Sediment, Surface Water, and SPMD
Lake Linden, Houghton County, Michigan

DRAFT

FILE: C:\temp\Projects\MDEQ0070\GIS\mxd\Planning\20161130-TorchLake_Removal_Planning\LkLindenRecArea_Draft\LLR_Fig02a_Beach_Campground_and_Sand_v20170113.mxd 9:23:34 AM 1/13/2017 KBrown

Image Source: ESRI World Imagery (NAIP 2014)

2nd St

188

Front St

LLV-MP4 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	340	mg/kg	[1,2,3]

LLV-Creek1 07/26/07

Depth	Parameter	Result	Units	[Criteria]
0-0	ANTIMONY	3	ug/l	[5]
0-0	*ARSENIC*	*20*	*ug/l*	*[5,6]*
0-0	BARIUM	530	ug/l	[4]
0-0	CADMIUM	1.2	ug/l	[4]
0-0	COPPER	990	ug/l	[4,5]
0-0	*LEAD*	*550*	*ug/l*	*[4,5]**
0-0	SILVER	4.6	ug/l	[4]
0-0	VANADIUM	20	ug/l	[4]
0-0	ZINC	110	ug/l	[4]

LLV-13 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	300	mg/kg	[1,2,3]
0-0.25	COPPER (DUP)	440	mg/kg	[1,2,3]
1-1.5	COPPER	1100	mg/kg	[1,2,3]
1-1.5	COPPER (DUP)	300	mg/kg	[1,2,3]
1-1.5	*LEAD*	*49*	*mg/kg*	*[1,2]*

CHLL-SD19 07/12/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	89	mg/kg	[1,2]
1-2.4	COPPER	140	mg/kg	[1,2]

TL07-01 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	140	mg/kg	[1,2]
0.5-2	COPPER	430	mg/kg	[1,2,3]
0.5-2	*LEAD*	*110*	*mg/kg*	*[1,2]**
0.5-2	SILVER	1.3	mg/kg	[1]
2-3.58	COPPER	670	mg/kg	[1,2,3]
2-3.58	*LEAD*	*150*	*mg/kg*	*[1,2,3]**
2-3.58	SILVER	1.2	mg/kg	[1]
3.58-5.33	*ARSENIC*	*49*	*mg/kg*	*[1,2,3,8]*
3.58-5.33	BARIUM	130000	mg/kg	[8]
3.58-5.33	CADMIUM	85	mg/kg	[1,2,3]
3.58-5.33	CHROMIUM	200	mg/kg	[1,2,3]
3.58-5.33	COPPER	120000	mg/kg	[1,2,3,8]
3.58-5.33	*LEAD*	*75000*	*mg/kg*	*[1,2,3,8]**
3.58-5.33	MERCURY	1.5	mg/kg	[1,2,3]
3.58-5.33	SILVER	450	mg/kg	[1]
3.58-5.33	ZINC	6800	mg/kg	[1,2,3]
3.58-5.33	*TOTAL PCBS*	*8900*	*ug/kg*	*[1,2,3,8]*

LLV-MP3 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	200	mg/kg	[1,2,3]
0-0.5	*LEAD*	*40*	*mg/kg*	*[1,2]*

SW-03 10/12/11

Depth	Parameter	Result	Units	[Criteria]
0-0.5	CYANIDE	20.7 J	ug/l	[4]
0-0.5	COPPER	19.6 J	ug/l	[4]
0-0.5	COPPER (DUP)	28.2	ug/l	[4]
0-0.5	*LEAD*	*1.5 J*	*ug/l*	*[4]*
0-0.5	BIS(2-ETHYLHEXYL)PHTHALATE (DUP)	3.6 J	ug/l	[4]

SD-03 10/12/11

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	164	mg/kg	[1,2,3]
0-0.25	COPPER (DUP)	97.7	mg/kg	[1,2]

CHLL-SD18 07/12/14

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	130	mg/kg	[1,2]
1-2.7	CADMIUM	3.1	mg/kg	[1,2]
1-2.7	COPPER	4400	mg/kg	[1,2,3]
1-2.7	*LEAD*	*1600*	*mg/kg*	*[1,2,3,8]**
1-2.7	SILVER	13	mg/kg	[1]
1-2.7	ZINC	220	mg/kg	[1,2]
1-2.7	*TOTAL PCBS*	*720 J*	*ug/kg*	*[1,2,3]*

LLV-MP5 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	310	mg/kg	[1,2,3]
0-0.5	*LEAD*	*130*	*mg/kg*	*[1,2]**

LLV-MP6 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	330	mg/kg	[1,2,3]
0-0.5	*LEAD*	*110*	*mg/kg*	*[1,2]**

LLV-14 07/31/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	72	mg/kg	[1,2]
1-1.5	*ARSENIC*	*11*	*mg/kg*	*[1,2,8]*
1-1.5	COPPER	1500	mg/kg	[1,2,3]
1-1.5	*LEAD*	*470*	*mg/kg*	*[1,2,3,8]**

CHLL-SW01 05/27/15

PCBS WERE ALL NON-DETECT

CHLL-SD73 05/27/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	CADMIUM	2.7	mg/kg	[1,2]
0-0.5	COPPER	3800	mg/kg	[1,2,3]
0-0.5	*LEAD*	*1900*	*mg/kg*	*[1,2,3,8]**
0-0.5	NICKEL	27	mg/kg	[1,2]
0-0.5	SILVER	13	mg/kg	[1]
0-0.5	ZINC	290	mg/kg	[1,2]
0-0.5	*TOTAL PCBS*	*180 J*	*ug/kg*	*[1,2]*
1-3	*TOTAL PCBS*	*250 J*	*ug/kg*	*[1,2]*
1-3	*TOTAL PCBS (DUP)*	*230 J*	*ug/kg*	*[1,2]*
1-3	FLUORANTHENE	940 J	ug/kg	[1,2]
1-3	FLUORANTHENE (DUP)	1200	ug/kg	[1,2]
1-3	PYRENE	700 J	ug/kg	[1,2]
1-3	PYRENE (DUP)	890	ug/kg	[1,2]

LLV-MP8 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	540	mg/kg	[1,2,3]
0-0.5	*LEAD*	*68*	*mg/kg*	*[1,2]*

CHLL-SW02 05/27/15

PCBS WERE ALL NON-DETECT

CHLL-SD74 05/27/15

Depth	Parameter	Result	Units	[Criteria]
0-0.5	*ARSENIC*	*12*	*mg/kg*	*[1,2,8]*
0-0.5	CADMIUM	2.6	mg/kg	[1,2]
0-0.5	COPPER	4000	mg/kg	[1,2,3]
0-0.5	*LEAD*	*1100*	*mg/kg*	*[1,2,3,8]**
0-0.5	MERCURY	0.2	mg/kg	[1,2]
0-0.5	NICKEL	43	mg/kg	[1,2]
0-0.5	SILVER	7.8	mg/kg	[1]
0-0.5	ZINC	440	mg/kg	[1,2]
0-0.5	*TOTAL PCBS*	*370 J*	*ug/kg*	*[1,2]*

TL07-03 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-1.75	COPPER	160	mg/kg	[1,2,3]
1.75-3.42	*ARSENIC*	*55*	*mg/kg*	*[1,2,3,8]*
1.75-3.42	BARIUM	99000	mg/kg	[8]
1.75-3.42	CADMIUM	37	mg/kg	[1,2,3]
1.75-3.42	CHROMIUM	120	mg/kg	[1,2,3]
1.75-3.42	COPPER	120000	mg/kg	[1,2,3,8]
1.75-3.42	*LEAD*	*42000*	*mg/kg*	*[1,2,3,8]**
1.75-3.42	MERCURY	2.6	mg/kg	[1,2,3]
1.75-3.42	SILVER	380	mg/kg	[1]
1.75-3.42	ZINC	4100	mg/kg	[1,2,3]
1.75-3.42	*TOTAL PCBS*	*6100*	*ug/kg*	*[1,2,3,8]*
3.42-5.83	CHROMIUM	44	mg/kg	[1,2]
3.42-5.83	COPPER	3500	mg/kg	[1,2,3]
3.42-5.83	*LEAD*	*300*	*mg/kg*	*[1,2,3]*
3.42-5.83	SILVER	9.3	mg/kg	[1]
3.42-5.83	ZINC	140	mg/kg	[1,2]

LLV-MP7 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	100	mg/kg	[1,2]

TL07-02 08/07/07

Depth	Parameter	Result	Units	[Criteria]
0-2.33	COPPER	370	mg/kg	[1,2,3]
0-2.33	*LEAD*	*100*	*mg/kg*	*[1,2]**
0-2.33	SILVER	0.87	mg/kg	[1]
2.33-4	*ARSENIC*	*38*	*mg/kg*	*[1,2,3,8]*
2.33-4	BARIUM	84000	mg/kg	[8]
2.33-4	CADMIUM	38	mg/kg	[1,2,3]
2.33-4	CHROMIUM	130	mg/kg	[1,2,3]
2.33-4	COPPER	78000	mg/kg	[1,2,3,8]
2.33-4	*LEAD*	*44000*	*mg/kg*	*[1,2,3,8]**
2.33-4	MERCURY	1.7	mg/kg	[1,2,3]
2.33-4	SILVER	290	mg/kg	[1]
2.33-4	ZINC	3500	mg/kg	[1,2,3]
2.33-4	*TOTAL PCBS*	*5800*	*ug/kg*	*[1,2,3,8]*
4-5.33	ARSENIC	8.2	mg/kg	[8]
4-5.33	CADMIUM	3.6	mg/kg	[1,2]
4-5.33	COPPER	9600	mg/kg	[1,2,3]
4-5.33	*LEAD*	*2500*	*mg/kg*	*[1,2,3,8]**
4-5.33	MERCURY	0.3	mg/kg	[1,2]
4-5.33	SILVER	39	mg/kg	[1]
4-5.33	ZINC	430	mg/kg	[1,2]
4-5.33	*TOTAL PCBS*	*280*	*ug/kg*	*[1,2]*

See Figure 2a

Lake Linden

Map Extent

Schoolcraft Twp

Hubbell

Torch Lake

Boyd Lake Rd

DATA SOURCES

Sample IDs **Date Range**

1) **"SPMD-..."** **November 2005**
- **MDEQ**, Water Bureau. *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake Houghton County, MDEQ Project Number 05-25.* March 2006

2) **"LLV-..."** **July 2007 - Aug 2007**
- **USEPA.** *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan.* November 2007

3) **"TL07-..."** **August 2007**
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5) **"CHLL-..."** **June 2014 - July 2015**
- **MDEQ** RRD. *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan.* March 2016

MDEQ Part 201 Cleanup Criteria for Response Action
[1]=Sediment Ecological Screening Levels
[2]=Threshold Effect Concentration (TEC)
[3]=Probable Effect Concentration (PEC)
[4]=Surface Water Ecological Screening Levels
[5]=Surface Water Rule 57 HNV Drink
[6]=Surface Water Rule 57 HCV Drink
[7]=Surface Water Rule 57 WV
[8]=Residential Soil Direct Contact Criteria
* = Potentially exceeds hazardous waste toxicity value

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included on a different figure

Locations Analyzed for PCBs
- No Detections
- At Least One Detection

- Sediment Exceeds MDEQ Part 201 Residential Soil Direct Contact Criteria
- Approximate Subject Area of PCBs, Lead, and Arsenic above Criteria
- Excavation Extent (EPA's 2007 ER)
- Mining Era Buildings and Structures

- mg/kg = milligrams per kilogram
- ug/kg = micrograms per kilogram
- ug/l = micrograms per liter
- Sample depths shown in feet below ground surface
- Only results greater than criteria are shown

- ***RED*** text indicates Total PCBs
- ***BLUE*** text indicates Lead
- ***GREEN*** text indicates Arsenic

N

0 100 Ft

Coordinate System: MIGeoRef(m)

Prepared for:
Michigan Department of Environmental Quality

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Figure 2b

Sample Analytical Result Map
Sediment and Surface Water
Lake Linden, Houghton County, Michigan

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FILE: C:\temp\Projects\MDEQ0007\GIS\mxd\Planning\20161130-TorchLake_Removal_Planning\LkLindenRecArea_DraftLLR_Fig02b_ER_Footprint_v20170113.mxd 9:44:16 AM 1/13/2017 KBrown

Image Source: ESRI World Imagery (NAIP 2014)

DATA SOURCES

Sample IDs **Date Range**

1) **"SPMD-..."** **November 2005**
- **MDEQ**, Water Bureau. *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake Houghton County, MDEQ Project Number 05-25.* March 2006

2) **"LLV-..."** **July 2007 - Aug 2007**
- **USEPA.** *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan.* November 2007

3) **"TL07-..."** **August 2007**
- **MDEQ**, Water Bureau, *A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2001*, Editor 2008: Lansing, Michigan

4) **"SD-03 / SW-03"** **October 2011**
- **MDEQ** RRD, Superfund Section, Pre-remedial Group, Site Evaluation Unit, *CERCLA Draft Site Inspection (SI) Report for C&H Lake Linden Operations, Lake Linden, Michigan, 49945, U.S. EPA ID No: MIN000510619,* 2013

5) **"CHLL-..."** **June 2014 - July 2015**
- **MDEQ** RRD. *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan.* March 2016

See Figure 2b

See Figure 2a

LLV-8 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1500	mg/kg	[1,2,3]
1-1.5	COPPER	1000	mg/kg	[1,2,3]

LLV-7 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1000	mg/kg	[1,2,3]
0-0.25	COPPER (DUP)	1100	mg/kg	[1,2,3]
1-1.5	COPPER	560	mg/kg	[1,2,3]
1-1.5	COPPER (DUP)	470	mg/kg	[1,2,3]

LLV-4 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	770	mg/kg	[1,2,3]
1-1.5	COPPER	1500	mg/kg	[1,2,3]

TL07-13 08/08/07

Depth	Parameter	Result	Units	[Criteria]
0-0.5	COPPER	800	mg/kg	[1,2,3]
0-0.5	SILVER	3.3	mg/kg	[1]
0.5-2.17	*ARSENIC*	*8.7*	*mg/kg*	*[8]*
0.5-2.17	COPPER	1300	mg/kg	[1,2,3]
0.5-2.17	*LEAD*	*70*	*mg/kg*	*[1,2]*
0.5-2.17	SILVER	4	mg/kg	[1]
2.17-3.33	*ARSENIC*	*18*	*mg/kg*	*[1,2,8]*
2.17-3.33	COPPER	2400	mg/kg	[1,2,3]
2.17-3.33	*LEAD*	*72*	*mg/kg*	*[1,2]*
2.17-3.33	SILVER	8.1	mg/kg	[1]
3.33-5.5	COPPER	7100	mg/kg	[1,2,3]
3.33-5.5	COPPER (DUP)	5800	mg/kg	[1,2,3]
3.33-5.5	SILVER	8	mg/kg	[1]
3.33-5.5	SILVER (DUP)	6.9	mg/kg	[1]

LLV-6 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	2600	mg/kg	[1,2,3]
1-1.5	COPPER	3900	mg/kg	[1,2,3]

LLV-5 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	6400	mg/kg	[1,2,3]
1-1.5	COPPER	1300	mg/kg	[1,2,3]

LLV-3 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	810	mg/kg	[1,2,3]
1-1.5	COPPER	1200	mg/kg	[1,2,3]

LLV-1 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	1900	mg/kg	[1,2,3]
1-1.5	*LEAD*	*40*	*mg/kg*	*[1,2]*

LLV-22 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	580	mg/kg	[1,2,3]
0-0.25	COPPER (DUP)	720	mg/kg	[1,2,3]
1-1.5	COPPER	580	mg/kg	[1,2,3]
1-1.5	COPPER (DUP)	570	mg/kg	[1,2,3]

LLV-23 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	630	mg/kg	[1,2,3]
1-1.5	COPPER	880	mg/kg	[1,2,3]

LLV-24 07/30/07

Depth	Parameter	Result	Units	[Criteria]
0-0.25	COPPER	750	mg/kg	[1,2,3]
1-1.5	COPPER	570	mg/kg	[1,2,3]

MDEQ Part 201 Cleanup Criteria for Response Action
[1]=Sediment Ecological Screening Levels
[2]=Threshold Effect Concentration (TEC)
[3]=Probable Effect Concentration (PEC)
[4]=Surface Water Ecological Screening Levels
[5]=Surface Water Rule 57 HNV Drink
[6]=Surface Water Rule 57 HCV Drink
[7]=Surface Water Rule 57 WV
[8]=Residential Soil Direct Contact Criteria
* = Potentially exceeds hazardous waste toxicity value

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included on a different figure

Locations Analyzed for PCBs
- No Detections
- At Least One Detection

- Sediment Exceeds MDEQ Part 201 Residential Soil Direct Contact Criteria
- Approximate Subject Area of PCBs, Lead, and Arsenic above Criteria
- Excavation Extent (EPA's 2007 ER)
- Mining Era Buildings and Structures

- mg/kg = milligrams per kilogram
- ug/kg = micrograms per kilogram
- ug/l = micrograms per liter
- Sample depths shown in feet below ground surface
- Only results greater than criteria are shown

- ***RED*** text indicates Total PCBs
- ***BLUE*** text indicates Lead
- ***GREEN*** text indicates Arsenic

0 150 Ft

N

Coordinate System: MIGeoRef(m)

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Figure 2c
Sample Analytical Result Map
Sediment and Surface Water
Lake Linden, Houghton County, Michigan

DRAFT

FILE: C:\temp\Projects\MDEQ0070\GIS\mxds\Planning\20161130-TorchLake_Removal_Planning\LkLindenRecArea_Draft\LLR_Fig02c_Park_and_Marina_v20170113.mxd 12:50:43 PM 1/13/2017 KBrown