DISTRIBUTION OF PCBS IN THE TORCH LAKE ENVIRONMENT
MEMORANDUM

ABANDONED MINING WASTES – TORCH LAKE NON-SUPERFUND SITE
HOUGHTON COUNTY, MICHIGAN
SITE ID# 31000098

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PREPARED FOR:

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
REMEDIATION & REDEVELOPMENT DIVISION
CALUMET FIELD OFFICE
CALUMET, MICHIGAN

Mannik Smith GROUP

EXECUTIVE SUMMARY

This memorandum summarizes the Abandoned Mining Wastes – Torch Lake non-Superfund Site (AMW Project) upland and in-lake findings relative to the distribution of Polychlorinated biphenyls (PCBs) in the Torch Lake environment.

The memorandum was prepared at the request of the Michigan Department of Environmental Quality (DEQ) Upper Peninsula District Remediation and Redevelopment Division (UPDO) by the Mannik & Smith Group, Inc. (MSG) as part of the AMW Project (Site ID: 31000098). This memorandum was prepared in accordance with the *Indefinite Scope Indefinite Delivery (ISID) Discretionary Proposal for FS and Remedial Action Activities* (24 February 2016) prepared by MSG in response to a request from the UPDO, under MSG's 2015 Environmental Services ISID Contract Number 00538 with the State of Michigan.

INTRODUCTION

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 Torch Lake's volume is estimated to be filled with tailings and other waste products.

The U.S. Environmental Protection Agency (EPA) designated Torch Lake and its western shoreline, and other areas of the Keweenaw Peninsula, as a Superfund site in 1986 (https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0503034) after over 100 years of mining and reclamation. 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). Under the Torch Lake Superfund Site project EPA took cleanup activities to address some of the byproducts of the mining industry while others were not addressed or left to recover through natural processes.

Environmental impairments within Torch Lake and along the shoreline resulting from historical mining era industrial operations:

- Present potential exposure risk to human and ecological receptors;
- Limit the recovery of the Torch Lake ecosystem;
- Create uncertainty over safe and beneficial reuse of the land; and,
- Prevent delisting of Torch Lake as an AOC under the Great Lakes Water Quality Agreement due to Beneficial Use Impairments (BUIs) related to restrictions on fish and wildlife consumption because of the on-going presence of polychlorinated biphenyls (PCBs) in fish and degradation of benthos because of metals contaminated sediments.

PCBs are of particular concern in Torch Lake sediments, surface water, and submerged abandoned container contents, as well as in upland soil, waste, residual processing materials

(RPM), and abandoned container contents in former industrial areas along the shoreline as they serve as a continuing source of PCBs into the environment.

The Upper Peninsula District Remediation and Redevelopment Division (UPDO) Abandoned Mining Wastes – Torch Lake non-Superfund Site (AMW Project) is addressing some of the remaining concerns in Houghton County not addressed by the EPA Torch Lake Superfund Site. The AMW Project concerns involve groundwater, surface water, sediments, and "upland" media. Known or suspected problems that were evaluated as part of the AMW Project include an unidentified, significant in-lake and/or terrestrial source of PCBs; uncharacterized waste deposits; >750 uncharacterized drums on the lake bottom; industrial waste dumps and ruins; coal storage areas; underground storage tanks (USTs); RPM; and, asbestos containing materials (ACM).

AMW Project Site Investigation (SI) and Interim Response (IR) activities completed from 2014 to 2017, along with assimilation of key information from prior DEQ and EPA studies have identified two in-lake sources of PCBs and an area of upland PCB contamination. The results of DEQ and EPA multi-media sampling in Torch Lake, coupled with DEQ Water Resources Division (WRD), (formerly the DEQ Water Bureau), semi-permeable membrane device (SPMD) and fish tissue studies, have confirmed the existence of on-going sources of PCBs to the Torch Lake environment. Major DEQ and EPA studies associated with Torch Lake completed between 2005 and 2015 included in this evaluation are available on the DEQ's AMW Project website at http://www.michigan.gov/deq/0,4561,7-135-3311_4109_9846_76560---,00.html.

Figures 1 through **Figure 3** graphically depict the distribution of maximum total PCB concentrations in sediments, surface water, abandoned container contents, soil, waste, and RPM within the Torch Lake environment, along with relevant human and ecological exposure pathways. Photographs on **Figures 1** through **Figure 3** in **Appendix A** depict conditions in the sources areas.

An overview of the AMW Project's upland and in-lake findings, IR actions, and a correlation of these results leading to the conclusion that PCBs are ubiquitous in the Torch Lake ecosystem follows.

UPLAND PCB CONTAMINATION

Terrestrial SI findings for the Hubbell Processing Area confirm that PCBs are present in soil, groundwater, waste piles, RPM, and abandoned container contents. These findings, coupled with physical property characteristics and observations of erosion, indicate that the Hubbell Processing Area is an upland source of PCBs to Torch Lake through airborne, groundwater, surface water, and soil erosion transport pathways. The locations of upland samples in the Hubbell Processing Area are depicted on **Figure 4** that also indicates sample locations where total PCBs either:

- Exceeded criteria established per Part 201 of Michigan's Natural Resources and Environmental Protection Act (NREPA), being PA 451 of 1994, as amended;
- Were detected, but did not exceed criteria; or,
- Were not detected.

The following subsections provide a summary of AMW Project derived analytical results for total PCBs by upland matrix and UPDO IR actions taken during 2016 and 2017.

Soil

Laboratory analytical results of soil samples collected from former industrial areas along the shoreline of Torch Lake show one distinct grouping of PCB contamination in the Hubbell Processing Area that includes the Coal Dock, Mineral Building, and Smelter properties. Total PCBs in the Hubbell Processing Area were detected in surficial and subsurface soil at concentrations up to 15.9 parts per million (ppm) and 11.4 ppm in surficial and subsurface soil samples, respectively.

Groundwater

Groundwater samples collected from shoreline locations in the Hubbell Processing Area contained total PCBs. The greatest concentration of total PCBs detected was 0.73 micrograms/liter (µg/l). The presence of PCBs in groundwater is significant since PCBs are considered not likely to leach to groundwater from soils or waste. The RRD UPDO is not aware of any potable wells on the three properties that compose the Hubbell Processing Area.

Waste Piles

Analytical results of waste samples collected from 7 out of 10 of the 35 waste piles located along the shoreline of Torch Lake on the Hubbell Processing Area Mineral Building property contained total PCBs. The PCB concentration in the 120-ton Waste Pile WP-11 was 100 ppm, thus it required management as a Toxic Substances Control Act (TSCA) PCB remediation regulated waste. TSCA addresses the production, importation, use, and disposal of PCBs based on origin, date of generation, and concentration. In the case of WP-11, it was determined the PCBs were released prior to 1978 and were present at a concentration greater than 50 ppm, a regulatory trigger. Waste Pile WP-11 also required management as a Resource Conservation and Recovery Act (RCRA) hazardous waste due to the results of a Toxicity Characteristic Leach Procedure (TCLP) test for lead, thus it required disposal at a RCRA hazardous waste regulated facility. TCLP testing identifies wastes likely to leach concentrations of contaminants that may be harmful to human health or the environment. As part of the AMW Project Waste Pile WP-11 was removed and disposed at a TSCA and RCRA hazardous waste regulated landfill.

Eighteen of the remaining waste piles totaling an estimated 4,758 tons consist of mining era waste and debris, many of which are either known or suspected to contain PCBs based on current SI results. The other 17 remaining waste piles totaling an estimated 3,486 tons consist of construction and demolition, roadwork, and/or woody debris and generally do not appear to have originated during the mining era. In addition to the waste piles, there is also an estimated 2,810 cubic yards of mining era stack debris present on the Mineral Building property.

Residual Processing Materials

Samples of RPM, which is primarily burnt cable and wire wrap (i.e. byproducts believed to have been discarded in-place following mining era reclamation operations), collected from the ground surface along the shoreline of Torch Lake in the Hubbell Processing Area on the Coal Dock property contained total PCBs at concentrations up to 860 ppm PCBs. As part of the AMW Project visible, surficial RPM was removed and disposed of as a TSCA PCB remediation waste in 2016 and 2017.

Abandoned Container Contents

Despite being part of the Torch Lake Superfund Site where environmental remediation actions occurred, mining era drums containing PCBs and other contaminants remained on the ground surface, buried on site and beneath the EPA cap in the Hubbell Processing Area.

The contents of two dilapidated mining era drums located on the Hubbell Processing Area Coal Dock property contained total PCBs in concentrations up to 0.185 ppm. The drum contents were also determined to be a RCRA hazardous waste due to TCLP results for lead.

The contents of partially buried abandoned drums protruding from the EPA cap near the Torch Lake shoreline adjacent to the Hubbell Processing Area Smelter property also contained total PCBs. In total eight abandoned containers were identified in the shoreline area. All eight of the drums contained total PCBs in concentrations up to 1.58 ppm. Four of these drums were also determined to be a RCRA hazardous waste due to the TCLP results for lead.

As part of the AMW Project, these abandoned containers were removed and disposed of in 2016 and 2017.

TORCH LAKE PCB CONTAMINATION

AMW Project SI findings confirmed that PCBs are present in the Hubbell Processing Area in various media including Torch Lake surface water, SPMDs, submerged abandoned container contents, and sediments. PCBs are also present in the Lake Linden Recreation Area in SPMDs and sediments. The SI results indicate that both of these in-lake areas are a source of PCBs to the Torch Lake environment, including to fish, through bioaccumulation and biomagnification pathways, and ultimately humans through fish ingestion. The locations of surface water and sediment samples throughout Torch Lake are depicted on **Figure 5** that also indicates sample locations where total PCB results either:

- Exceeded MDEQ – Rule 57 Water Quality Values criteria for surface water;
- Exceeded ecological screening levels (ESLs), threshold effect concentrations (TECs), probable effect concentrations (PECs) for sediments;
- Were detected, but did not exceed criteria; or,
- Were not detected.

Risk based ESLs, TECs below which adverse effects are not expected to occur and PECs above which adverse effects are expected to frequently occur, allow for evaluation of data to assess potential ecological concerns. As part of the AMW Project, sediment data was compared to ESLs, TECs, and PECs adapted from Appendix A and Appendix B of DEQ - Remediation and Redevelopment Division Operational Memorandum No. 4 Attachment 3, Interim Final August 2, 2006.

The following subsections provide a summary of AMW Project derived analytical results for total PCBs and prior DEQ and EPA results by in-lake matrix.

Sediment

Results of the AMW Project and prior DEQ and EPA multi-media sampling show two distinct groupings of PCB contamination in Torch Lake sediments. The first grouping is located in the Lake Linden Recreation Area and the second is located in the Hubbell Processing Area.

Total PCBs were detected in surficial sediment samples and deep sediment samples collected from the Lake Linden Recreation Area up to a concentration of 8.9 ppm. Concentrations of lead

in shallow water nearshore sediment samples also exceeded DEQ direct contact criteria and potentially hazardous toxicity values similar to the sediments removed by the EPA Emergency Response Branch (ERB) as reported in a document entitled *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan* (November 2007). Direct contact criteria is considered relevant in the nearshore area since there is potential exposure 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.

Total PCBs were also detected in surficial sediment samples collected from the Hubbell Processing Area up to a concentration of 74 ppm.

Abandoned Container Contents

Side scan sonar surveys conducted as part of the AMW Project identified a high concentration of industrial materials on the lake bottom out from the shoreline in the Hubbell Processing Area, particularly offshore of the southernmost Smelter property. Visual inspection of these anomalies using an autonomous underwater vehicle (AUV) equipped with a video camera confirmed that abandoned containers including drums, metal debris, circuit board waste, and similar materials are present on the lake bottom.

Using an AUV equipped with a sampling arm, the contents of 12 of the reported hundreds of submerged abandoned containers were sampled near known PCB-contaminated sediments in the Hubbell Processing Area. Total PCBs were detected in all 13 of the samples collected from the contents of 12 submerged drums. Total PCBs were detected up to a concentration of 17.4 ppm.

A potentially responsible party (PRP) group document entitled *Final Drum Removal Report Torch Lake Drum Removal Houghton County, Michigan* (24 March 1992) stated "The final drum count off-shore of the PCI property (referred to as the Hubbell Processing Area Smelter property in this evaluation) was 742 empty drums located, and eight (8) drums of unknown solid contents located. The 742 empty drums were all thoroughly inspected by the divers, and the empty nature of the drums in this area was confirmed by the USEPA OSC, the EMS Field Manager, and the Geraghty & Miller Project Engineer by means of a diver-held video camera

and an on-board video monitor. All 8 drums with unknown contents were overpacked and removed from this area."

The AMW Project underwater surveillance and abandoned container content sampling conducted in 2017 indicated 12 of the drums sampled with the AUV, seemingly among the previously reported empty drums, are deteriorated or breached, and the non-liquid contents contain PCBs.

Surface Water and Fish Tissue

Analytical results of one AMW Project surface water sample indicated total PCB concentrations of 2.3 ug/l in the Hubbell Processing Area. This surface water sample was collected near a deteriorated, partially buried abandoned container with PCB-containing waste contents, which was protruding from the EPA cap near the Torch Lake shoreline adjacent to the Hubbell Processing Area. The container contents were subject to disturbance from wave action.

DEQ Water Bureau analytical results from SPMDs indicated the presence of PCBs throughout Torch Lake. The general purpose of the collection method is to provide a time-weighted exposure that is representative of chemical uptake through fish respiration. SPMD sample results do not provide for a direct comparison to surface water criteria, but are an indicator of contaminants in the water column. The SPMD results provide a qualitative comparison of PCB concentrations in Torch Lake to concentrations in connecting waters to Lake Superior. As reported by the Great Lakes Environmental Center in a document entitled *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake, Houghton County* (March 2006), analytical results from the SPMD samples confirmed the presence of PCBs in surface waters of Torch Lake. The SPMD sampling results were inconclusive in identifying a specific PCB source within Torch Lake, but noted that the concentrations of PCBs measured in the SPMD samples were consistent with analytical results previously measured. In addition, the SPMD sample results demonstrated that concentrations of PCBs in Torch Lake were significantly higher than the results of samples collected from the connecting waters to Lake Superior. Of note, the greatest SPMD PCB concentration was detected in the SPMD sample collected in the Hubbell Processing Area.

The SPMD analytical results were corroborated in a fish tissue study completed by the DEQ Water Bureau in 2008. The study was documented in a report prepared by the DEQ Water Bureau entitled *PCB Concentrations in Walleye Collected from Torch Lake (Houghton County) and Lake Superior* (June 2008). The study documented that "PCB concentrations in fish collected from Torch Lake have been consistently higher than in fish found in nearby surface water bodies." The Michigan Department of Community Health (MDCH) first issued a fish consumption advisory due to elevated levels of PCBs for Torch Lake fish in 1998.

Fish in Torch Lake were known to contain elevated levels of PCBs, but it was previously unclear whether the cause of elevated PCB concentrations in fish was from sources within the Torch Lake watershed, from air deposition, or from fish exposure at other locations. It had been postulated in the 2008 DEQ Water Bureau study cited above that the elevated concentrations of PCBs in fish caught in Torch Lake might actually represent exposure to the contaminant in Lake Superior waters since PCBs are known to be elevated in several species in Lake Superior, and there are no barriers to fish movement between the two water bodies. The elevated PCB concentration in Lake Superior fish is believed to be due primarily to atmospheric deposition.

The report concluded that "higher total PCB concentrations and different congener compositions were found in walleye collected from Torch Lake versus walleye caught in Huron Bay indicating that there is a source of PCBs in the Torch Lake watershed" (DEQ, 2008). See the following section for a discussion of PCB congener analysis.

The DEQ WRD and Michigan Department of Health and Human Services (MDHHS) continue 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. An update of the status of contaminant concentrations using fish samples collected in 2013 was documented in a report prepared by the DEQ WRD entitled *Status of Fish Contaminant Levels in the Torch Lake Area of Concern 2013* (January 2016). This report provided an update of the status of contaminant concentrations using fish samples collected in 2013 from Torch Lake and from two Lake Superior reference sites. The 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 anticipated continued fish consumption advisories for total PCBs and mercury.

CORRELATION OF RESULTS IN THE TORCH LAKE ECOSYSTEM

PCBs were manufactured as blends based on the overall percent chlorine present in the blend. Different chlorine contents dictated the physical and chemical properties of the blend, each of which had different commercial/industrial applications. The commercial name for PCB blends was “Aroclor”. The Aroclor number generally indicated the percent chlorine present; Aroclor 1242 contains 42% chlorine, Aroclor 1254 contains 54% chlorine, etc. The manufacture and use of the various Aroclors is well documented (Frame, 1996). Analysis of PCBs as Aroclors (EPA Method 8082) is the most common approach to measuring PCB concentration, and is the basis for most regulatory standards. PCBs can be analyzed by “homolog”, the composition by percent chlorine (EPA Method 680). Results are expressed as either ppm or percent of total PCB by chlorine grouping, such as monochlorobiphenyl, dichlorobiphenyls, etc., on up to decachlorobiphenyl. PCBs can also be analyzed by “congener”. There are 209 possible PCB compounds, or congeners. Like homolog analysis, the results of congener analysis are expressed as either ppm or percent of total PCB by each individual congener. The composition of Aroclors by congener has been studied extensively (Frame, 1996). Most Aroclors have unique, or “marker” congeners that can help identify the source Aroclor in a degraded sample.

Comparison of Aroclors in source material and environmental media is commonly used to determine contamination pathways. While higher PCB concentrations like in the RPM resulting from mining era reclamation operations can be readily identified by Aroclor analysis, low PCB concentrations in the environment are sometimes degraded (through evaporation or biodegradation of the lighter congeners); therefore, homolog and congener analysis can be a useful tool when trying to identify the source of PCB contamination in degraded samples, such as in sediment and fish tissue.

As part of the AMW Project SI, a subset of known PCB containing environmental and waste samples collected during field sampling efforts were selected for PCB congener analysis in addition to Aroclor analysis. SI results are reported by the DEQ in a document entitled *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan* (March 2016). The purpose of the analysis was to compare the observed congener/homolog/Aroclor patterns in soil,

sediment, RPM, abandoned container contents, waste piles, surface water, and groundwater from the Hubbell Processing Area and Lake Linden Recreation Area with the observed congener/homolog/Aroclor patterns in Torch Lake fish tissue data and contrasting with congener/homolog/Aroclor patterns in waters believed to be contaminated with PCBs via only air deposition to confirm or refute the hypothesis that identified upland and in-lake PCB sources are continuing to contribute to the PCBs in the fish tissue. The results of the congener analysis that confirmed that PCBs in Torch Lake fish tissue are a result of sources within the Torch Lake environment is provided in the next section.

Figure 6 depicts the locations of samples with the greatest total PCB concentrations in soil, groundwater, RPM, waste pile, surface water, sediment, and abandoned container content in the Torch Lake environment. **Figure 6** also provides a summary of maximum total PCB concentrations by matrix and a comparison to the applicable DEQ cleanup criteria.

Hubbell Processing Area

Maximum total PCB concentrations in the Hubbell Processing Area were:

- Residual Process Materials (wire wrap/sheathing) = 860 ppm
- Waste Piles = 100 ppm
- Surficial Soils = 15.9 ppm
- Subsurface Soils = 11.4 ppm
- Terrestrial Abandoned Container Contents Near Shoreline = 1.58 ppm
- Terrestrial Abandoned Container Contents = 0.185 ppm
- Groundwater = 0.73 micrograms/liter (µg/l)
- Sediments = 74 ppm
- Surface Water = 2.3 µg/l
- In-Lake Submerged Abandoned Container Contents = 17.4 ppm

The samples from this area contained a wide range of Aroclors, including Aroclors 1242, 1248, 1254, 1260, 1262, and 1268. The U.S. Department of Health and Human Services Public Health Services Agency for Toxic Substances and Disease Registry document entitled *Toxicological Profile for PCBs* (November 2000) reported that these Aroclors were commonly used in several applications including capacitors (1254), transformers (1242, 1254, and 1260), and plasticizers (1242, 1248, 1254, 1260, 1262, and 1268). Aroclors 1262 and 1268 had limited commercial use (commonly used in plasticizers) and are therefore particularly notable when identified in

environmental or fish tissue samples; both are solids at room temperature, and contain the heaviest (most chlorinated) PCB congeners.

Lake Linden Recreation Area

Maximum total PCB concentrations in the Lake Linden Recreation Area, where sediments are the primary issue, were:

- Sediment = 8.9 ppm

The Lake Linden Recreation Area Aroclors included Aroclors 1242, 1248, and 1254 that were commonly used in electrical equipment, hydraulics/lubricants, and plasticizers. Aroclor 1262 that had limited commercial use (commonly used in plasticizers) was also detected.

Hubbell Processing Area and Lake Linden Recreation Area PCB Pattern Analysis

The following observations have been made, comparing the observed congener/homolog/Aroclor patterns in soil, sediment, RPM, abandoned container contents, waste pile, and groundwater from the Hubbell Processing Area and Lake Linden Recreation Area with the observed congener/homolog/Aroclor patterns in Torch Lake fish tissue data:

Aroclor 1242

- No Aroclor 1242 was detected in upland soil, groundwater, waste, RPM or abandoned container contents.
- Aroclor 1242 was detected in the contents of submerged abandoned containers in the Hubbell Processing Area.
- Aroclor 1242 was detected primarily in sediments in the Lake Linden Recreation Area.
- No Aroclor 1242 was detected in the 1988 fish tissue (without congener data, and assuming analysis is correct).
- Little or no Aroclor 1242 seems to be present in the 2013 fish tissue based on the congener comparison with the Aroclor 1242 standard.

Aroclor 1242 may have entered the water at some time in the past and potentially is currently from the contents of submerged drums, but does not appear to be affecting fish tissue now based on the 2013 fish tissue analyses.

Aroclor 1254

- Aroclor 1254 was present in nearly every PCB containing soil, sediment, RPM, abandoned container content, waste pile, surface water, and groundwater sample.
- Aroclor 1254 was present in the 1988 fish tissue.
- Aroclor 1254 is probably present in the 2013 fish tissue based on congener analysis, given that the pentachlorobiphenyl homolog common to Aroclor 1254 is significant (16%). Pentachlorobiphenyl is barely present in heavier Aroclors. Pentachlorobiphenyl is present in Aroclor 1242 (in lower proportions than in Aroclor 1254). Although Aroclor 1242 is not present in the upland areas, it is in the contents of deteriorated submerged drums therefore the Hubbell Processing Area in-lake source is likely to be affecting fish tissue.
- Aroclor 1254 from sediment, surface water, and submerged abandoned container contents, and upland soils, RPM, abandoned container contents, waste piles, and groundwater could still be affecting fish tissue. Airborne deposition of Aroclor 1254 (presenting as pentachlorobiphenyl vapors) could be occurring and cannot be ruled out based on the available data, but the airborne contribution relative to other pathways would be extremely small given its low vapor pressure. Ambient air monitoring would be needed to confirm whether the Aroclor homologs are detectable in the local air, and even then, it would be difficult to assess their relative contribution to the water column.

Aroclor 1260 and Higher

- Aroclors 1260, 1262, and 1268 were detected in upland soil, RPM, abandoned container contents, waste piles, groundwater, submerged abandoned container contents, and sediment.
- These three Aroclors were not detected in the 1988 Torch Lake fish tissue samples.
- One or more of these heavier Aroclors is present in the 2013 Torch Lake fish tissue based on the congener test results. A number of the heavier homologs (hexa through octa in particular) are present in the 2013 fish tissue samples and could not have come from Aroclor 1254.
- Either Aroclor 1262 and/or 1268 are present in the 26 of 33 2013 Torch Lake fish tissue samples, based on the presence of the octa homolog. Octachlorobiphenyl is also present in Aroclor 1260 but not at levels that could explain the results shown.
- Note also that octa congeners were detected in the groundwater samples, which could in part explain the fish exposure pathway. SPMD test results did not show octachlorobiphenyl, but the method only measures soluble PCBs (solids are cleaned off) and octachlorobiphenyl is a solid (non-soluble) at room temperature.

Correlation Findings

As part of the correlation evaluation the Torch Lake 2013 fish tissue results were then compared with fish tissue test data from other water bodies (Huron and Keweenaw bays) believed to be contaminated with PCBs via only air deposition (where there was no identified PCB sources).

The congener makeup in the control sample fish (particularly in the Huron Bay samples) looks most like Aroclor 1260. The homolog percentages in some cases were higher than in the commercial mixture, but probably due to loss of the lower chlorinated congeners. There is little if any evidence of Aroclors 1262 or 1268 in the control fish tissue, unlike those of the Torch Lake samples. Only 1 out of 38 samples from Huron Bay contained any octa, a marker for the Aroclors 1262/1268.

Based on these results, it appears that the source of some of the PCBs in the Torch Lake fish tissue is different from the control samples from other areas with no known PCB source. In summary:

- It is apparent based on the above analysis that fish in Torch Lake are being exposed to PCB contamination from the Hubbell Processing Area upland area that perhaps wasn't occurring in the past. Since Aroclor 1260 and up were not in 1988 fish samples but were in 2013 samples, and are present in upland soil, RPM, abandoned container contents, waste piles, and groundwater, it is apparent that Aroclor 1260 and up have made their way into fish tissue after 1988;
- Because these heavier congeners are present in the Hubbell Processing Area groundwater, surface water, sediments, and submerged abandoned container contents (and may be present in the water column as indicated by SPMD results), it is possible that the exposure is ongoing from the in-lake source (i.e. sediments and deteriorating drum contents) near the Hubbell Processing Area, but the pathway is unclear. It is possible that the exposure is ongoing from the in-lake source near the Lake Linden Recreation Area as well; and,
- Because Aroclor 1242 (i.e. the lighter congeners) have a relatively short half-life in animals and the environment, it is possible that 1242 was present in some of the 1988 fish tissue, but is now undetectable. If true, this would affect the relative percentage of the various homologs present, but not enough to impact the conclusions above nor does it explain the shift to the presence of the heavier congeners in regards to the Hubbell Processing Area particularly. Aroclor 1242 was most common in sediments near the Lake Linden Recreation Area and in the contents of submerged abandoned containers in the Hubbell Processing Area indicating that both source areas could also have been contributing to fish exposure in the past and are currently.

CONCLUSIONS AND RECOMMENDATIONS

The analytical results and interpretation, and IR actions summarized in the preceding sections document potential human health and ecological risks that are present in, and the implications of those findings on environmental conditions throughout Torch Lake. The following subsections provide a synopsis of these findings and a recommended path forward for further mitigating these risks in the Torch Lake environment.

Conclusions

The investigative results from the AMW Project SI and IR actions have identified one upland and two in-lake sources of PCBs. These source areas, as confirmed by the results of upland and in-lake SI results coupled with the SPMD and fish tissue studies, are ongoing sources of PCBs that pose both ecological and potential human health risks. In addition, the on-going sources support the continued BUI related to restrictions on fish and wildlife consumption because of the continued presence of PCBs in fish.

DEQ UPDO has partially mitigated the upland PCB source areas through a series of IR and/or regulatory actions as follows:

- Removal of Waste Pile WP-11 (120 tons) from the Hubbell Processing Area Mineral Building property near a drainage ditch that discharges directly into Torch Lake. WP-11 was disposed as a TSCA waste that contained 100 ppm PCBs and a RCRA hazardous waste due to a TCLP lead result.
- Removal of 93 abandoned containers from the Hubbell Processing Area including partially buried abandoned drums protruding from the EPA cap near the Torch Lake shoreline adjacent to the Hubbell Processing Area southernmost Smelter property. Contents of the abandoned containers removed included PCB-containing waste and/or hazardous and non-hazardous materials.
- Removal of two, 55-gallon drums of PCB-containing RPM, disposed as a TSCA waste, from the Hubbell Processing Area.
- Implementation of drainage ditch improvements, storm water control, and capping measures in the area of greatest upland PCB contamination in the Hubbell Processing Area to reduce erosion and deposition of PCB-contaminated soils into Torch Lake.
- Referral of PCB-contaminated sediments and wastes in the Lake Linden Recreation Area to the EPA ERB for action. To date the EPA ERB has engaged with a PRP that is contemplating an early removal action near shore and further SI to support a remedy design for the offshore surficial and deep sediments.

Recommendations

AMW Project SI, past investigative results derived from multiple sources, and DEQ UPDO IR actions have confirmed that ongoing sources of contamination are present in the Torch Lake environment. Of these contaminants, PCBs present a unique hazard due to their chemical properties that allow the chemical to migrate, bioaccumulate, and biomagnify, such as in fish tissue where concentrations of the contaminant can exceed measured concentrations in environmental samples. Although DEQ UPDO IR actions have partially mitigated upland PCB source areas and the restrictions on fish and wildlife consumption BUI is in place, there is potential for increased risk to human health due to the presence of PCBs in the food chain and in Torch Lake, and the on-going potential for upland sources of PCBs in the Hubbell Processing Area at the Mineral Building property to enter Torch Lake.

Although unrelated to PCBs, the degradation of benthos BUI is also in place as due to the metals contaminated sediments in Torch Lake, the benthic macroinvertebrate community structure in Torch Lake is limited and significantly less than similar lakes with uncontaminated sediment. The benthic community is made up of organisms that live in and on the bottom of Torch Lake and include snails, clams, worms, insects, and others. These organisms are good indictors of local environmental conditions over extended time.

Hubbell Processing Area

For the Hubbell Processing Area where upland and in-lake sources of PCBs and other wastes not previously addressed by the EPA Superfund Site project, EPA ERB emergency removals or DEQ UPDO IRs to date, are still present (beyond MDHHS's issuance of fish consumption guidelines), it is recommended that remedial alternatives to mitigate concerns related to human health and/or the environment be evaluated and implemented. Specifically, these remedial alternatives may include addressing:

- Proper management of the Hubbell Processing Area Mineral Building property including PCB and metal contaminated surface soils, RPM, waste piles, stack debris, and ACM.
- Implementation of storm water control and capping measures at the Hubbell Processing Area Mineral Building property to reduce erosion and deposition of PCB-contaminated soils and wastes into Torch Lake.

- Proper management of the Hubbell Processing Area in-lake PCB source area inclusive of surface water, sediments and submerged drum contents.

Lake Linden Recreation Area

For the Lake Linden Recreation Area in-lake source of PCBs previously partially addressed by EPA through a nearshore removal action and MDHHS fish consumption guidelines, it is recommended that remedial alternatives to mitigate remaining concerns related to human health and/or the environment be evaluated and implemented. Specifically, these remedial alternatives may include addressing:

- Proper management of the Lake Linden Recreation Area nearshore wastes and offshore surficial and deep sediments with concentrations of metals and total PCBs that exceed multiple human health and ecological regulatory criteria.

For both areas, the DEQ UPDO should continue to:

- Provide new AMW Project study data to the RRD Superfund Section (RRD SFS), which is responsible for monitoring EPA's Superfund Site project remedy for the terrestrial and in-lake portion of the Torch Lake Superfund Site. RRD SFS should evaluate whether any remedy modifications are necessary either for the terrestrial or in-lake PCB source areas.
- Request that DEQ WRD continue to conduct congener analysis on future fish tissue samples to build on the current analysis and allow for an evaluation of fish tissue concentrations in response to upland and in-lake remedial actions.

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2. Frame, S. *Complete PCB Congener Distribution for 17 Aroclor Mixtures. J. High Resol. Chromatogr., Volume 18*. December 1996.
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4. Great Lakes Environmental Center. *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake, Houghton County, MDEQ Project Number 05-25*. March 2006.
5. Weston Solutions of Michigan, Inc. (WESTON). *Letter Report for Lake Linden Emergency Response Site*, Lake Linden, Houghton County, Michigan. November 2007.
6. MDEQ, Water Bureau. *PCB Concentrations in Walleye Collected from Torch Lake (Houghton County) and Lake Superior*. June 2008.
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8. WESTON. *Site Investigation Report for Abandoned Mining Wastes Torch Lake Non-Superfund Site, Calumet and Hecla – Lake Linden Operations, Houghton County, Michigan.* March 2016.

FIGURES

South

North

Ecologicol Receptors

Mining Era Buildings and Industrial Operations

Airborne Erosion and Migration

Capped and Vegetated Waste Deposits

Uncapped Soils and Abandoned Containers

Mining Era Structures, Residual Process Materials, and Waste Deposits

Redeveloped Residential and Public Properties and Beaches

Parks and Playgrounds

Stormwater Discharge and Historic industrial Discharges

Direct Contact, Erosion, and Contaminant Leaching

Human Receptors

0.185 ppm

15.9 ppm

11.4 ppm

1.58 ppm

860 ppm

100 ppm

0.73 µg/L

2.3 µg/L

PCBs in Fish Tissue

17.4 ppm

Human Receptors

74 ppm

Ecologicol Receptors

Ecological Receptors

Direct Contact and Food Chain Uptake

8.9 ppm

Nearshore Recreation- Swimming, Boating, Fishing

Submerged Waste and Debris

Contaminant Leaching into Sediment

Groundwater Contaminant Migrotion (Into Torch Lake)

ELEVATION (ft)

640
630
620
610
600
590
580
570
560

A Portion of the Hubbell Processing Area

A Portion of the Lake Linden Recreation Area

LEGEND

- Conceptual Extent of Contaminated Soil
- Conceptual Extent of Groundwater Contamination
- Conceptual Extent of Wastes and Contaminated Sediment
- Conceptual Groundwater and Surface Water Elevations
- 8.9 ppm — Maximum Detected PCB Concentration by Media

ppm = parts per million
µg/L = micrograms per liter

VERTICAL: 20', 10', 0
HORIZONTAL: 0, 500', 1,000'

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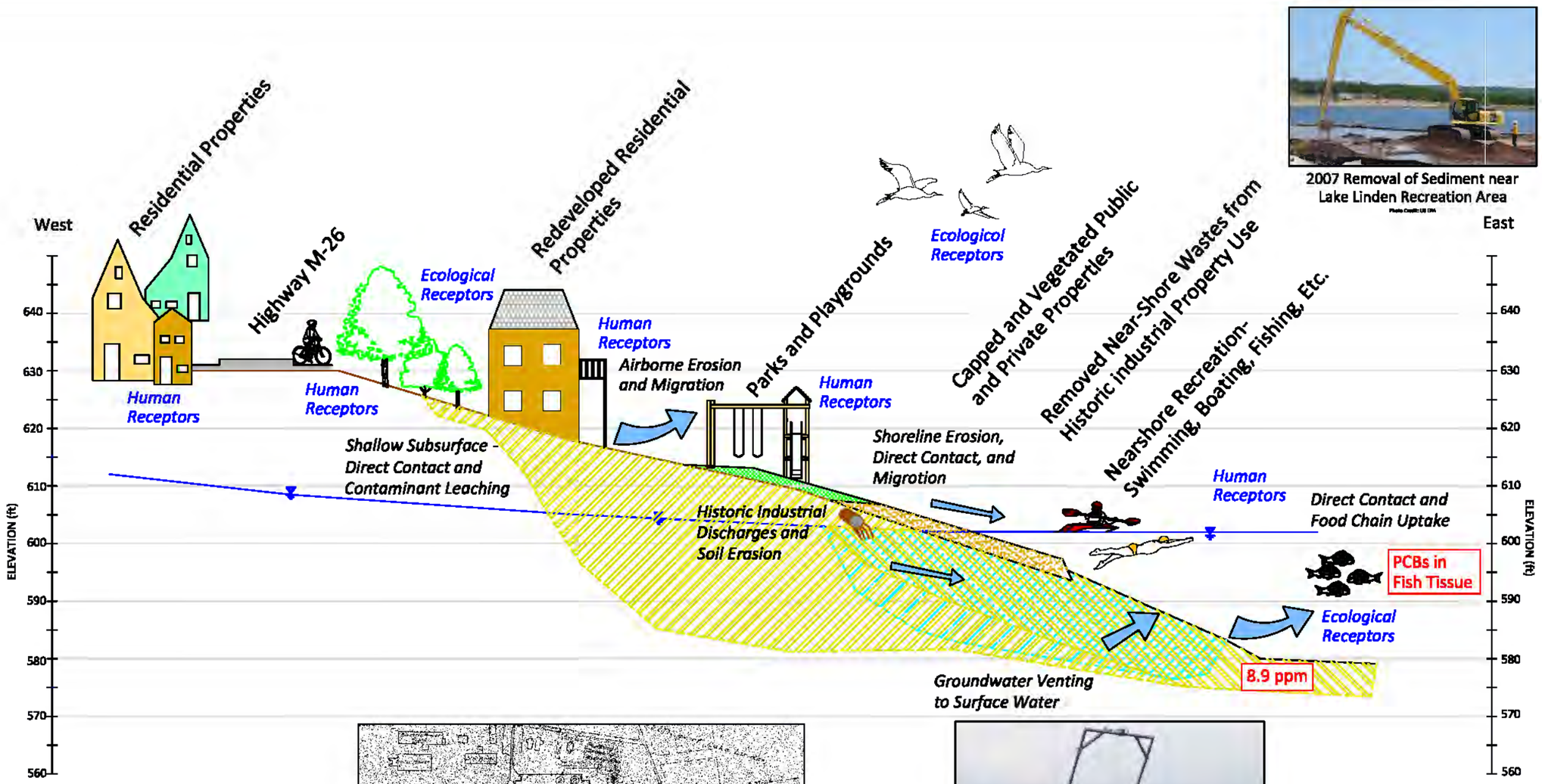
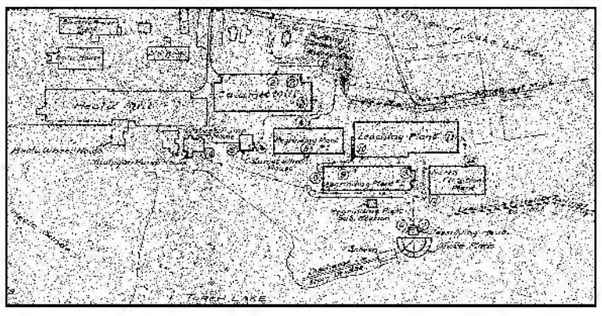
FIGURE 1
PCBs CONCEPTUAL SITE MODEL
LONGITUDINAL
TORCH LAKE NON-SUPERFUND SITE
Houghton County, Michigan

SCALE:	DRAWN:	DATE:	CHECKED BY:
AS NOTED	JBC	9-27-17	JSB



2007 Removal of Sediment near Lake Linden Recreation Area



Historic 1929 Map of Industrial Development near Lake Linden Recreation Area

Collection of Sediment Samples near Lake Linden Recreation Area

LEGEND

- Conceptual Extent of Contaminated Soil
- Conceptual Extent of Groundwater Contamination
- Conceptual Extent of Wastes and Contaminated Sediment
- Conceptual Groundwater and Surface Water Elevations
- 8.9 ppm — Maximum Detected PCB Concentration by Media

ppm = parts per million
µg/L = micrograms per liter

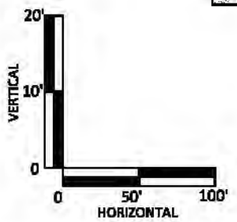


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FIGURE 2
PCBs CONCEPTUAL SITE MODEL
RESIDENTIAL/RECREATIONAL USE SCENARIO
TORCH LAKE NON-SUPERFUND SITE
Houghton County, Michigan

SCALE:	DRAWN:	DATE:	CHECKED BY:
AS NOTED	JBC	9-25-17	JSB

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West

East

Residential Properties

Mining Era Buildings and Industrial Operations

Highway M-26

Building Material - Airborne Erosion and Migrotion

Ecologicol Receptors

Abandoned Containers in Hubbell Processing Area

Abandoned Containers in Hubbell Processing Area

Abandoned Containers and Waste Piles

Surface Debris and Rubble Piles - Airborne Erosion and Migrotion

Ecologicol Receptors

Human Receptors

Human Receptors

Surface Debris and Rubble Piles - Direct Contact and Contaminant Leaching

Residual Process Materiol, Soil, Debris, and Rubble Piles - Surface Erosion and Migrotion

Capped and Vegetated Area

Abandoned Containers and Mining Era Structures - Offshore Timber Pilings

Torch Lake

Offshore Disposal Areas

Human Receptors

Direct Contact and Food Chain Uptake

PCBs in Fish Tissue

Ecological Receptors

0.185 ppm

100 ppm

15.9 ppm

860 ppm

11.4 ppm

1.58 ppm

2.3 µg/L

0.73 µg/L

17.4 ppm

74 ppm

Groundwater Contaminant Migration

Groundwater Venting to Surface Water

Submerged Debris and Wastes - Contaminant Leaching

ELEVATION (ft)

640
630
620
610
600
590
580
570
560

Waste Pile WP-11

Smelter-Related Items in Waste Pile WP-11

Collection of Abandoned Container Contents Sample CHLL-SDM01 from Underwater Autonomous Vehicle

LEGEND

- Conceptual Extent of Contaminated Soil and Wastes
- Conceptual Extent of Groundwater Contamination
- Conceptual Extent of Contaminated Sediment
- Conceptual Groundwater and Surface Water Elevations
- 100 ppm — Maximum Detected PCB Concentration by Media

ppm = parts per million
µg/L = micrograms per liter

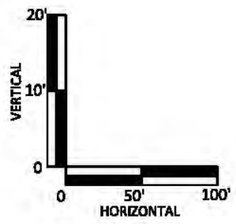

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FIGURE 3
PCBs CONCEPTUAL SITE MODEL
NON-RESIDENTIAL USE SCENARIO
TORCH LAKE NON-SUPERFUND SITE
Houghton County, Michigan

SCALE:	DRAWN:	DATE:	CHECKED BY:
AS NOTED	JBC	9-25-17	JSB

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Image Source: MIS - Public Imagery

Eight PCB-containing abandoned containers removed near shoreline

Sampling Location Type

- Abandoned Container
- Groundwater
- Residual Process Material
- Soil
- Waste Pile

- RED Symbols = Location with PCB exceedance
- YELLOW Symbols = Location with PCBs detected but no exceedance
- GREEN Symbols = Location sampled for PCBs but not detected
- Waste Pile Boundary
- Removed Waste Pile

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

0 250 Ft

Coordinate System: MIGeoRef(m)

Prepared for:
Michigan Department of Environmental Quality

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Figure 4

Summary of Upland PCB Contamination
Hubbell Processing Area
Lake Linden, Houghton County, Michigan

Image Sources: MIS - Public Imagery

LAKE LINDEN RECREATION AREA

0 300 Feet

Coordinate System: MIGeoRef(m)

Map Extent

L'Anse Reservation

HUBBELL PROCESSING AREA

0 750 Feet

Coordinate System: MIGeoRef(m)

Sampling Location Type

- Surface Water
- Sediment

- RED Symbols = Location with PCB exceedance
- YELLOW Symbols = Location with PCBs detected but no exceedance
- GREEN Symbols = Location sampled for PCBs but not detected

N

0 ½ Miles

Coordinate System: MIGeoRef(m)

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Figure 5
Summary of In-Lake PCB Contamination
Torch Lake
Houghton County, Michigan

Image Source: MIS - Public Imagery

TL07-01
8.9 ppm

CHLL-HPA-DM-01
0.185 ppm

CHLL-RPM-02
860 ppm

Waste Pile 11
100 ppm

CHLL-SB153
15.9 ppm

CHLL-SB64
11.4 ppm

CHLL-GW23
0.73 ug/L

Container 7
1.58 ppm

CHLL-SW12
2.3 ug/L

CHLL-SDM09
17.4 ppm

CHLL-SD114
74 ppm

See Figure Page 2 for a Summary of Maximum PCB Concentrations by Matrix and Applicable DEQ Cleanup Criteria

Torch Lake

PCBs in Fish Tissue

Sampling Location Type

- Abandoned Containers
- Soil
- Groundwater
- Residual Process Material
- Surface Water
- Sediment
- Waste Pile
- Submerged Abandoned Container

Notes:
ppm = parts per million
ug/L = micrograms per Liter

N

0 1,250 Feet

Coordinate System: MIGeoRef(m)

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Michigan Department of Environmental Quality

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Figure 6
Summary of Maximum Total PCB Concentrations
Torch Lake Environment
Houghton County, Michigan

SUMMARY OF MAXIMUM PCB CONCENTRATON BY MATRIX AND APPLICABLE DEQ CLEANUP CRITERIA[1]

UPLAND PCB SOURCE AREA

SOIL AND WASTE				Residential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Residential Particulate Soil Inhalation Criteria	Residential Direct Contact Criteria	Nonresidential Drinking Water Protection Criteria	Nonresidential Particulate Soil Inhalation Criteria	Nonresidential Direct Contact Criteria
Sample Type	**Sample ID**	**Date**	**Concentration (ppm)**							
Surficial Soil	CHLL-SB153	05/12/15	15.9	NLL	NLL	5,200 (J)	1.0 (J,T)	NLL	6,500 (J)	1.0 (J)
Subsurface Soil	CHLL-SB64	08/19/14	11.4	NLL	NLL	5,200 (J)	1.0 (J,T)	NLL	6,500 (J)	1.0 (J)
Terrestrial Abandoned Container Content[2]	CHLL-HPA-DM-01	09/21/16	0.185	NLL	NLL	5,200 (J)	1.0 (J,T)	NLL	6,500 (J)	1.0 (J)
Terrestrial Abandoned Container Content Near Shoreline[2]	Container 7	07/11/17	1.58	NLL	NLL	5,200 (J)	1.0 (J,T)	NLL	6,500 (J)	1.0 (J)
Residual Process Material[3]	CHLL-RPM-02	10/15/14	860	NLL	NLL	5,200 (J)	1.0 (J,T)	NLL	6,500 (J)	1.0 (J)
Waste Pile[2,3]	Waste Pile 11	05/17/17	100	NLL	NLL	5,200 (J)	1.0 (J,T)	NLL	6,500 (J)	1.0 (J)

SURFACE WATER				EPA Region 5 Ecological Screening Level (ESL)	Rule 57 Human Cancer Value Drink	Rule 57 Wildlife Value
Sample Type	**Sample ID**	**Date**	**Concentration (ug/L)**			
Surface Water	CHLL-SW12	08/20/15	2.3	0.00012	0.000026	0.00012

GROUNDWATER				Residential Drinking Water Criteria	Nonresidential Drinking Water Criteria	Groundwater Surface Water Interface Criteria	Residential Groundwater Volatilization to Indoor Air Inhalation Criteria	Nonresidential Groundwater Volatilization to Indoor Air Inhalation Criteria	Water Solubility	Flammability and Explosivity Screening Level
Sample Type	**Sample ID**	**Date**	**Concentration (ug/L)**							
Groundwater	CHLL-GW23	06/11/14	0.73	0.5 (A,J,T)	0.5 (A,J,T)	0.2 (J,M,T)	45 (J,S,T)	45 (J,S,T)	44.7 (J,T)	ID

IN-LAKE PCB SOURCE AREAS

SEDIMENT AND WASTE				EPA Region 5 Ecological Screening Level (ESL)	Threshold Effect Concentration (TEC)	Probable Effect Concentration (PEC)
Sample Type	**Sample ID**	**Date**	**Concentration (ppm)**			
Sediment (Hubbell Processing Area)	CHLL-SD114	08/19/17	74.0	0.0598	0.0598	0.676
Sediment (Lake Linden Recreation Area)	TL07-01	08/07/07	8.9	0.0598	0.0598	0.676
Submerged Abandoned Container Content	CHLL-SDM09	08/16/17	17.4	0.0598	0.0598	0.676

[1] DEQ Part 201 residential and non-residential generic cleanup criteria and screening levels criteria were originally promulgated December 21, 2002 within the Administrative Rules for Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. This table reflects revisions to the criteria pursuant to the December 2010 Part 201 amendments and new criteria consistent with the provisions of R299.5706a Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
Release Date: December 30, 2013
ESLs, TECs, and PECs are adapted from Appendix A and Appendix B of DEQ - Remediation and Redevelopment Division Operational Memorandum No. 4 Attachment 3, Interim Final August 2, 2006.
DEQ Rule 57 values derived from the DEQ, 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.

[2] Determined to be Resource Conservation and Recovery Act (RCRA) characteristically hazardous waste per Title 40 of the Code of Federal Regulations, Chapter 1, Section 261.20-24 for disposal purposes based on TCLP lead level. TCLP identifies wastes likely to leach concentrations of of contaminants that may be harmful to human health or the environment.

[3] Determined to be Toxic Substances Control Act (TSCA) remediation waste per 40 C.F.R. §761.61(b) for disposal purposes based on PCB levels. TSCA addresses the production, importation, use, and disposal of specific chemicals based on origin, date of generation, and concentration.

NLL = Hazardous substance is not likely to leach under most soil conditions.

ID = Insufficient Data to Develop Criterion.

(A) = Criterion is the state of Michigan drinking water standard established pursuant to Section 5 of 1976 PA 399, MCL 325.1005.

(J) = Hazardous substance may be present in several isomer forms. Isomer-specific concentrations shall be added together for comparison to criteria.

(M) = Calculated criterion is below the analytical target detection limit; therefore, the criterion defaults to the target detection limit.

(S) = Criterion defaults to the hazardous substance-specific water solubility limit.

(T) = Refer to the federal Toxic Substances Control Act (TSCA), 40 C.F.R. §761, Subpart D and 40 C.F.R. §761, Subpart G, to determine the applicability of TSCA cleanup standards. Subpart D and Subpart G of 40 C.F.R. §761 (July 1, 2001) are adopted by reference in these rules and are available for inspection at the DEQ, 525 West Allegan Street, Lansing, Michigan. Copies of the regulations may be purchased, at a cost as of the time of adoption of these rules of $55, from the Superintendent of Documents, Government Printing Office, Washington, DC 20401, or from the DEQ, RRD, 525 West Allegan Street, Lansing, Michigan 48933, at cost. Alternatives to compliance with the TSCA standards listed below are possible under 40 C.F.R. §761 Subpart D. New releases may be subject to the standards identified in 40 C.F.R. §761, Subpart G.
Use Part 201 soil direct contact cleanup criteria in the published table if TSCA standards are not applicable.

Area capped by DEQ.

Item removed by DEQ.

APPENDIX A

Photographs

Hubbell Processing Area, looking northerly at a portion of the Mineral Building Property with Torch Lake on the right and Highway M-26 on the left

Hubbell Processing Area, looking easterly at a portion of the Mineral Building Property in the foreground and the Smelter Property in the background with Torch Lake beyond

A portion of the Lake Linden Recreation Area, looking south at Torch Lake with the Lake Linden Park in the background on the right and the campground in the background on the left

Hubbell Processing Area, Coal Dock Property, looking northerly prior to capping and drainage improvements