SAMPLING AND ANALYSIS PLAN
FOR THE
ABANDONED MINING WASTES
TORCH LAKE NON-SUPERFUND SITE
HOUGHTON COUNTY, MICHIGAN
SITE IDENTIFICATION NO. 31000098

Prepared for:

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
Remediation and Redevelopment Division
55195 US Highway 41
Calumet, Michigan 49913

Prepared by:

WESTON SOLUTIONS OF MICHIGAN, INC.
P.O. Box 577
Houghton, MI 49931

May 2014

Work Order No. 20177.001.001.0010

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LIST OF ABBREVIATIONS AND ACRONYMS

°C	Degrees Celsius
µm	Micron
ACM	Asbestos Containing Materials
AUV	Autonomous Underwater Vehicle
bgs	Below Ground Surface
BUI	Beneficial Use Impairments
C&H	Calumet and Hecla
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	Chain of Custody
CSV	Comma-Separated-Value
DCC	Direct Contact Criteria
DO	Dissolved Oxygen
DQO	Data Quality Objective
DWPC	Drinking Water Protection Criteria
ERB	Equipment Rinsate Blank
EPA	U.S. Environmental Protection Agency
ESL	Ecological Screening Levels
GPS	Global Positioning System
GSIPC	Groundwater/Surface Water Interface Protection Criteria
GSU	Geological Services Unit
HASP	Health and Safety Plan
HDPE	High-Density Polyethylene
ID	Identification
IDW	Investigative derived Waste
ISID	Indefinite Scope Indefinite Delivery
LCS	Laboratory Control Sample
MDEQ	Michigan Department of Environmental Quality
MeOH	Methanol
mg/kg	Milligram per kilogram
Michigan Tech	Michigan Technological University
MS	Matrix Spike

MSD	Matrix Spike Duplicate
ORP	Oxidation-Reduction Potential
PCB	Polychlorinated Biphenyls
PCI	Peninsula Copper Industries
PEC	Probable Effect Concentration
PID	Photoionization Detector
PNA	Polynuclear Aromatic Hydrocarbon
PPE	Personal Protective Equipment
ppm	Parts Per Million
PSIC	Particulate Soil Inhalation Criteria
QA/QC	Quality Assurance/Quality Control
ROV	Remotely Operated Vehicle
RRD	Remediation and Redevelopment Division
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SI	Site Inspection
SOO	Statement of Objectives
SOP	Standard Operating Procedure
SOW	Statement of Work
SPM	State Project Manager
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TBD	To Be Determined
TDD	Technical Direction Document
TDL	Target Distance Limit
TEC	Threshold Effect Concentration
USCS	Unified Soil Classification System
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WESTON	Weston Solutions, Inc.

1. INTRODUCTION

Weston Solutions of Michigan, Inc. (WESTON®) has prepared this Sampling and Analysis Plan (SAP) to identify data collection activities and associated quality assurance/quality control (QA/QC) measures specific to the Abandoned Mining Wastes – Torch Lake non-Superfund Site (Torch Lake NS Site) in Houghton County, Michigan.

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

The SAP has been developed to detail the project's organization and operational responsibilities of key MDEQ, WESTON, and Michigan Technological University (Michigan Tech) personnel working on the Site. The SAP also describes the design and implementation of measurement systems that will be used during the collection of environmental samples at the Site. The document describes the sampling procedures, analytical methods/procedures, data quality objectives (DQOs), data handling, and documentation procedures.

Section 1 of the SAP defines the objectives of the investigation and the organizational structure of the project team. **Section 2** provides the Site's background including a description of the Site and a brief account of the previous investigative activities implemented at the Site. **Section 3** provides an outline of the proposed implementation schedule. **Section 4** provides a summary of the sampling rationale and environmental media to be sampled during the field activities. **Section 5** provides a summary of field procedures, sampling protocols, and laboratory analyses necessary to complete the field activities, and **Section 6** includes a list of the proposed analytical laboratories, and **Section 7** outlines the QA/QC protocols that will be implemented to assess the overall reproducibility of the laboratory analytical results.

1.1 PROBLEM DEFINITION

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

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

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

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

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

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

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

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

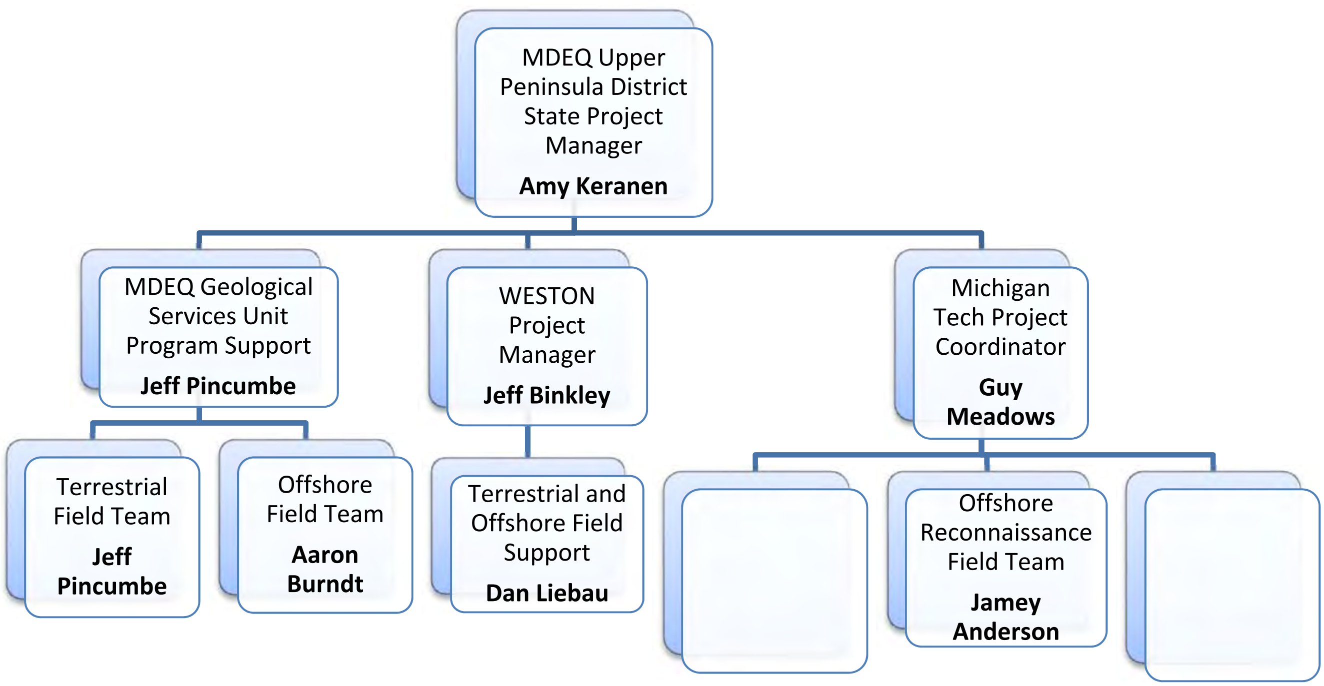
1.2 PROJECT MANAGEMENT

The Torch Lake NS Site project is built upon partnerships and stakeholder engagement. Engagement among team members requires regular communication and is often driven by updated and additional information as well as shifting project priorities. The management approach, dictated by the MDEQ SPM will be supported by the WESTON Project Manager and Project Coordinators from Michigan Tech. Additionally, investigative activities will be supported by the MDEQ Geological Services Unit (GSU), which will provide the tools, equipment, and resources to facilitate the investigative work within the C&H Lake Linden Operations Geographic Area.

Coordination of multiple team members will facilitated by establishing the project goals, building consensus, exchanging and integrating ideas, and setting a path forward with all team members. This approach will allow for team members to discuss the scope and objectives, clarify issues, and learn individual goals, success factors, and ideas. The kick off meeting will establish the foundation for the development and execution of the remainder of the project.

The general project organization is presented on **Figure 1-1**.

FIGURE 1-1
PROJECT ORGANIZATION



The following key project personnel will be involved in planning and/or technical activities performed during the various phases of data collection on the project. Each will receive a copy of the approved SAP. A copy of the SAP will also be retained in the Site file.

TABLE 1-1
KEY PROJECT PERSONNEL

Personnel	Title	Organization	Phone Number	Email
Amy Keranen	State Project Manager	MDEQ-RRD	(906)-337-0389	KERANENA@michigan.gov
Guy Meadows	Project Coordinator	Michigan Tech	(906) 487-1106	gmeadows@mtu.edu
Jeff Binkley	Project Manager	WESTON	(906) 523-5457	J.Binkley@WestonSolutions.com
Jeff Pincumbe	Field Team Leader	MDEQ-GSU	(517) 335-6418	pincumbej@michigan.gov
Dan Liebau	Field Team Leader	WESTON	(906) 523-5569	daniel.liebau@westonsolutions.com

Carol MacLennan	Historical Research Team Leader	Michigan Tech	(906) 487-2870	camac@mtu.edu
Jamey Anderson	Offshore Reconnaissance Team Leader	Michigan Tech	(906) 487-2914	jameya@mtu.edu
Marcel Dijkstra	Offshore Sampling Field Team Leader	Michigan Tech	(231) 676-3400	mldijkst@mtu.edu

2. PROJECT DESCRIPTION

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

The Torch Lake NS Site includes properties remote from Torch Lake proper, such as the 270+

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

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

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

2.1 SITE BACKGROUND

As reported by the MDEQ in the document entitled *Draft Site Inspection Report for C&H Lake Linden Operations, Lake Linden, Michigan 49945* dated March 2013, the MDEQ was authorized to conduct Site Inspection (SI) activities at the C&H Lake Linden Operations Geographic Subset in April 2011. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site assessment activities in the State of Michigan are conducted by the MDEQ under the authority of a cooperative agreement with the EPA. The report summarizes the results of the SI conducted by the MDEQ as part of the site assessment activities designated in the cooperative agreement.

The Torch Lake NS Site is located adjacent to the Torch Lake Superfund Site; however, the properties identified for assessment under the Torch Lake NS Site project are generally not included in the Torch Lake Superfund Site, nor are remedies in place to mitigate environmental conditions on the properties. The only property included in this investigation that underwent previous remedial activities is the capped portion of the Lake Linden Sands where historical dumping was reported. Historically, numerous environmental investigations have been completed within the geographic subset by state, federal, and private parties. Considered in the development of this SAP, data and information derived from these investigations are currently being assimilated and compiled by the MDEQ.

Response activities completed within the geographic area include the EPA's emergency removal of contaminated soil and sediment from the shoreline of Torch Lake near the Village of Lake Linden's park and EPA's facilitation, through an identified responsible party, of cleanup activities at the C&H Power Plant Site, both located in the Lake Linden Processing Area. Investigative activities have also been completed at the PCI property which includes an existing monitoring well network and regular reporting to the MDEQ.

Investigations at these properties have indicated elevated levels of metals in surficial soils, and in some cases, asbestos; lead and arsenic in sludges; polynuclear aromatic hydrocarbons (PNAs) and PCBs in waste materials; volatile organic compounds (VOCs) venting into Torch Lake from contaminated groundwater; and metals in groundwater. Further, the findings of the MDEQ SI and other investigations confirm that significant quantities of waste are present at terrestrial and offshore locations in and around Torch Lake. Further, analytical results indicate that shallow and subsurface soils, groundwater, and sediments have become contaminated with heavy metals, especially arsenic, chromium, copper, and lead.

2.2 SITE LOCATION AND DESCRIPTION

The C&H Lake Linden Operations Geographic Subset is located along the northwest and north shores of Torch Lake, between Hubbell and the Trap Rock River, in Houghton County, Michigan. The C&H Lake Linden Operations Geographic Subset is depicted on **Figure 2-1**.

The C&H Lake Linden Operations Geographic Subset consists of approximately 155 acres of land extending approximately two miles along the shoreline of Torch Lake. The geographic subset also incorporates up to 22 different parcels with multiple property owners. Building on the organization of the Preliminary Assessment completed by the MDEQ in October 2009, the C&H Lake Linden Operations Geographic Subset was divided six smaller organizational areas based on the historical industrial operations in each area. For consistency, WESTON has expanded upon the Subarea identification established by the MDEQ, while focusing on the identified industrial sites defined in the Statement of Objectives (SOO) prepared by the MDEQ. The investigative areas and their respective former industrial sites are summarized as follows:

- Torch Lake Backwater Area
  - Traprock Slag Dump; and,
  - Torch Lake Backwater.
- Lake Linden Sands Area
  - No Industrial Sites identified;
  - Reported disposal areas; and,
  - Lake Linden Beach (stamp sands, campground, beach, day park, and boat launch).
- Lake Linden Processing Area
  - Calumet Stamp Mill; and,
  - C&H Power Plant (exclusive of on-going EPA efforts).
- Hubbell Coal Dock Area
  - Hubbell Coal Dock.

- Hubbell Smelter Area
  - Mineral Building; and,
  - Former Peninsula Copper Industries (PCI) property.
- Hubbell Slag Dump and Beach Area
  - Hubbell Red Slags; and,
  - Hubbell Slag Dump (including beach, marina and the bay).

The following subsections provide additional detail related to the organizational areas identified above.

2.2.1 Torch Lake Backwater Area

The Torch Lake Backwater Area is located along the northern limits of the C&H Lake Linden Operations Geographic Subset of the Torch Lake NS Site. The Torch Lake Backwater Area includes three areas of interest that were potentially negatively impacted by former industrial operations in the region, including the Traprock Slag Dump and the Torch Lake Backwater Area. The general locations of these areas are depicted on **Figure 2-2**.

Historically, the area did not appear to feature large industrial complexes as identified in several of the other areas. Sanborn Fire Insurance maps from the area show a facility identified as Houghton County Electric Light and Power located along 9th Street. Similarly, the website www.coppercountryexplorer.com identifies this facility as an electrical generating station for the Houghton County Traction Company, an electric street car line that served Lake Linden and Calumet. Refer to **Appendix A** for a historical account of the Traprock Slag Dump and the Torch Lake Backwater areas prepared by Michigan Tech.

The Torch Lake Backwater Area comprises the central and western portion of the subarea featuring over 3,000 feet of shoreline. The Traprock Slag Dump makes up approximately 1,000 feet of the Torch Lake Backwater Area shoreline and generally comprises the eastern portion of the subarea. The Traprock Slag Dump is bordered on the east by the Traprock River.

The areas of interest are generally bound to the north by 9th Street, which transitions to Bootjack Road in the vicinity of the Traprock River along the eastern boundary of the Torch Lake Backwater

Area. Properties within the Torch Lake Backwater Area are generally privately owned. Residential properties with private water wells are located within the subarea.

The Torch Lake Backwater Area is generally characterized as being a slag disposal area. The limits of slag deposits and the approximated extent of surface contamination observed during previous investigations are shown on **Figure 2-2**.

2.2.2 Lake Linden Sands Area

The Lake Linden Sands Area is located south of and adjacent to the Torch Lake Backwater Area. The Lake Linden Sands Area is located east of downtown Lake Linden along the shore of Torch Lake. The area is generally accessible to vehicular and pedestrian traffic; however there are currently no areas of former industrial activity that are planned for investigation under this SAP. Areas that will be characterized include reported disposal areas within the capped stamp sand deposit north/northeast of the Lake Linden public beach. The location of the Lake Linden Sands Area is depicted on **Figure 2-3**.

2.2.3 Lake Linden Processing Area

The Lake Linden Processing Area is located south and adjacent to the Lake Linden Sands Area. The Lake Linden Processing Area features one of the largest industrial complexes in all of C&H's operations. The Lake Linden Processing Area includes two industrial areas of interest specific to this SAP, including the C&H Power Plant and the Calumet Stamp Mill. The general locations of these areas are depicted on **Figure 2-4**.

The Lake Linden Processing Area includes the C&H stamp mill complex that historically included two stamp mills and a reclamation plant. C&H reportedly also operated a laboratory near the complex. One stamp mill was named Calumet and the second was named Hecla. The mills "stamped" the ore bearing source rock so that the copper could be recovered. The waste rock, commonly referred to as stamp sand or tailings, generated by the stamping process was discharged into Torch Lake.

The C&H Power Plant was located within the same complex, west of the stamp mills. The C&H Power Plant was established in 1905 to meet the electrical demands of the evolving industrial complex and mining operations. The power plant was one of two electrical generating stations that operated in parallel and supplied electricity throughout the region. By 1931, the power plant was connected to the electrical grid through transformers and eight outgoing feeders that exited the west side of the building overhead.

In approximately 1915, C&H began reclaiming stamp sand and constructed two regrinding plants (No. 1 and No. 2), a flotation plant, a leaching plant, and a distillation plant. Most of these facilities were located on the adjacent property northeast of the Site. Sand reclamation operations at the property were terminated in approximately 1968. Refer to **Appendix A** for a historical account of the power plant, stamp mill complex, and the reclamation plant prepared by the MDEQ.

The properties in the Lake Linden Processing Area are privately and municipally owned and include areas that are accessible by the public. The Houghton County Historical Society operates a museum on the northern portion of the stamp mill complex, specifically in the footprint of the Calumet stamp mill. The Village of Lake Linden maintains public facilities east of the museum, including tennis courts, a skate board park, marina, and boat launch. The industrial areas of interest in the Lake Linden Processing Area are generally bound to the west by Highway M26.

The EPA is currently overseeing remedial action implementation at the power plant. Prior to the initiation of the cleanup activities, investigative activities were completed to identify contaminants present at the property. The extent of contamination observed in the Lake Linden Processing Area during previous investigations is shown on **Figure 2-4**.

2.2.4 Hubbell Coal Dock Area

The Hubbell Coal Dock Area is located south and adjacent to the Lake Linden Processing Area in the Village of Hubbell. The Hubbell Coal Dock is the only industrial area of interest specific to this SAP, in the Hubbell Coal Dock Area. The general locations of these areas are depicted on **Figure 2-5**.

The coal dock in the Hubbell Coal Dock Area is located along the shoreline of Torch Lake, between the stamp mill complex (Lake Linden Processing Area) and the C&H smelter complex (Hubbell Smelter Area). “The C&H Coal Dock featured a large coal shed, reportedly measuring approximately 650 feet by 400 feet. C&H maintained a large storage shed to allow coal to be stored over the winter and to protect against uncertainties associated with the coal industry. The coal dock featured massive shovel, boom, and rail systems that allowed for the unloading and storage of the bituminous coal and anthracite being shipped from Pennsylvania and West Virginia" (Kahn, 1898). The coal dock operations featured an electrical substation in the northern portion of the property. Refer to **Appendix A** for a historical account of the property prepared by the MDEQ.

The coal dock property is privately owned and includes roughly 2,000 feet of the Torch Lake shoreline. The property is bound to the west by Highway M26. A chain link fence has been established along the western property boundary. The property is generally vacant and runoff into the lake has been observed during previous investigative activities. Abandoned drum carcasses were also observed in the southern portion of the property. A review of aerial photographs also shows the development of apparent erosion channels in the south-central portion of the property. The extent of contamination and areas of observed runoff identified in the Hubbell Coal Dock Area during previous investigations are shown on **Figure 2-5**.

2.2.5 Hubbell Smelter Area

The Hubbell Smelter Area is located south of and adjacent to the Hubbell Coal Dock Area the in C&H Lake Linden Operations Geographic Subset of the Torch Lake NS Site. The Hubbell Smelter Area includes two former industrial areas of interest including the Mineral Building and the PCI property. The location of the Hubbell Smelter Area and the former industrial areas of interest are depicted on **Figure 2-6**.

The Mineral Building and the PCI Property are the location of the former C&H smelter complex. "The C&H smelter complex was one of the most technologically advanced smelters in the region, and the only one to utilize an electrolytic plant to refine copper using electricity. The facility was used to smelt only low-grade ore, while the high grade material was smelted in Buffalo at C&H's other smelting complex. By the 1930′s the complex had already managed to build up a rather sizable slag pile just south of the main facility, with no sign of its output slowing anytime soon. Today most of the plant has been demolished save for the old electrolytic plant, mineral house, and a few other smaller structures" (Copper Country Explorer, 2014).

Historically, the Mineral Building which is currently inactive was part of the former smelter complex. The Mineral Building would have received the processed copper ore from the stamp mills. The copper ore was sorted and stored in the mineral house prior to transfer to the smelter for additional processing.

2.2.6 Hubbell Slag Dump and Beach Area

The Hubbell Slag Dump and Beach Area is the southern-most area located south of and adjacent to the Hubbell Smelter Area the in C&H Lake Linden Operations Geographic Subset of the Torch Lake NS Site. The Hubbell Slag Dump and Beach Area include two former industrial areas of interest including the Hubbell Red Slags and the Hubbell Slag Dump (including beach, marina and the bay). The location of the Hubbell Slag Dump and Beach Area and the former industrial areas of interest are depicted on **Figure 2-7**.

The Hubbell Red Slag and the Hubbell Slag Dump were likely smelting waste generated by the C&H smelter complex. The slag dumps, similar to those in The Torch Lake Backwater Area are located along the shoreline of Torch Lake. The slag dumps are located near public access areas, including a public beach and marina. The extent of contamination and slag deposits identified in the Hubbell Smelter Area during previous investigations are shown on **Figure 2-7**.

2.2.7 Torch Lake

The geographic subareas described in the preceding subsections are all located along the shoreline of Torch Lake. Each of these former industrial operations relied on the waters of Torch Lake for shipping, process water, and waste discharge. In addition, the communities established around these industrial facilities also used the lake for similar purposes, historically discharging sewage and other wastes into the lake. The location of Torch Lake as it relates to the C&H Lake Linden Operations Geographic Area is depicted on **Figure 2-8**.

Historically, containers, drums, and building materials have been identified in Torch Lake. Some of these items were characterized and recovered as part of previous removal actions; however, many areas of similar waste deposits remain submerged or partially submerged along the shoreline of the lake. In addition, the abandoned or vacant state of the properties in several of the subareas, make Torch Lake susceptible to the erosion or discharge of contaminated environmental media emanating from properties along the shoreline.

Numerous investigations have been completed in Torch Lake to evaluate sediment and water quality within the lake. PCBs have been detected in sediment and surface water in the lake and have resulted in the placement of the following beneficial use impairments (BUIs):

- **Restrictions on fish and wildlife consumption** - When contaminant levels in fish or wildlife populations exceed current standards, objectives or guidelines, or public health advisories are in effect for human consumption of fish and wildlife.
- **Degradation of benthos** - When the benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when toxicity (as defined by relevant, field-validated bioassays with appropriate quality assurance/quality controls) of sediment associated contaminants at a site is significantly higher than controls.

Despite the effectiveness of these prior investigations in identifying sediment contamination; the investigations were not focused on identifying and characterizing the sources of contamination. As such, the goals of this investigation are to verify the presence of these abandoned containers and wastes on the bottom of the lake and to more fully characterize the nature and extent of these likely contaminant sources. The evaluation of potential PCB sources and PCB "hot spots" in and around Torch Lake are an integral component of this SAP that will support the long-term protection and rehabilitation of the lake.

2.3 CONTAMINANTS OF CONCERN AND TARGET ANALYTES

Contaminants attributable to the Site include VOCs, PNAs, PCBs, inorganic contaminants, and asbestos. The properties in the C&H Lake Linden Operations Geographic Area feature vacant land, historical and recreational parks, in mixed residential/non-residential areas within the villages of Lake Linden and Hubbell.

The analytical results from the 2007 and 2011 investigative activities were used to assist in the characterization of the geographic areas. Further, the sample locations from these events were also evaluated to assist in locating the horizontal and vertical locations of proposed sampling locations included in this SAP. The locations and respective analytical results used to develop this SAP are summarized in the WESTON prepared document entitled, *Compilation and Interpretation of Key Historic Studies (2007 – 2011) at Torch Lake Technical Memorandum* dated May 2014.

As part of the 2011 SI, the MDEQ obtained a 4-Mile Radius Map and a 15-Mile Surface Water Target Distance Limit Map (TDL) from Environmental Data Resources. The radius maps are included as **Appendix B**.

2.3.1 Torch Lake Backwater Area

During 2007 and 2011 samples were collected for laboratory analysis from the following environmental media in the Torch Lake Backwater Area.

- Surface soil;
- Subsurface Soil;
- Sediment;
- Groundwater; and,
- Surface Water.

The analytical and screening results indicate that inorganic contaminants are present in surface and subsurface soils in excess of Part 201 of Michigan's Natural Resources and Environmental Protection Act (NREPA), being Public Act (PA) 451 of 1994, as amended Residential and Non-Residential Cleanup Criteria for Response Activity.

Three monitoring wells were installed in the Torch Lake Backwater Area during the 2011 SI. Monitoring well, MW-01 was established as a "background" monitoring well. Analytical results from monitoring well sampling activities show elevated detections of inorganic contaminants. PCBs were not detected in the groundwater samples.

The 2011 SI noted that several potential sources of contamination were present in the area and samples were collected to evaluate these conditions. The MDEQ noted that “slag waste was observed over several acres of the area. The slag was found in numerous chunks as tall 5-6 feet in height, but the ground was also covered with much smaller pieces (less than 6 inches in diameter). In the southern part of this area, the slag was buried, but is now exposed from excavation activities or erosion. The slag varied in color, featuring blue, black, brown, and red hues” (MDEQ, 2013).

Based on the results of the previous investigations, the prevailing contaminants of concern in environmental media are generally inorganic contaminants in surface and subsurface soils and groundwater. The analytical results exceeded multiple Residential and Non-Residential Cleanup Criteria for Response Activities including the following:

- Statewide Default Background Levels;
- Groundwater Surface Water Interface Protection Criteria (GSIPC);
- Residential Drinking Water Protection Criteria (DWPC);
- Non-residential DWPC;
- Residential Direct Contact Criteria (DCC); and,
- Non-residential Particulate Soil Inhalation Criteria (PSIC).

Based on the findings summarized above it is anticipated that up to 10 sampling locations, including soil, groundwater, surface water, and sediment will be established in the Torch Lake Backwater Area including the following target analytes:

Surface Soils/Waste Deposits (0 to 6 inches below ground surface [bgs])

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A**.**

Subsurface Soils (Greater than (>) 6 inches bgs)

- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

Groundwater

- VOCs by SW-846 Method 8260;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Sediment

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Drums, Containers, and Waste Deposits – Not Associated with Sediment/Depositional Wastes

- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A;
- PNAs by SW-846 Method 8310; and,
- Oil and Grease by SW-846 Method 1664.

2.3.2 Lake Linden Sands Area

During 2007 and 2011 samples were collected for laboratory analysis from the following environmental media in the Lake Linden Sands Area.

- Surface soil;
- Subsurface Soil;
- Sediment;
- Groundwater; and,
- Surface Water.

The analytical results indicate that inorganic contaminants are present in surface and subsurface soils, groundwater, surface water, and sediment in excess of Residential and Non-Residential Cleanup Criteria for Response Activity.

Based on the findings summarized above it is anticipated that up to 25 sampling locations, including soil, groundwater, surface water, and sediment will be established in the Lake Linden Sands Area including the following target analytes:

Surface Soils/Waste Deposits (0 to 6 inches bgs)

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010;
- VOCs by SW-846 Method 8260;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Subsurface Soils (>6 inches bgs)

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010;
- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Groundwater

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010;
- VOCs by SW-846 Method 8260;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Sediment

- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A;
- PNAs by SW-846 Method 8310; and,
- PCBs by SW-846 Method 8082A.

Surface Water

- PCBs by SW-846 Method 8082A.

Drums, Containers, and Waste Deposits – Not Associated with Sediment/Depositional Wastes

- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A;
- PNAs by SW-846 Method 8310; and,
- Oil and Grease by SW-846 Method 1664.

2.3.3 Lake Linden Processing Area

During 2007 and 2011 samples were collected for laboratory analysis from the following environmental media in the Lake Linden Processing Area.

- Surface soil;
- Subsurface Soil;
- Sediment;
- Groundwater; and,
- Surface Water.

The analytical and screening results indicate that inorganic contaminants and PCBs are present in surface and subsurface soils in excess of Residential and Non-Residential Cleanup Criteria for Response Activity.

Seven monitoring wells were installed in the Lake Linden Processing Area during the 2011 SI. Analytical results from monitoring well sampling activities show elevated detections of inorganic contaminants. PCBs were not detected in the groundwater samples.

"The findings of the 2011 SI indicated that contaminated soils in the Lake Linden Processing Area exceeded direct contact criteria for arsenic, copper, and lead. Some of the contaminated shallow soils seem to be associated with three suspect areas. These include the location near the lead sludge 2007 removal action, and a location where buried lead-containing sludge was found near the tennis courts, and also the area between the former Calumet Stamp Mill and Torch Lake.

The most significant observed releases in subsurface soils also appear to be located in the Lake Linden Processing Area, based on the concentrations of inorganic contaminants. These areas are associated with documented waste sludge buried in the subsurface. At soil boring SB-13, a gray sludge layer was discovered during the soil boring installation. XRF screening of that sludge documented lead at 16,726 part per million (ppm). The soil sample below the sludge contained lead at 16,100 ppm.

The analytical results from subsurface soils included PNAs. No VOCs or PCBs were identified at concentrations that would be evidence of a release or source of continued contamination. PNAs in subsurface soil boring samples were found primarily in analytical samples collected from boring locations SB-04 and SB-05, located in the village parking lot of the Lake Linden Processing Area.

The MDEQ concluded that the screening and sampling results from the Lake Linden Processing Area suggest a high risk to the surface water pathway from copper, arsenic, and lead. Sediment samples SD-03 and SD-03D both exceeded GSI protection criteria for copper, but the same samples were below the GSI protection criteria for arsenic and lead. Sample SD-03 was collected just east of the 2007 removal area, where lead was found to be over 40,000 ppm, so it is possible that the high lead sediment was already removed from the location where SD-03 was collected. A 2008 MDEQ report from a sediment survey in this area found lead at 7,800 ppm and copper at 28,000 ppm in shallow sediments, at a location perhaps 130 feet further east-southeast of sample SD-03, suggesting still existing contamination in the sediment in this area. Another reason why copper, arsenic, and lead are likely to pose a high risk to the surface water pathway is that the three metals significantly exceed GSI criteria in four or more monitoring wells. Monitoring well MW-07, located at the GSI, had the highest concentration of copper of all water samples collected, 24,700 micrograms per liter (µg/L) exceeding the GSI criterion of 4.5 µg/L. With groundwater flowing toward the lake in this area, venting groundwater is likely to cause an impact to surface water. In addition, considerable surficial contamination exists, especially at the area from the historical museum to the lakeshore, which could contribute to surface runoff of the three metals into Torch Lake waters and sediment"(MDEQ, 2013).

Based on the results of the previous investigations and removal actions in the Lake Linden Processing Area, the prevailing contaminants of concern in environmental media are generally inorganic contaminants in surface and subsurface soils and groundwater and PCBs in sediment.

The analytical results exceeded multiple Residential and Non-Residential Cleanup Criteria for Response Activities including the following:

- Statewide Default Background Levels;
- GSIPC;
- Residential DWPC;
- Non-residential DWPC;
- Residential DCC; and,
- Non-residential DCC.

Based on the findings summarized above it is anticipated that up to 19 sampling locations, including soil, groundwater, surface water, and sediment will be established in the Lake Linden Processing Area including the following target analytes:

Surface Soils/Waste Deposits (0 to 6 inches bgs)

- VOCs by SW-846 Method 5035A;
- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010;
- PCBs by SW-846 Method 8082A; and,
- Asbestos by Polarizing Light Microscopy (PLM) – California Air Resource Board (CARB) 435 – 1,000 point count – analytical sensitivity 0.1%.

Subsurface Soils (>6 inches bgs)

- VOCs by SW-846 Method 5035A;
- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

Sediment

- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

Surface Water

- PCBs by SW-846 Method 8082A.

Groundwater

- VOCs by SW-846 Method 8260;
- PCBs by SW-846 Method 8082A;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PNAs by SW-846 Method 8310.

Drums, Containers, and Waste Deposits – Not Associated with Sediment/Depositional Wastes

- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A;
- PNAs by SW-846 Method 8310; and,
- Oil and Grease by SW-846 Method 1664.

2.3.4 Hubbell Coal Dock Area

During 2007 and 2011 samples were collected for laboratory analysis from the following environmental media in the Hubbell Coal Dock Area.

- Surface soil;
- Sediment; and,
- Surface Water.

The analytical and screening results indicate that inorganic contaminants are present in surface and subsurface soils in excess of Residential and Non-Residential Cleanup Criteria for Response Activity.

Based on the results of the previous investigations, the prevailing contaminants of concern in environmental media are generally inorganic contaminants in surface and subsurface soils and groundwater.

The analytical results exceeded multiple Residential and Non-Residential Cleanup Criteria for Response Activities including the following:

- Statewide Default Background Levels;
- GSIPC;
- Residential DWPC;
- Non-residential DWPC;
- Residential DCC; and,
- Non-residential PSIC.

Based on the findings summarized above it is anticipated that up to 19 sampling locations, including soil, groundwater, surface water, and sediment will be established in the Hubbell Coal Dock Area including the following target analytes:

Surface Soils/Waste Deposits (0 to 6 inches bgs)

- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

Subsurface Soils (>6 inches bgs)

- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

Groundwater

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series & 6010
- VOCs by SW-846 Method 8260;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Sediment

- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

Surface Water

- PCBs by SW-846 Method 8082A.

Drums, Containers, and Waste Deposits – Not Associated with Sediment/Depositional Wastes

- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A;
- PNAs by SW-846 Method 8310; and,
- Oil and Grease by SW-846 Method 1664.

2.3.5 Hubbell Smelter Area

During 2007 and 2011 samples were collected for laboratory analysis from the following environmental media in the Hubbell Smelter Area.

- Surface soil;
- Subsurface Soil;
- Sediment;
- Groundwater; and,
- Surface Water.

The analytical and screening results indicate that inorganic contaminants are present in surface and subsurface soils in excess of Residential and Non-Residential Cleanup Criteria for Response Activity. In addition, PCBs were detected in sediment samples exceeding Sediment Quality Guidelines, Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs).

The Hubbell Smelter Area includes the PCI property which has an existing monitoring well network. Two monitoring wells were installed in the Hubbell Smelter Area during the 2011 SI. Analytical results from monitoring well sampling activities show elevated detections of inorganic contaminants. PCBs were not detected in the groundwater samples.

Based on the results of the previous investigations, the prevailing contaminants of concern in environmental media are generally inorganic contaminants in surface and subsurface soils and groundwater.

The analytical results exceeded multiple Residential and Non-Residential Cleanup Criteria for Response Activities including the following:

- Statewide Default Background Levels;

- GSIPC;
- Residential DWPC;
- Non-residential DWPC;
- Residential PSIC;
- Non-residential PSIC;
- Residential DCC; and,
- Non-residential DCC.

Based on the findings summarized above it is anticipated that up to 21 sampling locations, including soil, groundwater (including two existing PCI monitoring wells [MW-108A and MW-108B]), surface water, and sediment will be established in the Hubbell Smelter Area including the following target analytes:

<u>Surface Soils/Waste Deposits (0 to 6 inches bgs)</u>

- VOCs by SW-846 Method 8260;
- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

<u>Subsurface Soils (>6 inches bgs)</u>

- VOCs by SW-846 Method 8260;
- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

<u>Groundwater</u>

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

<u>Sediment</u>

- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

<u>Surface Water</u>

- PCBs by SW-846 Method 8082A.

<u>Drums, Containers, and Waste Deposits – Not Associated with Sediment/Depositional Wastes</u>

- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A;
- PNAs by SW-846 Method 8310; and,
- Oil and Grease by SW-846 Method 1664.

2.3.6 Hubbell Slag Dump and Beach Area

During 2007 and 2011 samples were collected for laboratory analysis from the following environmental media in the Hubbell Smelter Area.

- Surface Soil;
- Sediment; and,
- Surface Water.

The analytical and screening results indicate that inorganic contaminants are present sediment in excess of Residential and Non-Residential Cleanup Criteria for Response Activity.

Based on the results of the previous investigations, the prevailing contaminants of concern in environmental media are generally inorganic contaminants in sediment; however, only limited investigation of terrestrial areas were completed during the previous investigations. The analytical results exceeded multiple Residential and Non-Residential Cleanup Criteria for Response Activities including the following:

- Statewide Default Background Levels;
- GSIPC;
- Residential DWPC; and,
- Non-residential DWPC.

Based on the findings summarized above it is anticipated that up to 17 sampling locations, including soil, groundwater (including three existing PCI monitoring wells [MW-113, MW-118, and MW-120), surface water, and sediment will be established in the Hubbell Slag Dump and Beach Area including the following target analytes:

Surface Soils/Waste Deposits (0 to 6 inches bgs)

- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010
- PCBs by SW-846 Method 8082A.

Subsurface Soils (>6 inches bgs)

- VOCs by SW-846 Method 5035A;

- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Groundwater

- VOCs by SW-846 Method 8260;
- PCBs by SW-846 Method 8082A; and,
- PNAs by SW-846 Method 8310.

Sediment

- PNAs by SW-846 Method 8310;
- Total Metals by SW-846 including 3000 Series Analysis 7000 Series and 6010; and,
- PCBs by SW-846 Method 8082A.

Surface Water

- PCBs by SW-846 Method 8082A.

Drums, Containers, and Waste Deposits – Not Associated with Sediment/Depositional Wastes

- VOCs by SW-846 Method 5035A;
- PCBs by SW-846 Method 8082A;
- PNAs by SW-846 Method 8310; and,
- Oil and Grease by SW-846 Method 1664.

2.3.7 Torch Lake

During 2007 and 2011 the analytical results from surface water and sediment samples indicated that contaminants emanating from documented contamination on land may be impacting the nearshore aquatic environment of Torch Lake. In addition, historical investigations in the lake have documented the presence of submerged drums, containers, and waste deposits on the bottom of Torch Lake.

To address these concerns, the MDEQ has developed a collaborative approach to this SAP that incorporates advanced technological methods and common sampling approaches for use in characterizing Torch Lake. Michigan Tech will assist in these characterization activities under three primary tasks.

The first of these tasks includes the research of industrial operations in the C&H Lake Linden Operations Geographic Area. The historical archive research and mapping phase of the work will identify historic shoreline and landward industrial operations responsible for the generation and/or disposal of wastes in and along Torch Lake. Michigan Tech will utilize the university archives, Sanborn Fire Insurance Maps, blueprints, C&H operational records, aerial photos, and interviews with former employees to reconstruct potential waste and disposal areas in and around Torch Lake.

The second phase of work to be completed by Michigan Tech includes the underwater investigation and mapping of the lake bottom and debris fields. In 2013 Michigan Tech demonstrated underwater research capabilities utilizing their Autonomous Underwater Vehicle (AUV). The AUV, named IVER3 was manufactured by Ocean Server Technology, Inc. in Fall River, Massachusetts. Once a mission is programmed, the AUV executes that mission (8 – 12 hours in duration) with no human intervention. The IVER3 is equipped with various technological capabilities, including three-dimensional mapping sonar, GPS, wireless communication, four onboard computers, and data mass storage. Michigan Tech, in consultation with the MDEQ and WESTON, will develop a plan for conducting an AUV assessment of the near shore environment in the C&H Lake Linden Operations Geographic Area. It is anticipated that the plan will outline the deployment strategies and data quality objectives (DQO) for the AUV assessment. The overall intent of the assessment is to collect qualitative data that can be used to develop a plan for investigation, sampling, and assessment of potential offshore contaminant sources. The underwater mapping and reconnaissance activities are anticipated to be completed as follows:

- Remotely Operated Vehicle (ROV) investigation & visualization of known drum locations. Field test of ROV through the ice if conditions permit prior to the on-lake investigation;
- Surface Vessel and AUV lake bottom/drum mapping;
- A field test with the ROV, if safe ice conditions permit, will be conducted to more closely evaluate at least one known drum disposal location on the lake bottom. Sediment sampling equipment deployed via the ROV will also be tested;
- Surface vessel and AUV surveys and mapping will be conducted as early in the spring as possible, after ice-out, to identify lake-bottom features, debris fields and anomalies, including a potential magnetometer study. The maps and images created from this AUV survey will be evaluated to establish the planned sediment and surface water sampling event scheduled for Torch Lake; and,

- Surface vessel - ROV cruises will be undertaken once the AUV mapping has been completed to re-visit sites with debris or debris fields.

The results and data derived from the underwater survey will be compiled and evaluated, allowing for the planning and completion of the third phase of work on Torch Lake. An AUV Assessment Plan developed by Michigan Tech is included in **Appendix C**.

The third phase of investigative activities on the lake will include the sampling and laboratory analysis of submerged container and drum contents, sediment, and surface water identified during the underwater reconnaissance and mapping effort and the analytical results from historic sampling events. It is anticipated that sampling of these submerged areas of Torch Lake will be completed using Michigan Tech's research vessel and ROV. Sampling techniques are expected to utilize a combination of vibra-core sampling, ponar dredge sampling, and ROV sampling. The MDEQ GSU and Michigan Tech will provide the sampling vessels and necessary equipment to complete the final scope of work. The resultant sampling approach will be dependent upon the findings of the first phase of the lakeward investigation.

3. PROPOSED SCHEDULE

WESTON has prepared this SAP to detail the planned approaches for investigative sampling, field screening, and laboratory analyses to be used at the C&H Lake Linden Operations Geographic Area. The proposed investigative and sampling methods are described in more detail in **Section 4** and **Section 5** of this SAP.

Field activities are scheduled to begin in June 2014. Sampling and screening activities will be implemented in a phased approach and are anticipated to be initiated in June 2014. Laboratory analytical are anticipated to become available approximately 30 to 45 days after receipt of the samples by the analytical laboratory. The anticipated schedule is outlined in the table below.

TABLE 3-1
SCHEDULE

Activities	Dates (Month Day, Year)		Deliverables	Deliverable Due Date
	Anticipated Date(s) of Initiation	Anticipated Date of Completion		
• HASP Preparation • SAP Preparation • Planning Meetings • ROV Testing	December 30, 2013	June 8, 2014	HASP, SAP	May 12, 2014
Michigan Tech Underwater Survey and Mapping	May 19, 2014	May 30, 2014	AUV Assessment Plan, Log Books, Video, Video Stills, Magnetometer Interpretation, and Maps	June 1, 2014
AUV Assessment Review and Offshore Sampling Program Refinement (Drums and Sediment)	June 2, 2014	June 5, 2014	Revised Offshore Sampling Location Maps	June 8, 2014
Michigan Tech Underwater Equipment and Field Procedure Testing	June 9, 2014	June 20, 2014	Images and Discussion of Effectiveness	June 27, 2014
Field Sample Collection – GSU Offshore Investigation	June 9, 2014	June 20, 2014	Log Books, Sampling and Screening Logs	2 weeks after completing field activities

Activities	Dates (Month Day, Year)		Deliverables	Deliverable Due Date
	Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Field Sample Collection – GSU Terrestrial Investigation	June 9, 2014	June 18, 2014	Log Books, Sampling and Screening Logs	2 weeks after completing field activities
Field Sample Collection – GSU and Michigan Tech Torch Lake Offshore Investigation	July 7, 2014	July 16, 2014	Log Books, Sampling and Screening Logs	2 weeks after completing field activities
Laboratory Analysis - MDEQ Environmental Laboratory	June 20, 2014	July 20, 2014	Laboratory Analytical Report	3 weeks after submitting the last sample(s)
Supplemental Sampling and Analysis – As needed based on preliminary data review – GSU Terrestrial Investigation	July 21, 2014	July 30, 2014	Log Books, Sampling and Screening Logs	2 weeks after completing field activities
Laboratory Analysis – MDEQ Environmental Laboratory	July 23, 2014	August 3, 2014	Laboratory Analytical Report	3 weeks after submitting the last sample(s)
Supplemental Sampling and Analysis – As needed based on preliminary data review – GSU Terrestrial Investigation	August 18, 2014	August 27, 2014	Log Books, Sampling and Screening Logs	2 weeks after completing field activities
Laboratory Analysis – MDEQ Environmental Laboratory	August 27, 2014	September 26, 2014	Laboratory Analytical Report	3 weeks after submitting the last sample(s)
Public Outreach and Technical Meeting Support	December 30, 2013	December 30, 2014	Website updates, newsletters, fact sheets, and public relations support	Attendance at up to Eight Meetings – TBD

4. FIELD PROCEDURES AND SAMPLE COLLECTION

The field procedures and sample collection activities that will be implemented in the C&H Lake Linden Operations Geographic Area to will be used to evaluate the presence of contaminated environmental media in the study areas defined in the preceding sections of the SAP.

As the primary contaminant of concern at the Site, PCB analytical results will be evaluated to determine if additional analyses is needed. Analytical results will initially be reported PCB Aroclors, including Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. Future analysis may include a more detailed analysis that includes the identification of the 209 PCB congeners, which may provide relevant data for comparison to analytical results from other sample media such as fish tissue. The selection of samples for PCB analyses will be based on the concentrations of PCB Aroclors. Only soil and sediment samples will potentially be analyzed for PCB congeners. All soil and sediment samples collected during the investigation will be labeled “To Hold Excess”, indicating that the laboratory will retain any excess sample volume for later analyses.

This section describes the sampling methodology and procedures that will be implemented to collect samples from various environmental media.

The proposed sampling rationale for each of the geographic areas within the C&H Lake Linden Operations Area are described in **Section 2**. Proposed sampling locations for the offshore investigation is dependent upon the findings of the Michigan Tech Underwater Survey and Reconnaissance Task and therefore, only the sampling methods are described in this Section. The proposed terrestrial sampling and screening locations within each subarea are depicted as follows:

- Torch Lake Backwater Area – **Figure 4-1**
- Lake Linden Sands Area – **Figure 4-2**
- Lake Linden Processing Area – **Figure 4-3**
- Hubbell Coal Dock Area – **Figure 4-4**
- Hubbell Smelter Area – **Figure 4-5**
- Hubbell Slag Dump and Beach Area – **Figure 4-6**

Proposed sampling locations, proposed laboratory analyses, and sampling rationale are summarized on **Table 4-1**.

4.1 POTENTIAL PHYSICAL AND HEALTH HAZARD INVENTORY

The investigation and of each organizational area included in the C&H Lake Linden Operations will include a physical inspection of the area. The inspection will include the inventory and locating of historical structures and artifacts associated with the former industrial operations within each area.

Each area will also be inspected for potential physical and health hazards. Such hazards may include potentially abandoned drums and containers, suspect asbestos containing materials, stained or oily soils, and similar observed environmental conditions. Potential physical hazards, including waste deposits, metal debris, and similar conditions in areas without restricted access will also be recorded.

Inventoried locations will be located with a global positioning system (GPS) unit with sub-meter accuracy. Field decisions may be made to collect samples from abandoned containers, however suspect asbestos containing materials will not be sampled unless an asbestos inspector licensed in the State of Michigan is present to complete the sampling.

4.2 SURFACE SOIL AND WASTE DEPOSIT SAMPLING

Grab soil sample will be collected from proposed surface soil (0-6 inches) sampling locations. In sampling areas where waste deposits or historical surface soils have been capped or covered, the surface soil sample will be collected from directly beneath the cover media. These conditions are anticipated to be encountered in capped areas, but also in areas that have been redeveloped or improved such as the beach areas, public parks, and private property. Proposed surface soil sampling locations are illustrated on **Figure 4-1** through **Figure 4-6**.

Surface soil sampling and decontamination procedures are described in MDEQ, Michigan Tech, and/or WESTON SOPs in **Appendix D**.

Specific procedures selected for this project are summarized as follows:

- The location of each sampling point will be sketched on field documentation, and the coordinates of the sample location will be recorded using a GPS receiver with sub-meter accuracy.
- Rocks and organic matter (including grasses, shallow vegetation roots, and leaves) will be scraped from the surface of each location before surface soil is collected.
- Direct push boring techniques will be used to collect soil samples from each location. The surface samples will be collected from the 0 to 6 inch interval of the extracted soil core. Down hole sampling equipment will be decontaminated prior to sampling at another location.
- Soil samples will be transferred directly into laboratory-provided sample jars.
- Sample jars will be labeled using the nomenclature outlined in **Section 5.1**, and placed in a cooler on ice for shipment to the identified analytical laboratory under chain of custody.
- Investigative-derived wastes (IDW), including potentially contaminated soil will be returned to the `boring location from which it was generated. Personal protective equipment (PPE) and waste generated by sample preparation will be bagged and staged for disposal as municipal solid waste.

Field team members will don a new pair of disposable nitrile gloves prior to collection of each sample. The stainless steel coring device will be decontaminated after collection of each sample by washing in an alconox-and-water solution, rinsing with distilled water, and drying with disposable paper towels.

The table below summarizes the container and anticipated analytical requirements for the surface soil sampling.

Field Screening

Soil cores will be field-screened with the following equipment:

- PID

Sample Collection Equipment

- Laboratory-provided sample containers
- Stainless steel trowels/coring tool

Container and Analytical Requirements List

Surface Soil	One 250 mL wide mouth (W.M.) glass jar	Metals	SW846-EPA 6020A /7470A	Cool to 4°C	6 months; 28 Days
		Lead, Fine-Grained Fraction (< 250 µm)	SW846-6010	Cool to 4°C	6 months
		Lead, Coarse-Grained Fraction (< 250 µm)	SW846-6010	Cool to 4°C	6 months
	One 250 mL W.M. glass jar	PCBs	EPA 8082	Cool to 4°C	12 months
		PNAs	SW846-EPA 8270C	Cool to 4°C	14 Days
	One 250 mL W.M. glass jar	Asbestos	PLM	Cool to 4°C	12 months
	1 MeOH Kit, 40 mL glass vial	VOCs	SW846-EPA 8260	Cool to 4°C	14 Days

Notes:
°C – degrees Celsius
µm - Micron
mL – Milliliter
MeOH – Methanol
PCBs – Polychlorinated Biphenyls
PLM - Polarized Light Microscopy
PNAs – Polynuclear Aromatic Hydrocarbons
VOCs – Volatile Organic Compounds

4.3 SUBSURFACE SOIL SAMPLING

Soil borings will be advanced in each sub area to evaluate subsurface conditions. It is anticipated that a track-mounted hydraulic push-probe drill rig will be used to retrieve continuous soil cores from the subsurface. Actual boring depths will be determined in the field and will be based on field observations and field screening results. Proposed soil boring locations are illustrated on **Figure 4-1** through **Figure 4-6**. Subsurface soil samples collected for laboratory analysis will be selected based on field screening results and visual or olfactory indication that contamination may be present. The soil borings will be logged and screened with a PID.

Select borings will be chosen for the collection of groundwater samples based on field observations. It is anticipated that a stainless steel slotted screen will be installed in select boring locations to allow for the collection of groundwater analytical samples.

- It is anticipated that soil borings will be advanced by the MDEQ GSU. MDEQ GSU will be responsible for coordinating utility locates using Michigan's one-call system and in accordance with *Public Act 174, Miss Dig Underground Facility Damage Prevention and Safety Act.*
- The location of each sampling point will be sketched on field documentation, and the coordinates of the sample location will be recorded using a GPS receiver with sub-meter accuracy.
- The lithology for each boring will be classified by the field geologist in accordance with the Unified Soil Classification System (USCS).
- Before advancing reusable downhole equipment, the driller will decontaminate all equipment including the working end of the Geoprobe. Care will be taken to avoid placing equipment, tools, and materials on the ground during the boring activities.
- It is anticipated that borings will be advanced using a 5-foot long, 1.5-inch diameter Macro-Core sampler to collect continuous soil samples at all borings using a motor-driven hydraulic hammer to the desired depth.
- Soil samples will be transferred directly into laboratory-provided sample jars.
- Sample jars will be labeled using the nomenclature outlined in **Section 5.1**, and placed in a cooler on ice for shipment to the identified analytical laboratory under chain of custody.
- IDW, including potentially contaminated soil cuttings, groundwater, and decontamination water will be discharged to the ground surface in the vicinity of the boring. PPE and waste generated by sample preparation will be bagged and staged for disposal as municipal solid waste.

<u>Field Screening</u>

Soil cores will be field-screened with the following equipment:

- PID

<u>Sample Collection Equipment</u>

- Laboratory-provided sample containers
- Stainless steel bowls
- Stainless steel trowels

<u>*Container and Analytical Requirements List*</u>

Subsurface Soil	One 250 mL W.M. glass jar	Metals	SW846-EPA 6020A /7470A	Cool to 4°C	6 months; 28 Days
		Lead, Fine-Grained Fraction (< 250 µm)	SW846-6010	Cool to 4°C	6 months
		Lead, Coarse-Grained Fraction (< 250 µm)	SW846-6010	Cool to 4°C	6 months
	One 250 mL W.M. glass jar	PCBs	EPA 8082	Cool to 4°C	12 months
		PNAs	SW846-EPA 8270C	Cool to 4°C	14 Days
	1 MeOH Kit, 40 mL glass vial	VOCs	SW846-EPA 8260	Cool to 4°C	14 Days

Notes:
°C – Degrees Celsius
µm - Micron
mL – Milliliter
MeOH – Methanol
PCBs – Polychlorinated Biphenyls
PNAs – Polynuclear Aromatic Hydrocarbons
VOCs – Volatile Organic Compounds

4.4 GROUNDWATER SAMPLING

Groundwater samples will be collected utilizing a Screen-Point-16 stainless steel screen, or similar reusable sampling rod from select soil borings advanced at the Site. The actual locations and depths of the groundwater samples will be determined in the field and will be based on field observations and field screening results. The proposed soil boring and groundwater sampling locations are illustrated on **Figure 4-1** through **Figure 4-6**.

The down hole sampling tools will be advanced into the water-bearing zone in each boring. The outer rod will be withdrawn to expose the internal stainless steel screen. Following the installation of the Screen-Point-16 sampling rod, a low-flow peristaltic pump with disposable Teflon tubing will be used to collect a groundwater grab sample from the screened sample interval. Field parameters for dissolved oxygen, pH, ORP, conductivity, temperature, and turbidity will be measured with a water-quality monitoring instrument equipped with a flow-through cell at the time of groundwater sample collection. In the event of minimal groundwater presence and/or slow recharge, the available groundwater will be sampled regardless of the purge volume or field parameter stability. Groundwater will be pumped directly into laboratory-provided sample containers. Sample containers will be labeled using the nomenclature outlined in **Section 5.1**, and placed in a cooler on ice for delivery to the designated laboratory under COC.

Sample Collection Equipment

Groundwater will be will be collected using the following equipment:

- Laboratory-provided sample containers
- Peristaltic pump
- Teflon tubing or similar compatible material
- Water quality meter with flow through cell such as a YSI Model 6820
- Turbidity-meter

Container and Analytical Requirements List

Groundwater	1 500-mL plastic	Metals	EPA 6020A /7471A	HNO^3 to PH<2; Cool to 4°C	6 months; 28 Days
	2 1-L Amber glass	PCBs	EPA 8082	Cool to 4°C	12 months
		PNAs	EPA 8270C	Cool to 4°C	14 Days
	3 40-mL glass vials	VOCs	EPA 8260B	HCl to pH < 2; Cool to 4°C	14 Days

Notes:
°C – Degrees Celsius
< - Less than
HCl – hydrochloric acid
HNO_3 – nitric acid
L – Liter
mL – Milliliter
PCBs – Polychlorinated Biphenyls
PNAs – Polynuclear Aromatic Hydrocarbons
VOCs – Volatile Organic Compounds

4.5 SURFACE WATER SAMPLING

The collection of surface water samples will be at the discretion of field sampling personnel. In locations where drums or other wastes are observed, suggesting unusual conditions, a surface water sample may be collected. If a surface water sample is collected, it will be prior to the collection of any sediment samples at that location. The tentatively proposed surface water and sediment locations are depicted on **Figure 4-1** through **Figure 4-6**. Final sampling locations may be modified based on the underwater reconnaissance completed by Michigan Tech. It is anticipated that sample locations will be located in the vicinity of landward sampling locations or submerged containers to assess the potential for contamination related to the migration of contaminants from potentially identified sources. It is anticipated that surface water samples will be collected from the water column within 1 foot of the lake bottom. Prior to sample collection, the depth to the bottom of the lake will be measured and recorded in the field log book.

Surface water may be collected directly into sample containers if the depth of the water is sufficient or a dip sampler may be used. Alternatively, a low-flow peristaltic pump and Teflon tubing may be used to pump water from the lake into laboratory-provided sample containers. Sample containers will be labeled using the nomenclature outlined in **Section 5.1**, and properly preserved for delivery to the designated laboratory COC. At the time of sample collection field measurements of temperature, conductivity, pH, ORP, turbidity, and dissolved oxygen will also be made at all locations.

The surface water chemical analyses will be performed by the MDEQ's Environmental Laboratory in Lansing, Michigan.

Sample Collection Equipment

Surface water will be collected using the following equipment:

- Laboratory-provided sample containers
- Dip sampler (if needed)
- Peristaltic pump (if needed)
- Teflon tubing (if needed)
- Water quality meter such as a YSI Model 6820
- Turbidity-meter

Container and Analytical Requirements List

Surface Water	1 500-mL plastic	Metals	EPA 6020A /7471A	HNO^3 to PH<2; Cool to $4^{o}C$	6 months; 28 Days
	2 1-L Amber glass	PCBs	EPA 8082	Cool to 4°C	12 Months

		PNAs	EPA 8270C	Cool to 4°C	14 Days
	3 40-mL glass vials	VOCs	EPA 8260B	HCl to pH < 2; Cool to 4°C	14 Days

Notes:
°C – Degrees Celsius
< - Less than
HCl – hydrochloric acid
HNO3 – nitric acid
L – Liter
mL – Milliliter
PCBs – Polychlorinated Biphenyls
PNAs – Polynuclear Aromatic Hydrocarbons
VOCs – Volatile Organic Compounds

4.6 SEDIMENT SAMPLING

Following the collection of surface water samples, sediment samples will be collected from the bottom of Torch Lake from the same location as the surface water samples. The tentatively proposed surface water and sediment locations are depicted on **Figure 4-1** through **Figure 4-6**. Final sampling locations may be modified based on the underwater reconnaissance completed by Michigan Tech. It is anticipated that sample locations will be located in the vicinity of terrestrial sampling locations or previous sediment sampling locations where PCBs were detected, or submerged containers to assess the potential for contamination related to the migration of contaminants from potentially identified sources.

It is anticipated that sediment will be collected from multiple intervals within the sediment to evaluate the vertical extent of contamination. Consistent with previous investigations at least one sediment will be collected from beneath the aqueous layer either directly, using a hand-held device such as a shovel, trowel, or auger, using Michigan Tech's AUV or ROV equipped with similar sampling tools, or indirectly using a remotely activated device such as an Ekman or Ponar dredge.

Sediment samples collected from depth will utilize the MDEQ GSU's vibracore sampler. Lexane tubing, or similar will be advanced in the sediment using the vibracore. The extracted sample core will be opened and the sediment column logged, screened and sampled, based on screening results and observations within the sample core.

Following collection, the sediment will be placed into a container constructed of inert material, homogenized, and transferred to the appropriate sample containers. The depth of water at the sample location will be recorded prior to sampling. Visual observations, including physical characteristics, staining, or olfactory evidence of contamination within the sediment will be recorded. Sample containers will be labeled using the nomenclature outlined in **Section 5.1**, and placed in a cooler on ice for delivery to the designated laboratory under chain of custody.

The sediment chemical analyses will be performed by the MDEQ's Environmental Laboratory in Lansing, Michigan.

Sample Collection Equipment

- Laboratory-provided sample containers
- Stainless steel bowls
- Stainless steel trowels
- Sample coring devices

Container and Analytical Requirements List

Sediment	One 250 mL W.M. glass jar	Metals	SW846-EPA 6020A /7470A	Cool to 4°C	6 months; 28 Days
		Lead, Fine-Grained Fraction (< 250 µm)	SW846-6010	Cool to 4°C	6 months
		Lead, Coarse-Grained Fraction (< 250 µm)	SW846-6010	Cool to 4°C	6 months
	One 250 mL W.M. glass jar	PCBs	EPA 8082	Cool to 4°C	12 months
		PNAs	SW846-EPA 8270C	Cool to 4°C	14 Days
	1 MeOH Kit, 40 mL glass vial	VOCs	SW846-EPA 8260	Cool to 4°C	14 Days

Notes:
°C – Degrees Celsius
< - Less than
HCl – hydrochloric acid
HNO3 – nitric acid
L – Liter
mL – Milliliter
PCBs – Polychlorinated Biphenyls
PNAs – Polynuclear Aromatic Hydrocarbons
VOCs – Volatile Organic Compounds

5. SAMPLING PROCEDURES

This Section describes the project-specific sample nomenclature, management of investigative-derived waste, decontamination, custody procedures, and other standard operating procedures intended for use on this project.

5.1 SAMPLE NOMENCLATURE

All samples for analysis, including QC samples, will be given a unique sample number. The sample numbers will be recorded in the field logbook, on the sample jars, and on the COC paperwork. The sample identification number will be used to track field-screening data and laboratory analytical results from each parcel in the project database.

WESTON and the field sampling team will assign each sample its unique identification based on the nomenclature outlined below. The sample identification will be used for documentation purposes in field logbooks, as well as for presentation of the analytical data in memoranda and reports. The project samples will be identified using the following format:

Project Identification Code

CHLL = C&H Lake Linden Operations

Sample Media Code

This shall consist of the following:

- SS = Surface soil sample
- SB= Subsurface soil sample
- GW = Groundwater sample
- SW = Surface water sample
- SD = Sediment sample
- DM = Drum or container sample

Sample Number Code

The two digit sample number code will correspond to the consecutive sample count for a given sample media. For example, soil borings are tentatively numbered 01 through 49 and sediment samples are tentatively numbered 01 through 71. Field decisions will ultimately determine the total number of sampling locations for each media type.

Sample Interval or Sample Depth Code

The sample depth or interval code will utilize the top and bottom of the sample interval consisting of the following:

- X-Y = Where X represents the top of the sample interval and Y represents the bottom of the sample interval. For groundwater samples, the screen interval of the monitoring well shall represent the top and bottom of the sample interval.

QA/QC Identification Code

FD = Field duplicate
RB = Rinsate blank

Surface soil sample ID's will be constructed with the project identification code, followed by the area code, followed by the sample media code, followed by the sample interval code, followed by the date code, followed by the QA/QC identification, if applicable.

An example sample identification for a surface soil sample collected from the Lake Linden Processing Area:

- **CHLL-SS01-0-6" =** the first surface soil sample collected from the C&H Lake Linden Operations Area from the 0-6 inch sample interval.

Subsurface soil sample ID's will be constructed with the project identification code, followed by the area code, followed by the sample media code, followed by the sample interval code, followed by the date code, followed by the QA/QC identification, if applicable.

An example sample identification for a subsurface soil sample collected from the Lake Linden Sands Area :

- **CHLL-SB14-1-3' =** subsurface soil sample collected from the fourteenth soil boring advanced in the C&H Lake Linden Operations Area from the 1-3 foot sample interval.

Groundwater sample ID's will be constructed with the project identification code, followed by the area code, followed by the sample media code, followed by the sample/screen interval code, followed by the date code, followed by the QA/QC identification, if applicable.

An example sample identification for a field duplicate groundwater sample collected from the Hubbell Coal Dock Area:

- **CHLL- GW03-8-13'-FD =** field duplicate of the third groundwater sample collected from the C&H Lake Linden Operations Area from a monitoring well screened from 8 to 13 feet.

Surface water sample ID's will be constructed with the project identification code, followed by the area code, followed by the sample media code, followed by the sample interval code, followed by the date code, followed by the QA/QC identification, if applicable.

An example sample identification for a surface water sample collected from the Lake Linden Processing Area:

- **CHLL-SW01-39-40'=** the first surface water sample collected from the C&H Lake Linden Operations Area from a depth of 39 to 40 feet.

Sediment sample ID's will be constructed with the project identification code, followed by the area code, followed by the sample media code, followed by the sample interval code, followed by the date code, followed by the QA/QC identification, if applicable.

An example sample identification for a drum/container sample collected from Torch Lake (outside of the limits of a given subarea):

- **CHLL- SD45-0-6" =** the forty-fifth sediment sample collected from the C&H Lake Linden Operations Area from the 0-6 inch sample interval.

Drum or Container sample ID's will be constructed with the project identification code, followed by the area code, followed by the sample media code, followed by the sample interval code, followed by the date code, followed by the QA/QC identification, if applicable.

An example sample identification for a drum/container sample collected from the Hubbell Smelter Area:

- **CHLL-DM03-0-6" =** the third drum/container sample collected from the C&H Lake Linden Operations Area from the 0-6 inch sample interval.

5.2 DECONTAMINATION PROCEDURES AND MANAGEMENT OF INVESTIGATIVE-DERIVED WASTES

For purposes of this SAP, investigative-derived wastes are defined as any byproduct of the field activities that is suspected or known to be contaminated with hazardous substances. The performance of field activities will produce waste products, such as spent sampling supplies (*e.g.*, sample tubing, disposable sample devices, paper towels, etc.), and expendable PPE. Disposable sampling supplies and PPE will be containerized in trash bags, in the vicinity of the work, which may include terrestrial locations and offshore locations, and disposed of as non-hazardous municipal solid waste at the end of the project phase.

5.2.1 Terrestrial Investigation

Soil boring advancement and monitoring well installation will result in the generation of soil cuttings, purge water, and decontamination water. It is anticipated that soil cuttings, following logging, screening, and sampling will be temporarily contained in a five-gallon bucket. Following completion of the boring installation the staged soil cuttings will be returned to the boring. For locations where groundwater samples are collected, the soil cuttings will be staged until all samples have been collected and the sampling equipment extracted from the boring. Purge water generated as a result of groundwater sampling activities will be temporarily containerized in five-gallon bucket. Following groundwater sampling collection the collected purge water will be returned to the boring and the boring will be backfilled with the soil cuttings. Expendable groundwater sampling materials will be containerized in a trash bag for disposal as non-hazardous municipal solid waste at the end of the project phase. Commercially-available topsoil may be added to soil sampling locations to restore original grade as necessary.

It is anticipated that reusable equipment, including the stainless steel sampling screen, will be decontaminated between boring locations using steam-cleaning methods which will minimize decontamination water. In addition, some parts or equipment may be decontaminated using an alconox wash and rinse. Decontamination water generated through washing and rinsing will be discharged in the vicinity of the sample locations. Spray bottles of wash and rinse water may be used to minimize the volume of decontamination fluids generated but the soil boring and well installation activities.

5.2.2 Offshore Investigation

Offshore sampling locations will result in the generation of similar waste streams. Spent Lexane tubing used in the collection of vibra-core sediment samples will be collected and staged for disposal as non-hazardous municipal solid waste. Sample tubing and similar reusable sampling equipment will collected in a trash bag for disposal as non-hazardous municipal solid waste. Spent sampling supplies and PPE will be staged on the sampling vessel until the vessel returns to the dock at which time bagged and containerized waste will be transferred to a dumpster for disposal.

Excess sediment, debris, and surface water generated as a result of the sampling activities will be temporarily containerized on the vessel in a five-gallon bucket until sampling at the location is complete. Following completion of the sampling activities the excess sediment and surface water will be returned to the lake in the vicinity of the sample location.

It is anticipated that reusable equipment will be decontaminated on board the sampling vessel using an alconox wash and rinse. Spray bottles of wash and rinse water may be used to minimize the volume of decontamination fluids generated during the surface water and sediment sampling activities. Decontamination water generated through washing and rinsing will be discharged to the lake in the vicinity of the sample location.

In the event that free phase oils or liquids or grossly contaminated media are encountered during the terrestrial or offshore sampling activities, contingency containment will be available in the area of the work. Contingencies for containment will include two, clean, five-gallon buckets with lids that will be used to contain any free phase product or residues. The contingency containment will also be used to containerize decontamination fluids resulting from encountering the grossly contaminated material. The containerized waste will be sampled and characterized for proper disposal. It is assumed that any grossly contaminated media collected as a contingency will be temporarily secured and staged at the property where it was generated or at facility secure location until it can be properly characterized and disposed.

5.3 SAMPLE HANDLING, TRACKING, AND CUSTODY PROCEDURES

All samples will be identified, handled, shipped, tracked, and maintained under COC. This section discusses sample identification (ID), sample labels, custody seals, sample documentation, sample chain-of-custody, the field logbook, and sample shipment.

5.3.1 Sample Identification

As described in **Section 5.1**, Each sample collected will be given a unique sample ID number that is project- and location-specific. A record of sample ID numbers will be kept with the field records and recorded on chain-of-custody forms.

5.3.2 Sample Labels

Sample labels will be affixed to sample containers. The label will be completed with the following information written in indelible ink:

- Project name and location
- Sample ID number
- Date and time of sample collection
- Preservative used
- Sample collector's initials
- Analyses required

After labeling, each sample will be placed in a cooler that contains ice to maintain the sample temperature at 4 ± 2 ºC. A temperature blank will be provided in each cooler for the laboratory to confirm storage temperature upon sample receipt.

5.3.3 Custody Seals

A self-adhesive custody seal will be placed across the lid of each sample cooler so that the cooler cannot be opened without breaking the seal. The shipping containers in which samples will be stored will be sealed with self-adhesive custody seals any time they are not in someone's possession or view before shipping. Custody seals will be signed and dated.

Custody seals also will be used in combination with strapping tape on the shipping containers to ensure that samples have not been disturbed during transport. Openings will be taped shut to prevent potential leakage during transport.

5.3.4 Sample Documentation

Documentation during sampling is essential to ensure proper sample identification. Sampling personnel will adhere to the general guidelines summarized below for maintaining field documentation:

- Documentation will be completed in permanent black ink;
- Entries will be legible;
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout in a manner that allows the initial entry to be read;
- Any serialized documents including the sampling forms will be maintained in a site file folder by WESTON field personnel and referenced in the site logbook; and,
- Unused portions of pages will be crossed out, and each page will be signed and dated.

WESTON field personnel will be responsible for ensuring that sampling activities are properly documented.

5.3.5 Sample Chain of Custody

The field team will use standard sample custody procedures to maintain and document sample integrity during sample collection, transportation, storage, and analysis. A sample will be considered to be in custody if one of the statements below applies:

- It is in a person's physical possession or view;
- It is in a secure area with restricted access;
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal; and,
- Special instructions regarding short holding/extraction times will be noted.

Chain-of-custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The chain-of-custody form will be used to document samples collected and the analyses requested. The field personnel will record the following information on the chain-of-custody record:

- Project name and number;
- Sampling location;
- Name and signature of sampler;
- Destination of samples (laboratory name);
- Sample ID number;
- Date and time of collection;
- Number and type of containers filled;
- Analyses requested;
- Preservatives used (if applicable);
- Filtering (if applicable);
- Sample designation (grab or composite);
- Signatures of individuals involved in custody transfer;
- Air bill number (if applicable); and,
- Project contact and telephone number.

Unused lines on the chain-of-custody record will be crossed out. Field personnel will sign chain-of-custody records that are initiated in the field, and the air bill number will be recorded. The record will be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed air bills will serve as evidence of custody transfer between field personnel and the courier and between the courier and the laboratory. Copies of the chain-of-custody records and the air bills will be retained and filed by field personnel before the containers are shipped.

Laboratory chain-of-custody begins with sample receipt and continues until samples are discarded. Laboratories analyzing samples must follow custody procedures at least as stringent as those required by the U.S. EPA Contract Laboratory Program (CLP) Statement of Work (SOW) (U.S. EPA 2007). The laboratory should designate a specific individual as the sample custodian. The custodian will receive incoming samples, sign the accompanying custody forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record pertinent information concerning the samples, including the person(s) delivering the samples, the date and time received, and sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; and other relevant remarks).

The sample ID numbers, along with unique laboratory ID numbers, will be recorded on the sample receipt form. After the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for samples. Access to this area will be restricted to authorized personnel. The custodian will ensure that samples requiring special handling, including samples that are heat- or light-sensitive or have other unusual physical characteristics, will be properly stored and maintained prior to analysis.

5.3.6 Sample Shipment

The procedures summarized below will be implemented to ship samples collected during this project.

- The cooler will be filled with bubble wrap, sample bottles, and packing material. Sufficient packing material will be used to prevent sample containers from breaking during shipment. Enough ice will be added to maintain the sample temperature at 4 ± 2 °C. A temperature blank will be provided in each cooler for the laboratory to confirm storage temperature upon sample receipt. In addition, in order to avoid interference with the laboratory analysis, the packing material will be handled and used in such a manner that it will not contact the sample media at the Site.

- The chain-of-custody records will be placed inside a waterproof plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The air bill, if required, will be filled out before the samples are handed over to the carrier. The laboratory will be notified if the sampler suspects that the sample contains any substance that would require laboratory personnel to take safety precautions.

- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, the drain will be taped shut both inside and outside the cooler.

- Signed and dated custody seals will be placed on the front and side of each cooler. Wide clear tape will be placed over the seals to prevent accidental breakage.

- The chain-of-custody record will be transported in the taped sealed cooler. When the cooler is received at the analytical laboratory, laboratory personnel will open the cooler and sign the chain-of-custody record to document the transfer of samples.

Multiple coolers may be sent in one shipment to the laboratory. The outsides of the coolers will be marked to indicate the number of coolers in the shipment.

Alternatively, samples may be transported by |MDEQ personnel directly to the environmental laboratory. Standard chain of custody procedures will be followed during transfer of the samples to the laboratory.

5.4 SAMPLING SOPS

The following SOPs will be used during the site evaluation:

- SOP 201 – Groundwater Sampling
- SOP 203 – Surface Water Sampling
- SOP 301 – Decontamination Procedures
- SOP 303 – Sediment Sampling
- SOP 304 – Subsurface Soil Sampling
- SOP 306 – Soil Boring Logging and Sampling

5.5 FIELD LOG BOOK

Complete and accurate documentation is essential to demonstrate that field measurement and sampling procedures are carried out as described in this. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the project name and number; the Site name and location; and the names of subcontractors.

At a minimum, the following information will be recorded in the field logbook:

- Names and affiliations of on-site personnel and visitors;
- Weather conditions during the field activity;
- Summary of daily activities and significant events;
- Information regarding sample collection, including collection date and time, sample ID number, sampling location, sample matrix (such as water or soil), sample type (such as regular, duplicate, blank, grab, or composite), and sampling depth;
- Notes of conversations with coordinating officials;
- References to other field logbooks or forms that contain specific information;
- Discussions of problems encountered and their resolution;
- Discussions of deviations from the SAP or other governing documents; and,
- Description of photographs taken.

Changes or corrections will be made by crossing out the item with a single line initialed and dated by the person performing the correction. The original item, although erroneous, will remain legible beneath the cross-out. The new information will be written above the crossed-out item. Corrections will be written clearly and legibly with indelible ink.

6. LABORATORY INFORMATION

Investigative samples will be delivered by a courier or shipped under chain of custody to the designated laboratory listed in the table below.

Surface Soil Subsurface Soil Groundwater Surface Water Sediment	MDEQ Environmental Laboratory	3350 N. Martin Luther King Blvd. Lansing, MI 48906-2933	MDEQ Laboratory Services Section – Kirby Shane		No

Although the selected laboratory does not perform asbestos analyses, the contract laboratory program requires that the samples be shipped and managed by the MDEQ Environmental Laboratory. The laboratory will deliver the samples under chain of custody to the appropriate laboratory in the Contract Laboratory Program.

6.1 MEASUREMENT AND PERFORMANCE CRITERIA

Generic measurement and performance criteria will be used. These criteria will ensure that data are sufficiently sensitive, precise, accurate, and representative to support Site decisions. The criteria are summarized below.

- Sensitivity **–** Sensitivity is the ability of the method or instrument to detect the contaminant of concern and other target analytes at the level of interest. For this project, the laboratory quantitation limits are below the site action levels for lead as required (see **Section 6.2**).

- Accuracy **–** Accuracy is a measure of the agreement between an observed value and an accepted reference value. It is a combination of the random error (precision) and systematic error (bias), which are due to sampling and analytical operations. Accuracy is determined by percent recovery calculations of laboratory QC samples.

- Precision **–** Precision is a measure of the closeness of agreement among individual measurements. Precision is determined by relative percent difference (RPD) and/or standard deviation calculations for laboratory duplicate samples.

- Completeness **–** Completeness is a measure of the amount of valid data obtained compared to the amount of data that was planned to be collected. Completeness is project specific but is generally around 90 percent.

- Representativeness – Representativeness is a measure of the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Simply, this is the degree to which samples represent the conditions for which they were taken.

- Comparability – Comparability is a measure of the degree to which one data set can be compared with another. Some conditions of comparability of data sets are as follows: standardized sampling and analysis, consistency of reporting units, and standardized data format.

The MDEQ Environmental Laboratory will validate analytical results, ensuring that the data is acceptable for use in supporting Site decisions.

6.2 DATA QUALITY OBJECTIVES

DQOs address requirements that include when, where, and how to collect samples; the number of samples; and the limits on tolerable error rates. Sufficient data will be obtained from a representative number of samples to support defensible decisions by MDEQ and to determine whether further actions at the Site are necessary. These steps should periodically be revisited as new information about a problem is learned.

The following is a list of DQOs that apply to the C&H Lake Linden Operations Geographic Area. Analytical data must meet all requirements for comparison to the following regulations:

Surface Soil

- MDEQ Cleanup Criteria Requirements for Response Activity.
    - Rule 299.46 Generic soil cleanup criteria for residential category; and,
    - Rule 299.48 Generic soil cleanup criteria for nonresidential category.

Subsurface Soil

- MDEQ Cleanup Criteria Requirements for Response Activity.
    - Rule 299.46 Generic soil cleanup criteria for residential category; and,
    - Rule 299.48 Generic soil cleanup criteria for nonresidential category.

Groundwater

- MDEQ Cleanup Criteria Requirements for Response Activity

  - Rule 299.44 Generic groundwater cleanup criteria.

Surface Water

- MDEQ – Rule 57 Water Quality Values, Surface Water Assessment Section
- EPA Ecological Screening Levels (ESLs)

Sediment

- MDEQ Cleanup Criteria Requirements for Response Activity;
  - Rule 299.46 Generic soil cleanup criteria for residential category; and,
  - Rule 299.48 Generic soil cleanup criteria for nonresidential category.
- EPA ESLs; and,
- Sediment Quality Guidelines, Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), MacDonald, et al, 2000.

7. QUALITY CONTROL ACTIVITIES

The following sections describe the field and laboratory quality control procedures.

7.1 FIELD QUALITY CONTROL

QC samples will be collected to evaluate the field sampling and decontamination methods, and the overall reproducibility of the laboratory analytical results. Specifically, QC samples will be collected at the following frequencies:

- Field duplicate samples
  - 1 per 10 investigative samples
- Equipment rinsate blank samples
  - 1 per 20 investigative samples

Field duplicate samples will be collected from the homogenized surface soil removed from the same disposable polyethylene bag as its associated investigative sample. Field duplicate samples will be processed, stored, packaged, and analyzed by the same methods as the investigative samples. Sample nomenclature specific to QC samples is listed in **Section 5.1**. For field duplicates, the RPD between the duplicate and investigative sample will be calculated by the WESTON QA reviewer and those RPDs greater than 50 percent (where detections are greater than the quantitation limit) will be summarized in a data validation report. Corrective actions may include resampling, reassessment of the laboratory's methods, or the addition of data qualifiers to laboratory results.

Equipment rinsate blanks will be collected at a frequency of 1 per 20 investigative samples. Equipment rinsate blanks are collected by slowly rinsing the decontaminated stainless steel coring device with laboratory-grade deionized water while simultaneously collecting the used rinse water in a laboratory-provided, pre-cleaned container. Rinsate blank samples will be delivered to the designated laboratory under chain-of-custody for analysis total lead. The table below lists equipment rinsate blank container and analytical requirements.

Matrix spike/matrix spike duplicate (MS/MSD) samples will not be collected during the implementation of field activities. Alternatively, MS/MSD will be selected by the laboratory or "batched". As such, MS/MSD samples may not be derived from investigative samples from the Site, but may come from another sample set at the laboratory. MS/MSD results will be reported with investigative sample results. The collection of samples for MS/MSD analyses will not be conducted as part of this investigation.

Water	1 500-mL plastic	Metals	EPA 6020A /7471A	HNO^{3} to PH<2; Cool to 4°C	6 months; 28 Days
	2 1-L Amber glass	PCBs	EPA 8082	Cool to 4°C	6 months
		PNAs	EPA 8270C	Cool to 4°C	14 Days
	3 40-mL glass vials	VOCs	EPA 8260B	HCl to pH < 2; Cool to 4°C	14 Days

Notes:
°C – Degrees Celsius
< - Less than
HCl – hydrochloric acid
HNO3 – nitric acid
L – Liter
mL – Milliliter
PCBs – Polychlorinated Biphenyls
PNAs – Polynuclear Aromatic Hydrocarbons
VOCs – Volatile Organic Compounds

The MDEQ will be notified and corrective actions may be considered if the WESTON QA reviewer determines that the laboratory analytical result from an equipment rinsate blank sample contains lead at a concentration exceeding the laboratory quantitation limit. Corrective actions may include resampling or the addition of data qualifiers to laboratory results.

7.2 ANALYTICAL QUALITY CONTROL

QC for analytical procedures will be performed at the frequency described in the laboratory SOPs. In addition, method-specific QC requirements will be used to ensure data quality.

7.3 PERFORMANCE EVALUATION SAMPLES

Performance evaluation samples will not be used in this site assessment.

7.4 QUALITY ASSURANCE ASSESSMENT / CORRECTIVE ACTIONS

Field activities are anticipated to require two 2 week mobilizations for completion; no long-term project field audit will be completed at this time.

7.5 DOCUMENTATION, RECORDS, AND DATA MANAGEMENT

The MDEQ Environmental Laboratory will be expected to provide analytical results in electronic data deliverable (EDD) and report formats, with QA/QC data included (case narrative, investigated data results summary, and QC sample summary results). Laboratory-generated data will be imported to a project database for mapping, reporting, and archival activities. Laboratory reports and data validation reports will be archived in the project file.

7.6 DATA VALIDATION REQUIREMENTS

WESTON will use the basic data validation guidance as specified in the "EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" dated June 2008 and "EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review" dated January 2010.

QA/ QC audit items reviewed for inorganic analyses will include at a minimum:

- Holding time and sample preservation;
- MS recoveries;
- laboratory duplicate results;
- Laboratory Control Sample (LCS) results;
- Method blank results;
- Instrument blank results;
- Field and/or rinsate blank results;
- Field duplicate results; and,
- Quantitation limits.

QA/QC audit items reviewed for organic analyses will include at a minimum:

- Holding time and sample preservation;
- Surrogate spike results;
- MS/MSD results;
- LCS results;
- Method blank results;

- Instrument blank results;
- Field and/or rinsate blank results;
- Field duplicate results; and,
- Quantitation limits.

8. REFERENCES

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4. Great Lakes National Program Office. *Aroclor Sediment Investigation, Torch Lake Area of Concern, Houghton County, Michigan.* June 2009.

5. Kahn Jr., Julius. The Iron Age, January 5, 1899 *"Abstract of Paper presented at the American Society of Civil Engineers January 4, 1899 – The Coal Hoists of the Calumet and Hecla Mining Company"*, December 1898.

6. MacDonald, D.D., Ingersoll, C.G., and Berger, T.A. *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems.* January 2000.

7. Michigan Department of Environmental Quality (MDEQ), *CERCLA Preliminary Assessment Report for C & H Lake Linden Operations, Lake Linden, MI 49945, U.S. EPA ID No: MIN000510619*, 2011.

8. MDEQ, *Draft Site Inspection Report for C & H Lake Linden Operations, Lake Linden, MI 49945, U.S. EPA ID No: MIN000510619*, 2013.

9. Weston Solutions of Michigan, Inc. (WESTON). *Summary Report for the Torch Lake Area Assessment, Torch Lake NPL Site and Surrounding Areas, Keweenaw Peninsula*, Michigan, December 2007.

10. WESTON. *Site Assessment Report for the Calumet and Hecla Power Plant Site, Lake Linden, Houghton County, Michigan.* December 2010.

TABLES

Table 4-1
Sampling and Analysis Summary
C&H Lake Linden Operations
Torch Lake Backwater Area
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sampling Method	Sample Type/Matrix						Sample Analyses						Duplicate Analyses				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SB01-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X									X							
CHLL-SB01-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB02-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB02-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X							X	X							
CHLL-SB03-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB03-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X						O	X	X				O	X	X	
CHLL-SB04-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X									X							
CHLL-SB04-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-MW01-X-Y'	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X		X							
CHLL-SD01-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore					X				X	X							
CHLL-SD01-1-3'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore					X			X		X							
CHLL-SD01-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore					X					X							
CHLL-SD02-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore					X				X	X							
CHLL-SD02-1-3'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore					X					X							
CHLL-SD02-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore					X					X						X	
CHLL-SD03-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the sediment sampling location	Vibracore					X				X	X							
CHLL-SD03-1-3'	Proximity to reported dumping/disposal areas	Sediment from 1-3 feet below the sediment surface	Vibracore					X					X							
CHLL-SD03-3-6'	Proximity to reported dumping/disposal areas	Sediment from 3-5 feet below the sediment surface	Vibracore					X					X							
CHLL-SD04-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the sediment sampling location	Vibracore					X				X	X							
CHLL-SD04-1-3'	Proximity to reported dumping/disposal areas	Sediment from 1-3 feet below the sediment surface	Vibracore					X					X							
CHLL-SD04-3-5'	Proximity to reported dumping/disposal areas	Sediment from 3-5 feet below the sediment surface	Vibracore					X					X							
CHLL-SD05-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the sediment sampling location	Vibracore					X				X	X							
CHLL-SD05-1-3'	Proximity to reported dumping/disposal areas	Sediment from 1-3 feet below the sediment surface	Vibracore					X					X							
CHLL-SD05-3-5'	Proximity to reported dumping/disposal areas	Sediment from 3-5 feet below the sediment surface	Vibracore					X					X							
CHLL-SD06-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the sediment sampling location	Vibracore					X				X	X						X	
CHLL-SD06-1-3'	Proximity to reported dumping/disposal areas	Sediment from 1-3 feet below the sediment surface	Vibracore					X			X		X							
CHLL-SD06-3-5'	Proximity to reported dumping/disposal areas	Sediment from 3-5 feet below the sediment surface	Vibracore					X					X							
			Total Sample Count	**4**	**4**	**1**	**0**	**18**	**0**	**1**	**4**	**10**	**27**		**0**	**0**	**1**	**1**	**3**	**0**

Notes:
CHLL = C&H Lake Linden Operations
O = Potential analyte based on field observations
PNAs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
VOCs = Volatile Organic Compounds
X = Planned analyte based on the sampling rationale and the horizontal and vertical location of the sample

Laboratory Quality Assurance/Quality Control Matrix Spike and Matrix Spike Duplicate samples will be a batch quality control sample prepared by the laboratory.
All sampling locations are subject to change based on visual observations or actual field conditions.
Additional analytes may be selected at the descretion of the field sampling team based on visual observations or field conditions.
Surface water and sediment sampling locations area subject to change based on underwater assessment activities.

For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.

In areas that have been resurfaced or capped, analytical samples will be collected from directly beneath the cap/resurfacing medium (i.e. soil cap, beach sand, gravel, etc...) so that samples are representative of historical waste deposits.

Table 4-1
Sampling and Analysis Summary
Lake Linden Sands Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SB05-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB05-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB06-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB06-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB07-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB07-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB07-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB08-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X			X	X	X	X	
CHLL-SB08-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB08-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB09-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB09-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB09-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB10-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB10-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB10-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB11-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB11-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X			X	X	X	X	
CHLL-SB11-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB12-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB12-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB12-X-Y	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB13-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB13-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB13-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB14-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB14-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB15-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X			X	X	X	X	
CHLL-SB15-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB16-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X							
CHLL-SB16-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-SB16-X-Y'	Proximity to reported dumping/disposal areas	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-MW02-X-Y'	Proximity to reported dumping/disposal areas	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW03-X-Y'	Proximity to reported dumping/disposal areas	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW04-X-Y'	Proximity to reported dumping/disposal areas	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW05-X-Y'	Proximity to reported dumping/disposal areas	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW06-X-Y'	Proximity to reported dumping/disposal areas	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW07-X-Y'	Proximity to reported dumping/disposal areas	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X						X	

Table 4-1
Sampling and Analysis Summary
Lake Linden Sands Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SD07-0-6"	Mouth of the Traprock River	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD07-1-3'	Mouth of the Traprock River	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD07-3-5'	Mouth of the Traprock River	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD08-0-6"	Mouth of the Traprock River	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD08-1-3'	Mouth of the Traprock River	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD08-3-5'	Mouth of the Traprock River	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD09-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD09-1-3'	Proximity to reported dumping/disposal areas	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SD09-3-5'	Proximity to reported dumping/disposal areas	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD10-0-6"	Proximity to reported dumping/disposal areas	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD10-1-3'	Proximity to reported dumping/disposal areas	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD10-3-5'	Proximity to reported dumping/disposal areas	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SW01-X-Y'	Proximity to reported dumping/disposal areas, proximity to the public beach	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD11-0-6"	Proximity to reported dumping/disposal areas, proximity to the public beach	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X		O	X	X	X							
CHLL-SD12-0-6"	Proximity to reported dumping/disposal areas, proximity to the public beach	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD12-1-3'	Proximity to reported dumping/disposal areas, proximity to the public beach	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD12-3-5'	Proximity to reported dumping/disposal areas, proximity to the public beach	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD13-0-6"	Proximity to reported dumping/disposal areas, proximity to the public beach	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X		O	X	X	X							
CHLL-SD13-1-3'	Proximity to reported dumping/disposal areas, proximity to the public beach	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SD13-3-5'	Proximity to reported dumping/disposal areas, proximity to the public beach	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD14-0-6"	Proximity to reported dumping/disposal areas, proximity to the public beach	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X		O	X	X	X							
CHLL-SD14-1-3'	Proximity to reported dumping/disposal areas, proximity to the public beach	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD14-3-5'	Proximity to reported dumping/disposal areas, proximity to the public beach	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD15-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD15-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD15-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD16-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD16-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD16-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SW02-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD17-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW03-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD18-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW04-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD19-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
			Total Sample Count	**12**	**20**	**6**	**4**	**31**	**0**	**41**	**44**	**44**	**73**		**0**	**3**	**3**	**3**	**7**	**0**

Notes:
CHLL = C&H Lake Linden Operations
O = Potential analyte based on field observations
PNAs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
VOCs = Volatile Organic Compounds
X = Planned analyte based on the sampling rationale and the horizontal and vertical location of the sample

Laboratory Quality Assurance/Quality Control Matrix Spike and Matrix Spike Duplicate samples will be a batch quality control sample prepared by the laboratory.
All sampling locations are subject to change based on visual observations or actual field conditions.
Additional analytes may be selected at the descretion of the field sampling team based on visual observations or field conditions.
Surface water and sediment sampling locations area subject to change based on underwater assessment activities.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.
In areas that have been resurfaced or capped, analytical samples will be collected from directly beneath the cap/resurfacing medium (i.e. soil cap, beach sand, gravel, etc...) so that samples are representative of historical waste deposits.

Table 4-1
Sampling and Analysis Summary
Lake Linden Processing Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SB17-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X		X					
CHLL-SB17-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X						O	X	X							
CHLL-SB18-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB18-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X						O		X							
CHLL-SB19-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X									X		X					
CHLL-SB19-X-Y	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X								X						X	
CHLL-SB20-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X									X							
CHLL-SB20-X-Y	Proximity to a historical generating station or electrical substation.	Above the Capillary fringe	Direct Push Boring		X								X							
CHLL-SB21-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X									X		X					
CHLL-SB21-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB22-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X		X					
CHLL-SB22-X-Y'	Proximity to a historical generating station or electrical substation.	Above the Capillary fringe	Direct Push Boring		X							X	X							
CHLL-SB23-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X									X							
CHLL-SB23-X-Y	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB24-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB24-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X								X						X	
CHLL-SB25-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB25-X-Y	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB50-0-6"	Proximity to a historical removal area.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X		X					
CHLL-SB50-X-Y'	Proximity to a historical removal area.	Composite sample from above water table	Direct Push Boring		X							X	X							
CHLL-SB51-0-6"	Proximity to historical assay laboratory.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X		X					
CHLL-SB51-X-Y'	Proximity to historical assay laboratory.	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-MW35-X-Y	Proximity to a historical removal area.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW36-X-Y	Proximity to historical assay laboratory.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW08-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X						X	X							
CHLL-MW09-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW10-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW11-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW12-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X						X	X							
CHLL-MW13-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X	X	X							
CHLL-MW14-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X						X	X							
CHLL-SD20-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD20-1-3'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD20-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD21-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD21-1-2'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD21-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							

Table 4-1
Sampling and Analysis Summary
Lake Linden Processing Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SD22-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X						X	
CHLL-SD22-1-3'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD22-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD23-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD23-1-3'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD23-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SW05-X-Y'	Proximity to a historical generating station or electrical substation.	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD24-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SD25-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD25-1-2'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD25-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SW06-X-Y'	Proximity to a historical generating station or electrical substation.	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD26-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X				O	O	X	
CHLL-SW07-X-Y'	Proximity to a historical generating station or electrical substation.	1 foot above the sediment surface	Remotely Operated Vehicle				X						O						O	
CHLL-SD27-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SD28-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD28-1-3'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD28-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD29-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD29-1-2'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD29-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD30-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD30-1-3'	Proximity to a historical generating station or electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD30-3-5'	Proximity to a historical generating station or electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SW08-X-Y'	Proximity to a historical generating station or electrical substation.	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD31-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW09-X-Y'	Proximity to a historical generating station or electrical substation.	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD32-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW10-X-Y'	Proximity to a historical generating station or electrical substation.	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD33-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
			Total Sample Count	11	11	9	6	30	0	8	16	26	67	0	6	0	1	1	6	0

Notes:
CHLL = C&H Lake Linden Operations
O = Potential analyte based on field observations
PNAs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
VOCs = Volatile Organic Compounds
X = Planned analyte based on the sampling rationale and the horizontal and vertical location of the sample

Laboratory Quality Assurance/Quality Control Matrix Spike and Matrix Spike Duplicate samples will be a batch quality control sample prepared by the laboratory
All sampling locations are subject to change based on visual observations or actual field conditions
Additional analytes may be selected at the descretion of the field sampling team based on visual observations or field conditions
Surface water and sediment sampling locations area subject to change based on underwater assessment activities.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.
In areas that have been resurfaced or capped, analytical samples will be collected from directly beneath the cap/resurfacing medium (i.e. soil cap, beach sand, gravel, etc...) so that samples are representative of historical waste deposits.

Table 4-1
Sampling and Analysis Summary
Hubbell Coal Dock Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SB26-0-6"	Proximity to a historical electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X							O	X	X							
CHLL-SB26-X-Y'	Proximity to a historical electrical substation.	Composite sample from above water table	Direct Push Boring		X						O	X	X							
CHLL-SB27-0-6"	Proximity to a historical electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X							O	X	X							
CHLL-SB27-X-Y	Proximity to a historical electrical substation.	Composite sample from above water table	Direct Push Boring		X						O	X	X							
CHLL-SB28-0-6"	Proximity to a historical electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X							X	X	X							
CHLL-SB28-X-Y'	Proximity to a historical electrical substation.	Composite sample from above water table	Direct Push Boring		X						X	X	X							
CHLL-SB29-0-6"	Proximity to a historical electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X							X	X	X							
CHLL-SB29-X-Y	Proximity to a historical electrical substation.	Composite sample from above water table	Direct Push Boring		X						X	X	X					X	X	
CHLL-SB30-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB30-X-Y'	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X							X	X							
CHLL-SB31-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB31-X-Y	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X							X	X							
CHLL-SB32-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB32-X-Y	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X							X	X							
CHLL-MW15-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				O	X	X	X							
CHLL-MW16-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				O	X	X	X							
CHLL-MW17-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				O	O	X	X			O	O	X	X	
CHLL-MW18-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				O	X	X	X							
CHLL-MW19-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				O	O	X	X							
CHLL-SW11-X-Y'	Data Gap - Lack of historical data	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD34-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW12-X-Y'	Data Gap - Lack of historical data	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD35-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SD36-0-6"	Proximity to a historical electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD36-1-3'	Proximity to a historical electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD36-3-5'	Proximity to a historical electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD37-0-6"	Proximity to a historical electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X						X	
CHLL-SD37-1-3'	Proximity to a historical electrical substation.	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD37-3-5'	Proximity to a historical electrical substation.	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SW13-X-Y'	Proximity to a historical electrical substation.	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD38-0-6"	Proximity to a historical electrical substation.	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							

Table 4-1
Sampling and Analysis Summary
Hubbell Coal Dock Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SW14-X-Y'	Data Gap - Lack of historical data	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD39-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SD40-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD40-1-3'	Data Gap - Lack of historical data	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD40-3-5'	Data Gap - Lack of historical data	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD41-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD41-1-3'	Data Gap - Lack of historical data	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD41-3-5'	Data Gap - Lack of historical data	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SD42-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD42-1-3'	Data Gap - Lack of historical data	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD42-3-5'	Data Gap - Lack of historical data	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SW15-X-Y'	Data Gap - Lack of historical data	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD43-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW16-X-Y'	Data Gap - Lack of historical data	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD44-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SD45-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD45-1-3'	Data Gap - Lack of historical data	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD45-3-5'	Data Gap - Lack of historical data	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
		Total Sample Count		**7**	**7**	**5**	**6**	**24**	**0**	**5**	**19**	**25**	**49**		**0**	**1**	**1**	**2**	**4**	**0**

Notes:
CHLL = C&H Lake Linden Operations
O = Potential analyte based on field observations
PNAs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
VOCs = Volatile Organic Compounds
X = Planned analyte based on the sampling rationale and the horizontal and vertical location of the sample

Laboratory Quality Assurance/Quality Control Matrix Spike and Matrix Spike Duplicate samples will be a batch quality control sample prepared by the laboratory.
All sampling locations are subject to change based on visual observations or actual field conditions.
Additional analytes may be selected at the descretion of the field sampling team based on visual observations or field conditions.
Surface water and sediment sampling locations area subject to change based on underwater assessment activities.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.
In areas that have been resurfaced or capped, analytical samples will be collected from directly beneath the cap/resurfacing medium (i.e. soil cap, beach sand, gravel, etc...) so that samples are representative of historical waste deposits.

Table 4-1
Sampling and Analysis Summary
Hubbell Smelter Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SB33-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X							O	X	X		X					
CHLL-SB33-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X						O		X							
CHLL-SB34-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X							O	X	X							
CHLL-SB34-X-Y'	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X						O		X				O		X	
CHLL-SB35-0-6"	Proximity to a historical generating station or electrical substation.	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X							O	X	X							
CHLL-SB35-X-Y	Proximity to a historical generating station or electrical substation.	Composite sample from above water table	Direct Push Boring		X						O		X							
CHLL-SB36-0-6"	Proximity to a historical smelter operations	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB36-X-Y'	Proximity to a historical smelter operations	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB37-0-6"	Proximity to a historical smelter operations	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB37-X-Y	Proximity to a historical smelter operations	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB52-0-6"	Proximity to a historical mineral building operations	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X						X	X	X	X		X					
CHLL-SB52-X-Y'	Proximity to a historical mineral building operations	Composite sample from above water table	Direct Push Boring		X					X	X	X	X							
CHLL-MW37-X-Y	Proximity to a historical mineral building operations	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X	X	X							
CHLL-MW20-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X	X	X							
CHLL-MW21-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X	X	X							
CHLL-MW22-X-Y	Proximity to a historical generating station or electrical substation.	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X	X	X							
CHLL-PCI-MW108A	Existing monitoring well on the PCI property	Existing monitoring well screen interval	Peristaltic Pump			X							X							
CHLL-PCI-MW108B	Existing monitoring well on the PCI property	Existing monitoring well screen interval	Peristaltic Pump			X							X							
CHLL-PCI-MW113	Existing monitoring well on the PCI property	Existing monitoring well screen interval	Peristaltic Pump			X							X						X	
CHLL-PCI-MW118	Existing monitoring well on the PCI property	Existing monitoring well screen interval	Peristaltic Pump			X							X							
CHLL-MW23-X-Y	Proximity to a historical smelter operations	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X		X							
CHLL-MW24-X-Y	Proximity to a historical smelter operations	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X		X							
CHLL-SD46-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD46-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SD46-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD47-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD47-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD47-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							

Table 4-1
Sampling and Analysis Summary
Hubbell Smelter Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SD48-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD48-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD48-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD49-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD49-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD49-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SD50-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD50-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD50-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD51-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD51-1-3'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD51-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD52-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD52-1-2'	Proximity to historical PCB detections	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD52-3-5'	Proximity to historical PCB detections	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SW17-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O						O	
CHLL-SD53-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X				O	O	X	
CHLL-SW18-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD54-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW19-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD55-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW20-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD56-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW21-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD57-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW22-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD58-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW23-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD59-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
			Total Sample Count	6	6	10	7	28	0	2	21	18	57		2	0	2	1	6	0

Notes:
CHLL = C&H Lake Linden Operations
O = Potential analyte based on field observations
PNAs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
VOCs = Volatile Organic Compounds
X = Planned analyte based on the sampling rationale and the horizontal and vertical location of the sample

Laboratory Quality Assurance/Quality Control Matrix Spike and Matrix Spike Duplicate samples will be a batch quality control sample prepared by the laboratory.
All sampling locations are subject to change based on visual observations or actual field conditions.
Additional analytes may be selected at the descretion of the field sampling team based on visual observations or field conditions.
Surface water and sediment sampling locations area subject to change based on underwater assessment activities.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.
In areas that have been resurfaced or capped, analytical samples will be collected from directly beneath the cap/resurfacing medium (i.e. soil cap, beach sand, gravel, etc...) so that samples are representative of historical waste deposits.

Table 4-1
Sampling and Analysis Summary
Hubbell Slag Dump and Beach Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SB38-0-6"	Data Gap - Lack of historical data, proximity to the public beach	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB38-X-Y'	Data Gap - Lack of historical data, proximity to the public beach	Composite sample from above water table	Direct Push Boring		X					X	X		X							
CHLL-SB39-0-6"	Data Gap - Lack of historical data, proximity to the public beach	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB39-X-Y'	Data Gap - Lack of historical data, proximity to the public beach	Composite sample from above water table	Direct Push Boring		X					X	X		X			X	X		X	
CHLL-SB40-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB40-X-Y	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X					X	X		X							
CHLL-SB41-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB41-X-Y'	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X					X	X		X							
CHLL-SB42-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB42-X-Y	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB43-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB43-X-Y'	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB44-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB44-X-Y	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X					X	X		X			X	X		X	
CHLL-SB45-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB45-X-Y'	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB46-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB46-X-Y	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X								X							
CHLL-SB47-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB47-X-Y'	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X					O	X		X							
CHLL-SB48-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB48-X-Y	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X					O	X		X							
CHLL-SB49-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the soil boring	Direct Push Boring	X								X	X							
CHLL-SB49-X-Y'	Data Gap - Lack of historical data	Composite sample from above water table	Direct Push Boring		X					O	X		X			O	X		X	
CHLL-PCI-MW120	Existing monitoring well on the PCI property	Existing monitoring well screen interval	Peristaltic Pump			X					X		X							
CHLL-MW25-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X							X							
CHLL-MW26-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X		X							
CHLL-MW27-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X					X		X							
CHLL-MW28-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X							X							
CHLL-MW29-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X							X							
CHLL-MW30-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X							X							
CHLL-MW31-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X							X							
CHLL-MW32-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X							X						X	
CHLL-MW33-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X							X							
CHLL-MW34-X-Y	Data Gap - Lack of historical data	Screen interval 5 -10 feet below the groundwater surface	Peristaltic Pump			X				X	X		X							

Table 4-1
Sampling and Analysis Summary
Hubbell Slag Dump and Beach Area
C&H Lake Linden Operations
Houghton County, Michigan

Proposed Sampling Location	Sampling Rationale	Sample Interval	Anticipated Sample Method	Sample Type/Matrix						Sample Analyses						Duplicates				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease
CHLL-SW24-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD60-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW25-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD61-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW26-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD62-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SW27-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O						O	
CHLL-SD63-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X				O	O	X	
CHLL-SW28-X-Y'	Proximity to historical PCB detections	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD64-0-6"	Proximity to historical PCB detections	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SD65-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD65-1-3'	Data Gap - Lack of historical data	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD65-3-5'	Data Gap - Lack of historical data	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD66-0-6"	Data Gap - Lack of historical data, proximity to the public beach	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X			X	X	X							
CHLL-SD66-1-3'	Data Gap - Lack of historical data, proximity to the public beach	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD66-3-5'	Data Gap - Lack of historical data, proximity to the public beach	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD67-0-6"	Data Gap - Lack of historical data, proximity to the public beach	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X			X	X	X							
CHLL-SD67-1-3'	Data Gap - Lack of historical data, proximity to the public beach	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD67-3-5'	Data Gap - Lack of historical data, proximity to the public beach	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X						X	
CHLL-SW29-X-Y'	Data Gap - Lack of historical data	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD68-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
CHLL-SD69-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD69-1-3'	Data Gap - Lack of historical data	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD69-3-5'	Data Gap - Lack of historical data	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD70-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Vibracore Sampler					X					X							
CHLL-SD70-1-3'	Data Gap - Lack of historical data	Sediment from 1-3 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SD70-3-5'	Data Gap - Lack of historical data	Sediment from 3-5 feet below the sediment surface	Vibracore Sampler					X					X							
CHLL-SW30-X-Y'	Data Gap - Lack of historical data	1 foot above the sediment surface	Remotely Operated Vehicle				X						O							
CHLL-SD71-0-6"	Data Gap - Lack of historical data	The upper-most 0-6 inches of the sediment sampling location	Remotely Operated Vehicle					X			O	O	X							
		Total Sample Count		**12**	**12**	**11**	**7**	**22**	**0**	**9**	**21**	**21**	**64**		**0**	**3**	**4**	**1**	**7**	**0**

Notes:
CHLL = C&H Lake Linden Operations
O = Potential analyte based on field observations
PNAs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
VOCs = Volatile Organic Compounds
X = Planned analyte based on the sampling rationale and the horizontal and vertical location of the sample

Laboratory Quality Assurance/Quality Control Matrix Spike and Matrix Spike Duplicate samples will be a batch quality control sample prepared by the laboratory.
All sampling locations are subject to change based on visual observations or actual field conditions.
Additional analytes may be selected at the descretion of the field sampling team based on visual observations or field conditions.
Surface water and sediment sampling locations area subject to change based on underwater assessment activities.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.
In areas that have been resurfaced or capped, analytical samples will be collected from directly beneath the cap/resurfacing medium (i.e. soil cap, beach sand, gravel, etc...) so that samples are representative of historical waste deposits.

Table 4-1
Sampling and Analysis Summary
C&H Lake Linden Operations
Field-Modified Sampling Locations
Houghton County, Michigan

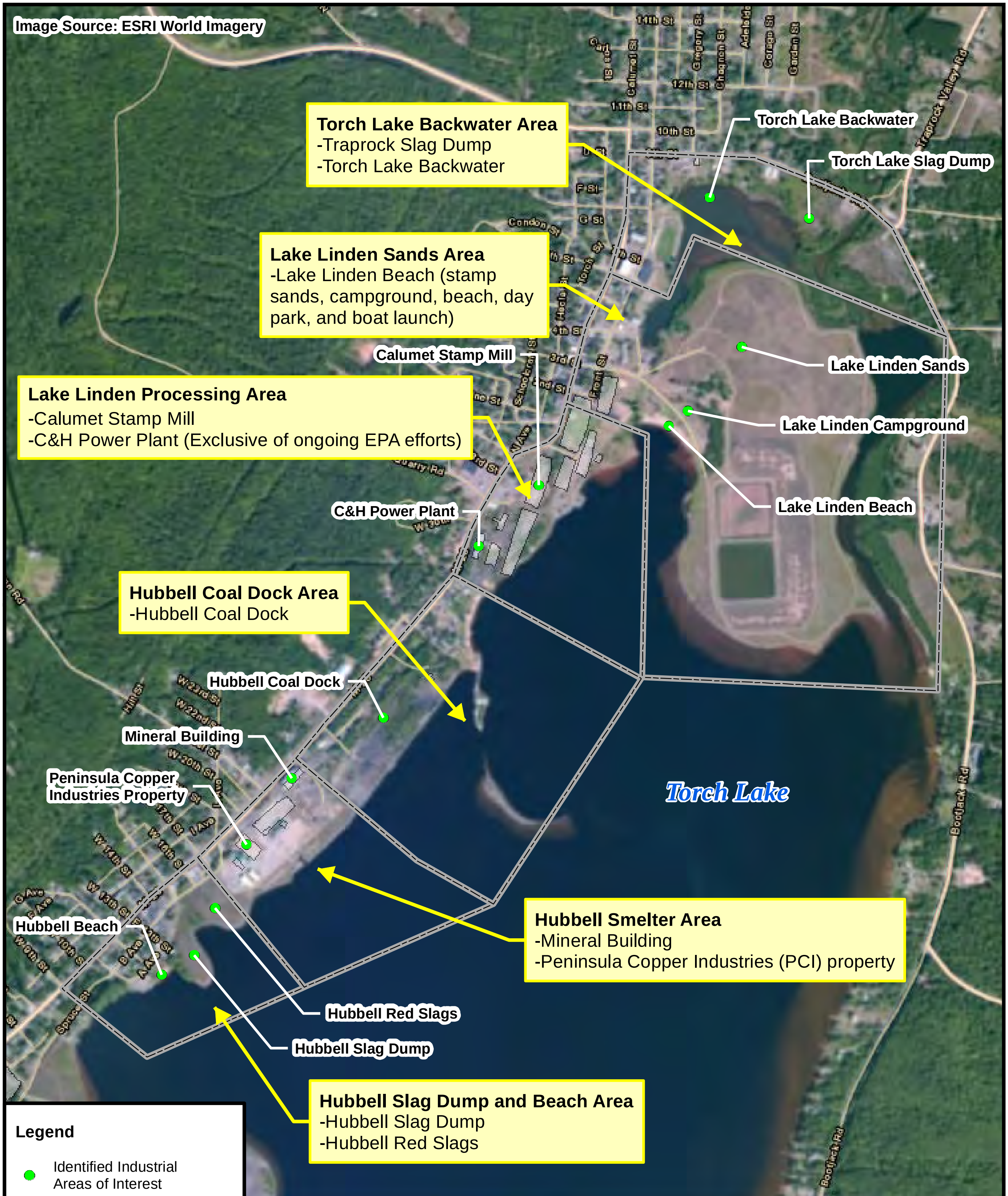
Additional/Revised Sampling Location ID	Sampling Rationale	Sample Interval	Sampling Method	Sample Type/Matrix						Sample Analyses						Duplicate Analyses				
				Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Drums and Containers	VOCs	PNAs	Metals	PCBs	Oil and Grease	Asbestos	VOCs	PNAs	Metals	PCBs	Oil and Grease

Notes:
CHLL = C&H Lake Linden Operations
ID = Identification
PNAs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
VOCs = Volatile Organic Compounds

Field sampling teamsshall use this form to document additional or revised sampling locations, not otherwise defined in Table 4-1. These sample locations may be added or revised based on accessibility, visual observations, and similar field conditions.

Sample nomenclature shall be consistent with the format defined in the Sampling and Analysis Plan.
Laboratory Quality Assurance/Quality Control Matrix Spike and Matrix Spike Duplicate samples will be a batch quality control sample prepared by the laboratory.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.
In areas that have been resurfaced or capped, analytical samples will be collected from directly beneath the cap/resurfacing medium (i.e. soil cap, beach sand, gravel, etc...) so that samples are representative of historical waste deposits.

FIGURES



Legend

- Identified Industrial Areas of Interest
- Conceptual Site and Geographic Area Boundaries
- Historical Buildings

0 1,500 Feet

N

Prepared for:
Michigan Department of Environmental Quality

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

Figure 2-1
Geographic Area Map
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

FILE: D:\Torch_Lake\mxd\SAP\F2-1_Area_Map.mxd 1:44:31 PM 5/9/2014 wojdakon

Legend

- Known residential water well
- Historical Buildings
- Estimated Property Boundaries
- Conceptual Site and Geographic Area Boundaries
- Approximate Limits of Observed Waste Deposits or Contaminated Soil

0 550 Feet

N

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Michigan Department of Environmental Quality

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

Figure 2-2
Site Location and Features Map
Torch Lake Backwater Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

FILE: D:\Torch_Lake\mxd\SAP\F2-2_Area_Map_A.mxd 1:45:37 PM 5/9/2014 wojdakon

Legend

- Historical Buildings
- Estimated Property Boundaries
- Conceptual Site and Geographic Area Boundaries
- Approximate Limits of Observed Waste Deposits or Contaminated Soil

0 650 Feet

N

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Michigan Department of Environmental Quality

Prepared By:
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Houghton, MI 49931

Figure 2-3
Site Location and Features Map
Lake Linden Sands Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

FILE: D:\Torch_Lake\mxd\SAP\F2-3_Area_Map_B.mxd 5/8/2014 8:55:42 AM wojdakon

FILE: D:\Torch_Lake\mxd\SAP\F2-4_Area_Map_C.mxd 1:46:29 PM 5/9/2014 wojdakon

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Houghton, MI 49931

Figure 2-4
Site Location and Features Map
Lake Linden Processing Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

Legend

- Remaining Coal Dock Foundation
- Historical Buildings
- Estimated Property Boundaries
- Conceptual Site and Geographic Area Boundaries
- Approximate Limits of Observed Waste Deposits or Contaminated Soil

0 400 Feet

N

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Houghton, MI 49931

Figure 2-5
Site Location and Features Map
Hubbell Coal Dock Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

FILE: D:\Torch_Lake\mxd\SAP\F2-5_Area_Map_D.mxd 5/9/2014 1:46:58 PM wojdakon

Legend

- Historical Buildings
- Estimated Property Boundaries
- Conceptual Site and Geographic Area Boundaries
- Approximate Limits of Observed Waste Deposits or Contaminated Soil

0 300 Feet

N

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Figure 2-6
Site Location and Features Map
Hubbell Smelter Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

FILE: D:\Torch_Lake\mxd\SAP\F2-6_Area_Map_E.mxd 5/9/2014 1:47:26 PM wojdakon

Legend

- Historical Buildings
- Estimated Property Boundaries
- Conceptual Site and Geographic Area Boundaries
- Approximate Limits of Observed Waste Deposits or Contaminated Soil

0 300 Feet

N

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Figure 2-7
Site Location and Features Map
Hubbell Slag Dump and Beach Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

FILE: D:\Torch_Lake\mxd\SAP\F2-7_Area_Map_F.mxd 1:47:51 PM 5/9/2014 wojdakon

Legend

Conceptual Site and Geographic Area Boundaries

0 1,250 Ft

N

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Figure 2-8
Torch Lake – Site Location and Features Map
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

File: D:\Torch_Lake\mxd\SAP\F2-8_Area_Map_TL.mxd, 5/9/2014 1:48:11 PM, wojdakon

Surface water and sediment sampling locations are subject to change based on underwater assessment activities.
All sampling locations are subject to change based on visual observations or actual field conditions.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.

Legend

Proposed Sampling Locations

- Soil Boring
- Soil Boring/ Monitoring Well
- Sediment
- Sediment/ Surface Water
- Monitoring Well
- Conceptual Site and Geographic Area Boundaries

0 350 Ft

N

DEQ

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Figure 4-1
Proposed Sampling Location Map - Torch Lake Backwater Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

File: D:\Torch_Lake\mxd\SAP\F4-1_Proposed_A.mxd, 5/23/2014 2:48:08 PM, wojdakon

Surface water and sediment sampling locations are subject to change based on underwater assessment activities.
All sampling locations are subject to change based on visual observations or actual field conditions.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.

Legend

Proposed Sampling Locations

- Soil Boring
- Soil Boring/ Monitoring Well
- Sediment
- Sediment/ Surface Water
- Conceptual Site and Geographic Area Boundaries

0 650 Ft

N

DEQ

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Houghton, MI 49931

Figure 4-2

Proposed Sampling Location Map - Lake Linden Sands Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

File: D:\Torch_Lake\mxd\SAP\F4-2_Proposed_B.mxd, 5/23/2014 2:56:05 PM, wojdakon

Surface water and sediment sampling locations are subject to change based on underwater assessment activities.
All sampling locations are subject to change based on visual observations or actual field conditions.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.

Legend

Proposed Sampling Locations

- Soil Boring/ Monitoring Well
- Sediment
- Sediment/ Surface Water
- Soil Boring
- Conceptual Site and Geographic Area Boundaries

0 400 Ft

N

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Houghton, MI 49931

Figure 4-3

Proposed Sampling Location Map - Lake Linden Processing Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

File: D:\Torch_Lake\mxd\SAP\F4-3_Proposed_C.mxd, 5/23/2014 2:56:49 PM, wojdakon

Surface water and sediment sampling locations are subject to change based on underwater assessment activities.
All sampling locations are subject to change based on visual observations or actual field conditions.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.

Legend

Proposed Sampling Locations

- Soil Boring
- Soil Boring/ Monitoring Well
- Sediment
- Sediment/ Surface Water
- Conceptual Site and Geographic Area Boundaries

0 450 Ft

N

Prepared for:
Michigan Department of Environmental Quality

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

Figure 4-4

Proposed Sampling Location Map - Hubbell Coal Dock Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

File: D:\Torch_Lake\mxd\SAP\F4-4_Proposed_D.mxd, 5/23/2014 2:57:32 PM, wojdakon

Surface water and sediment sampling locations are subject to change based on underwater assessment activities.
All sampling locations are subject to change based on visual observations or actual field conditions.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.

DEQ

Prepared for:
Michigan Department of Environmental Quality

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

Figure 4-5
Proposed Sampling Location Map - Hubbell Smelter Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

File: D:\Torch_Lake\mxd\SAP\F4-5_Proposed_E.mxd, 5/23/2014 2:58:11 PM, wojdakon

Surface water and sediment sampling locations are subject to change based on underwater assessment activities.
All sampling locations are subject to change based on visual observations or actual field conditions.
For the purposes of this investigation, sediments include residues and waste material associated with chemical containers and deposits on the lake bottom historically discarded in Torch Lake.

Legend

Proposed Sampling Locations

- Soil Boring
- Soil Boring/ Monitoring Well
- Sediment
- Sediment/ Surface Water
- Monitoring Well
- Conceptual Site and Geographic Area Boundaries

0 300 Ft

N

Prepared for:
Michigan Department of Environmental Quality

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

Figure 4-6
Proposed Sampling Location Map -
Hubbell Slag Dump and Beach Area
C & H Lake Linden Operations
Lake Linden, Houghton County, Michigan

File: D:\Torch_Lake\mxd\SAP\F4-6_Proposed_F.mxd, 5/23/2014 3:00:06 PM, wojdakon

APPENDIX A

HISTORICAL SUMMARIES

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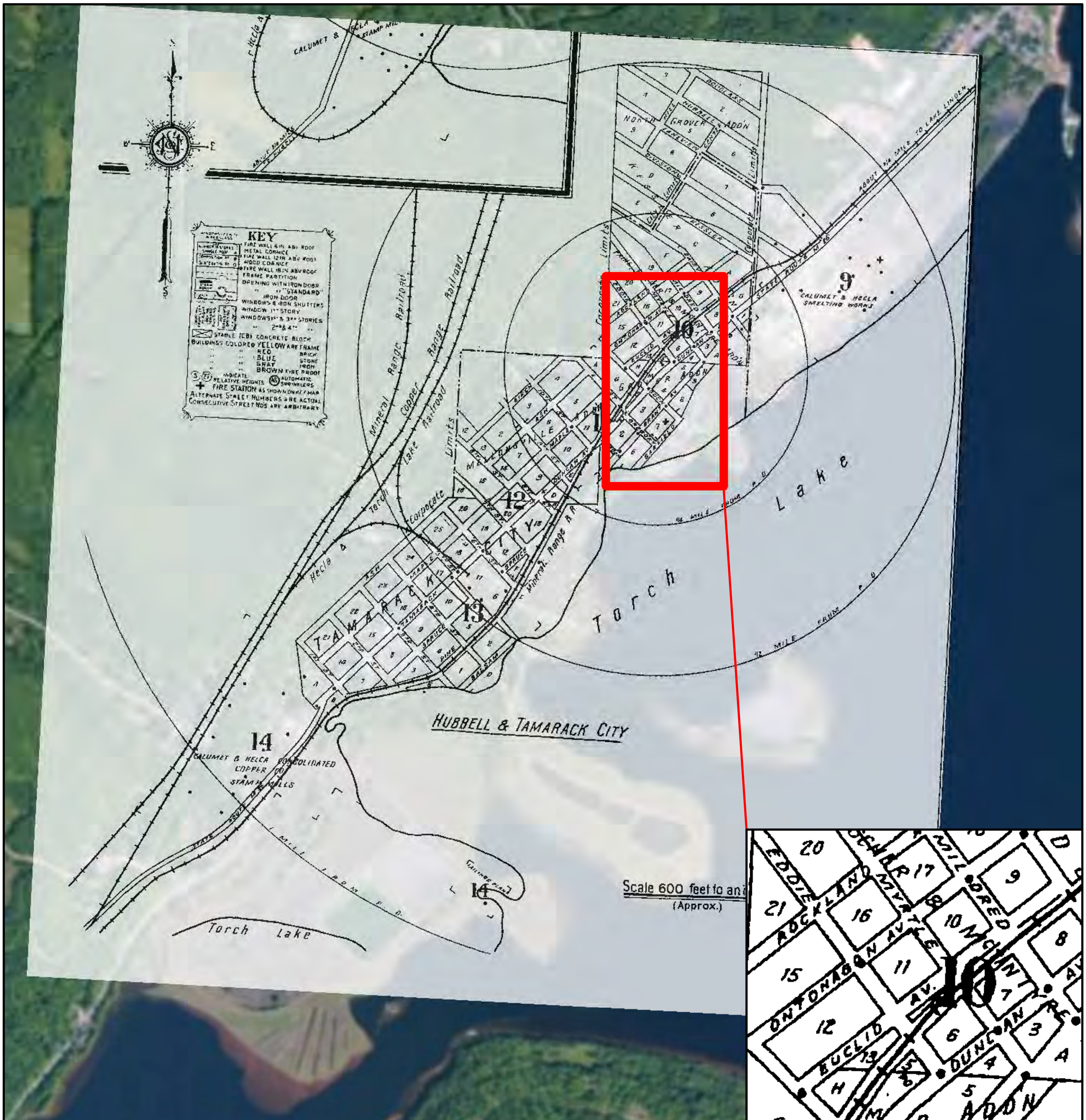

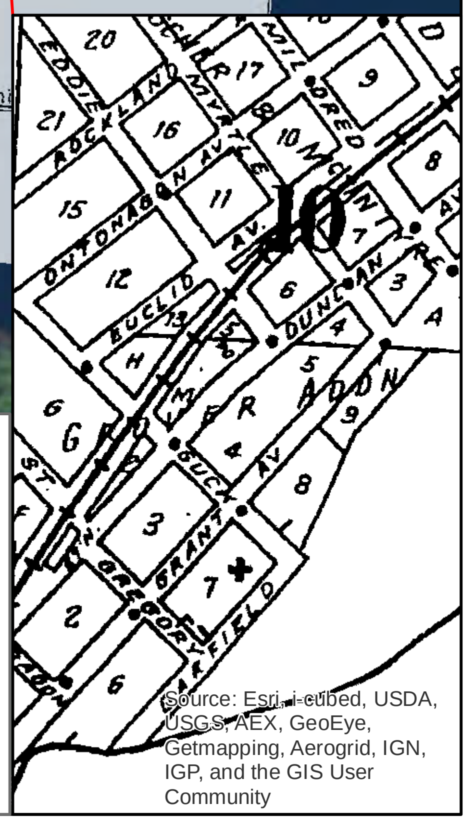

Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Imagery Source: ESRI World Imagery

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MichiganTech

Imagery Source: ESRI World Imagery

MichiganTech Research Institute

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MichiganTech

Imagery Source: ESRI World Imagery

MichiganTech Research Institute

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File Name: 1928LakeLindenAug1928Sheet8.tif

Document Path: J:\project\TorchLakeGIS\MXD\Sanborn_geotiffs.mxd

File Name: 1928LakeLindenAug1928Sheet1index_HubbellTamarack.tif

MichiganTech

Imagery Source: ESRI World Imagery

MichiganTech Research Institute

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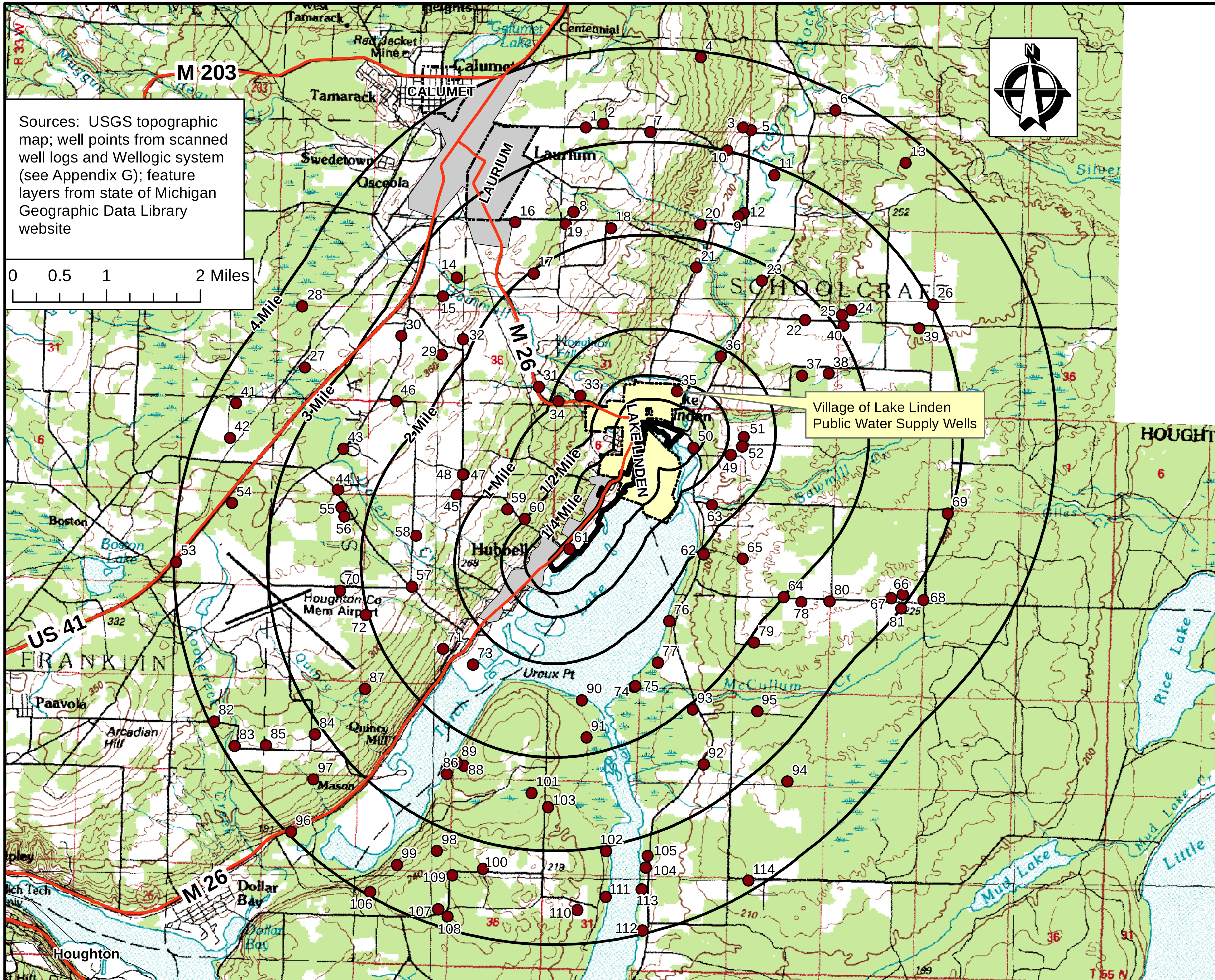
Document Path: J:\project\TorchLakeGIS\MXD\Sanborn_geotiffs.mxd

APPENDIX B

ENVIRONMENTAL DATA RESOURCE MAPS



APPENDIX A
SITE 4-MILE RADIUS MAP

Legend

- Groundwater well (35)
- State highway
- Site boundary
- Village

Area Served by Public Water Supply from Groundwater Sources, showing the Supply Owner/Operator

- Village of Lake Linden
- Michigan American Water Co.

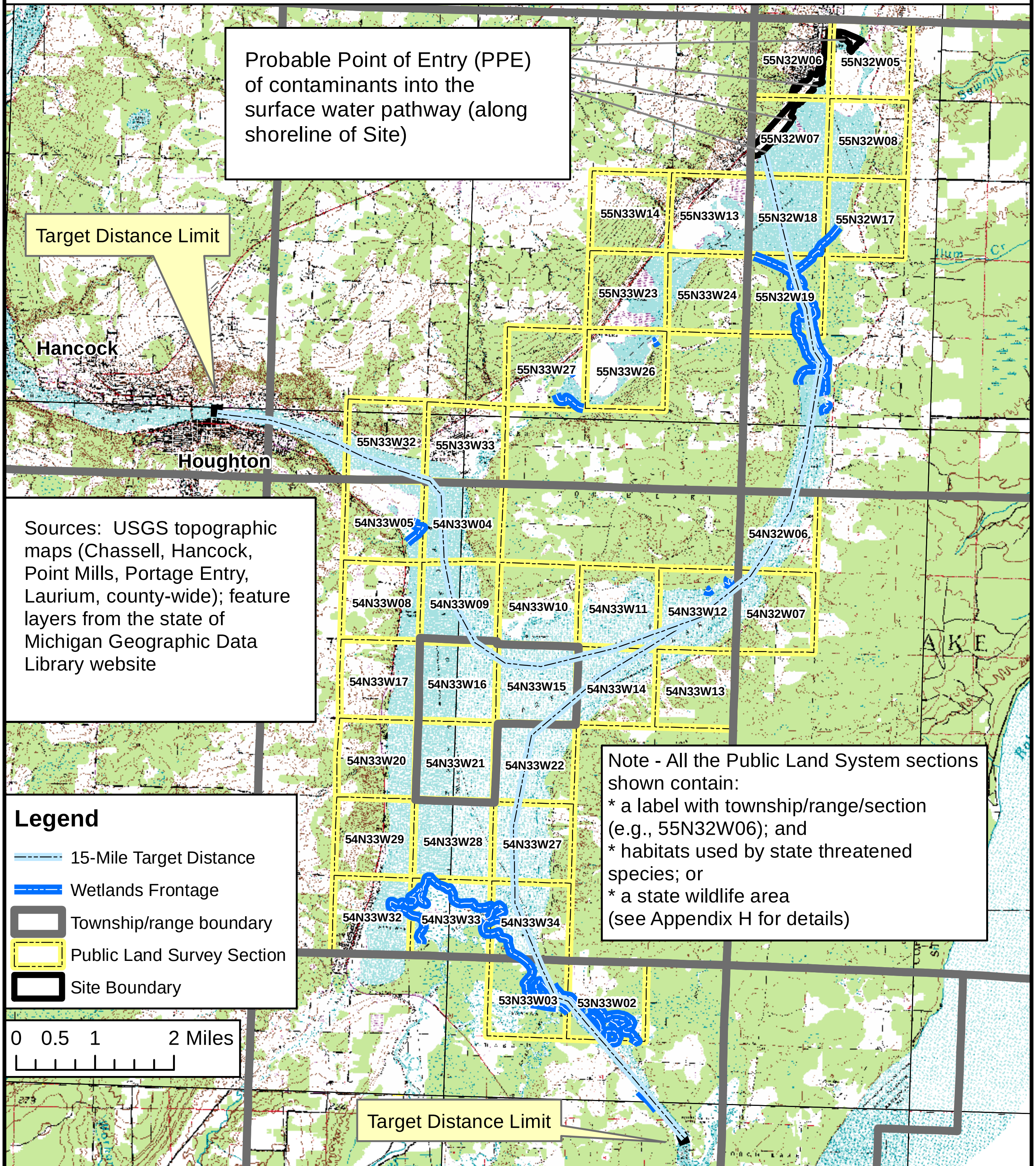
(Mich. Am. supply wells are northwest of Calumet on the shore of Lake Superior)

Compiled by JES, 1/25/12
(revised by JES, 4/2/13)
Projected coordinate system:
Michigan GeoRef, NAD-83, meters
Done in ESRI ArcMap 10.1

DEQ

Site Inspection Report
C & H Lake Linden Operations, MIN000510619
Michigan Department of Environmental Quality
Remediation Division - Superfund Section
Site Assessment and Site Management Unit

APPENDIX B
SITE 15-MILE SURFACE WATER TARGET DISTANCE LIMIT MAP



Site Inspection Report
C & H Lake Linden Operations, MIN000510619
Michigan Department of Environmental Quality
Remediation and Redevelopment Division - Superfund Section
Site Assessment and Site Management Unit

Compiled by JES, 7/29/2011
(revised 4/3/13, JES)
Projected coordinate system:
Michigan GeoRef, NAD-83, meters
Done in ESRI ArcMap 10.1

APPENDIX C

AUV ASSESSMENT PLAN

Work Plan for Surface and AUV survey, and ROV sampling (Tasks 1 and 2 from MTU's Scope of Work Elements for 2014, "Source Identification of PCBs in Torch Lake") Project.

The purpose of this document is to formalize Michigan Technological University's Survey Assessment Plan (SAP) for conducting bottom mapping, side scan sonar surveying, and ROV sediment sampling for the Source Identification of PCBs in Torch Lake Project. This plan will document Michigan Technological University's proposed procedures for these parts of the project.

Task 1

Underwater Investigation and Mapping of Lake Bottom and Debris Fields

- *Remotely Operated Vehicle (ROV) investigation and visualization of known drum locations.* This task was undertaken during the summer of 2013. Discrete barrels were located by a side scan sonar survey and their GIS position identified for later ROV investigation. The S/V Polar was anchored at the GIS coordinates and the ROV was deployed to investigate bottom targets. The ROV located numerous drums and collected video from which still images were extracted (see figure 1).
  - *Field test of ROV through the ice if conditions permit prior to the on-lake investigation.* Weather did not allow the through ice ROV survey.
- *Surface Vessel and Autonomous Underwater Vehicle (AUV) lake bottom/drum mapping.* We will conduct the AUV survey from the S/V Osprey (see figure 2). The Osprey is a 24' closed pilot house vessel equipped with radar, chart plotter, GPS, autopilot, and standard communication and safety equipment. The AUV is an OceanServer IVER3 equipped with an EdgeTech 2205 side scan sonar (see figure 3). The sonar transducer can simultaneously collect both ultra-high (1600 kHz) and high (600 kHz) frequency sonar data. Since the sonar can also collect bathymetric data, additional bottom mapping will be conducted by the AUV. The AUVs planned survey will provide 100% overlap of the survey area. We will collect and process side scan sonar and bathymetric data of both Area 1 and Area 2 (see figure 4). The AUV will fly 10 meters (Height from Bottom) or 10% of the range (100 meters). Alternatively, the side scan sonar survey and bottom mapping may be conducted from an EdgeTech 4125 Towfish. The 4125 is the same side scan sonar system as on the IVER 3 and can collect both high (900 kHz) and low (400 kHz) sonar data. The 4125s planned survey will provide 100% overlap of the survey area and will be towed 15 meters Height from Bottom. The field work portion of the bottom and drum mapping will take 80 man hours to complete. The data processing of the side scan sonar images and bathymetric data will take 40 man hours to complete.
- *Surface Vessel and ROV sediment sampling.* Once images and GIS compatible layers are created from the processed side scan sonar data and bathymetric data, debris fields will be selected for further investigation. The ROV will be deployed and will be navigated using dead reckoning to the debris fields that were located during the AUV survey. The ROV will collect real time video of the debris fields and discrete drums can be identified for future or concurrent sediment sampling. Multiple sediment sampling alternative techniques have been proposed to remotely acquire samples from these depths. These

proposed techniques include collecting water, bottom sediment, drum contents and possibly other unknown substances from the bottom with the ROV. The ROV cruises will take 80 man hours to complete.

Figure 1.

Figure 2.

Figure 3.

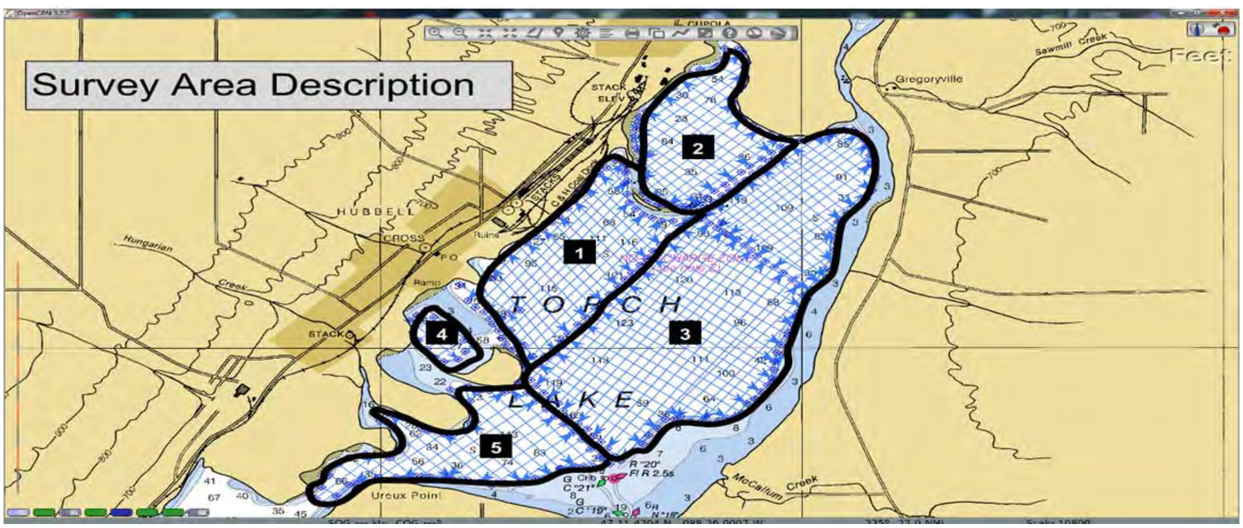


Figure 4.

Task 1 Deliverables and Timeframes

N/A	Under ice ROV survey completed and data archived.
30 May	Surface vessel and AUV surveys of Areas 1 and 2 completed and data archived.
30 May	AUV survey data interpreted and sites for ROV re-visits identified
15 June	ROV site re-visits, preparatory to over water sampling, completed.
1 July	All survey data transferred to team members responsible for entry to the Information Management System.

Task 2

Specialized Sampling

- *Evaluation and analysis of AUV and ROV survey results and historical information in support of selecting lake sampling locations.* MDEQ, Weston, and MTU will analyze the side scan sonar images and ROV video and decide where to conduct sediment sampling.
- *Assist in development of the sampling and analysis plan (SAP).* Weston is developing the SAP plan with input from Michigan Technological University.
- *Collaborate with MDEQ and Weston to collect samples of water, debris (e.g. drums) and sediment from Torch Lake.* The water, debris, and sediment samples will be collected while using the R/V Agassiz. The ROV will be navigated to the sample location using dead reckoning. Michigan Technological University has constructed a pump operated sampler that can collect water above the bottom and light sediment from the top 0-2" of the bottom sediment. Weston will evaluate the sediment collector for compliance with standard scientific sampling standards. Sediment samples will be collected from discrete, open barrels, with a 2" stainless steel corer. All sample containers, management, shipment and analysis will be provided by MDEQ and its contractors. Weston will handle and label all samples once on the surface. MTU and Weston will specify the format in which analytical results will be provided by the lab for input to the Project's Information Management System.

Task 2 Deliverables and Timeframes

15 June	Sampling locations identified and sampling and analysis plan completed.
1 July	First sampling effort completed. Sampling site locations and video documentation archived. Samples transferred to the laboratory.
1 October	Second sampling effort completed. Sampling site locations and video documentation archived. Samples transferred to the laboratory. The timing of this sampling effort will be dictated by the laboratory turnaround on samples collected in June.

APPENDIX D

STANDARD OPERATING PROCEDURES

WESTON SOPS

GENERAL FIELD SAMPLING GUIDELINES

SOP#: 2001
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist REAC personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the material over distance, both laterally and vertically.

Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.

Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

(1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.

(2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

7.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

7.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

7.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- Objective and purpose of the investigation.
- Basis upon which data will be evaluated.
- Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data.
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
- Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all-inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

7.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

8.0 CALCULATIONS

Refer to the specific SOPs for any calculations which are associated with sampling techniques.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

SOIL SAMPLING

SOP#: 2012
DATE: 11/16/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Soil samples may be collected using a variety of methods and equipment. The methods and equipment used are dependent on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems associated with soil sampling. These include cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

5.0 EQUIPMENT/APPARATUS

Soil sampling equipment includes the following:

- Sampling plan
- Maps/plot plan
- Safety equipment, as specified in the Health and Safety Plan
- Survey equipment
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and seals
- Field data sheets
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel

- C Spatula
- C Scoop
- C Plastic or stainless steel spoons
- C Trowel
- C Continuous flight (screw) auger
- C Bucket auger
- C Post hole auger
- C Extension rods
- C T-handle
- C Sampling trier
- C Thin wall tube sampler
- C Split spoons
- C Vehimeyer soil sampler outfit
  - Tubes
  - Points
  - Drive head
  - Drop hammer
  - Puller jack and grip
- C Backhoe

6.0 REAGENTS

Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations will be utility-cleared by the property owner prior to soil sampling.

7.2 Sample Collection

7.2.1 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop can be used to collect the sample.

This method can be used in most soil types but is limited to sampling near surface areas. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A stainless steel scoop, lab spoon, or plastic spoon will suffice in most other applications. The use of a flat, pointed mason trowel to cut a block of the desired soil can be helpful when undisturbed profiles are required. Care should be exercised to avoid use of devices plated with chrome or other materials. Plating is particularly common with garden implements such as potting trowels.

The following procedure is used to collect surface soil samples:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.

2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.

3. If volatile organic analysis is to be performed, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or

other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle (Figure 1, Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory for use when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of three feet.

The following procedure will be used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from boring. When sampling directly from the auger, collect the sample after the auger is removed from the boring and proceed to Step 10.

5. Remove auger tip from drill rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube samplerinto soil. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rods to facilitate coring as the vibrations may cause the boring walls to collapse.

7. Remove the tube sampler, and unscrew the drill rods.

8. Remove the cutting tip and the core from the device.

9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the

caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly.

When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.

12. Abandon the hole according to applicable State regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

7.2.3 Sampling at Depth with a Trier

The system consists of a trier, and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure will be used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 2, Appendix A) into the material to be sampled at a 0º to 45º angle from horizontal. This orientation minimizes the spillage of sample.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

The procedure for split spoon sampling describes the collection and extraction of undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D 1586-67 (reapproved 1974).

The following procedures will be used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.

2. Place the sampler in a perpendicular position on the sample material.

3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.

4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.

5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler

is typically available in 2 and 3 1/2 inch diameters. However, in order to obtain the required sample volume, use of a larger barrel may be required.

6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

7.2.5 Test Pit/Trench Excavation

These relatively large excavations are used to remove sections of soil, when detailed examination of soil characteristics (horizontal, structure, color, etc.) are required. It is the least cost effective sampling method due to the relatively high cost of backhoe operation.

The following procedures will be used for collecting soil samples from test pit/trench excavations:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of utility lines, subsurface pipes and poles (subsurface as well as above surface).

2. Using the backhoe, a trench is dug to approximately three feet in width and approximately one foot below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.

3. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.

4. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.

5. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

6. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OHSA and corporate health and safety procedures.

12.0 REFERENCES

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason, Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

U.S. EPA. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. 1984 EPA-600/4-84-076.

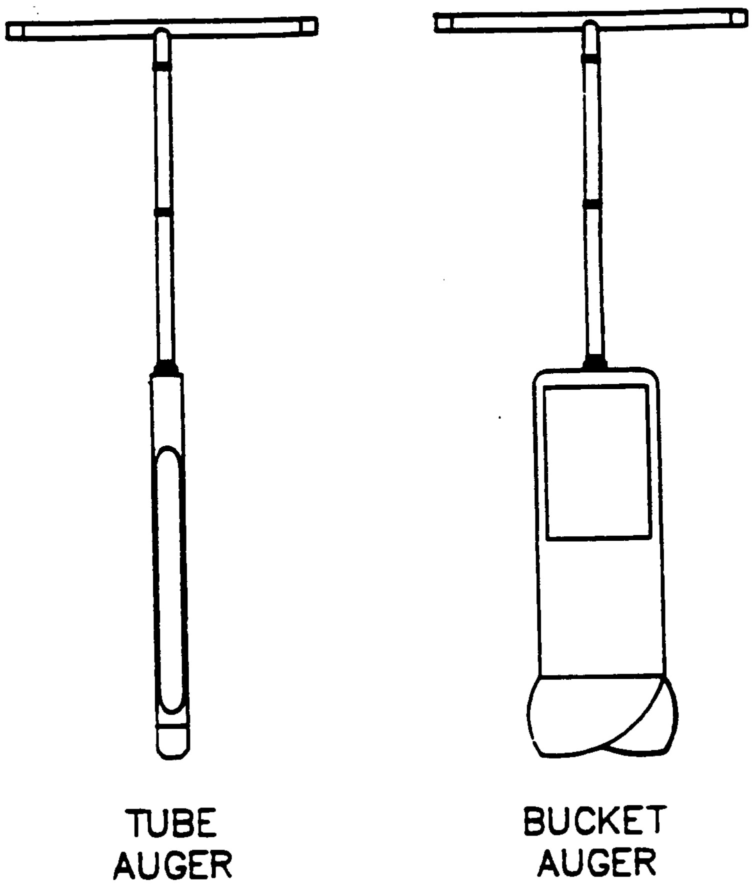
de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

ASTM D 1586-67 (reapproved 1974), ASTM Committee on Standards, Philadelphia, PA.

APPENDIX A

Figures

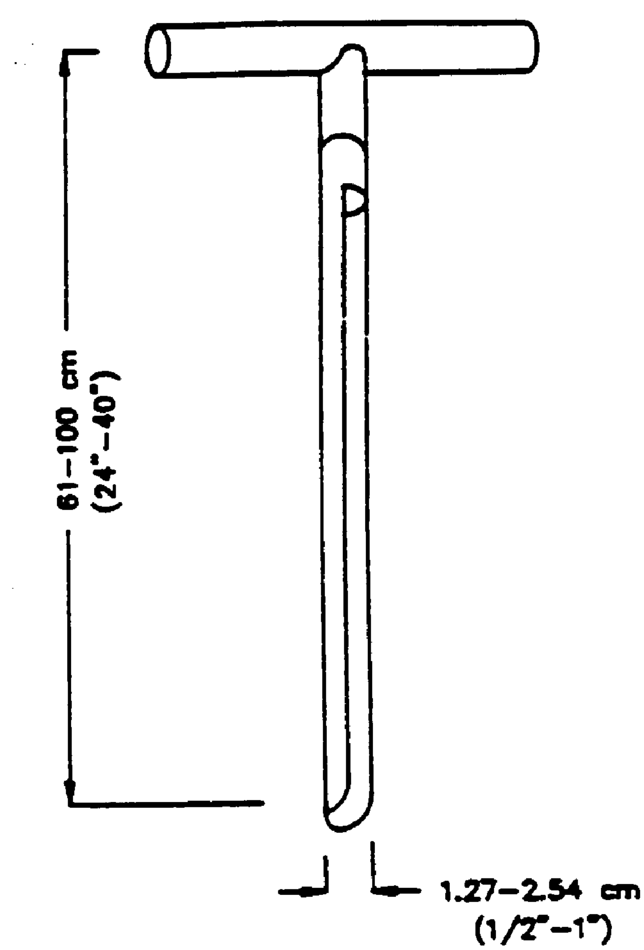
FIGURE 1. Sampling Augers



APPENDIX A (Cont'd)

Figures

FIGURE 2. Sampling Trier



SURFACE WATER SAMPLING

SOP#: 2013
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

C Kemmerer bottle
C Bacon bomb sampler
C Dip sampler
C Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, the following procedure should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers.

2. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.

3. Cap the container, place in a ziploc plastic bag and cool to 4^{o}C.

4. Record all pertinent data in the site logbook and on field data sheets.

5. Complete the Chain of Custody record.

6. Attach custody seals to cooler prior to shipment.

7. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP.

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Bacon bomb sampler
- Dip sampler
- Line and messengers
- Sample bottles/preservatives
- Ziploc bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Sample bottle labels

6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain the necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

7.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in impoundments, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

Water quality measurements such as dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths when surface water samples are collected.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?

2. What is the desired depth at which you wish to collect the sample?

3. What is the overall depth and flow direction of river or stream?

4. What type of sample will be collected (i.e., water or lagoon liquids)?

7.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

7.3 Sample Collection

7.3.1 Kemmerer Bottle

A Kemmerer bottle (Figure 1, Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the sampling end pieces (upper and lower stoppers) are pulled away from the sampling tube (body), allowing the substance to be sampled to pass through this tube.

2. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.

3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.

4. Retrieve the sampler and discharge from the bottom drain the first 10-20 mL to clear any potential contamination of the valve. Transfer the sample to the appropriate sample container.

7.3.2 Bacon Bomb Sampler

A bacon bomb sampler (Figure 2, Appendix A) may be used in situations similar to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.

2. Release the trigger line and retrieve the sampler.

3. Transfer the sample to the appropriate sample container by pulling up on the trigger.

7.3.3 Dip Sampler

A dip sampler (Figure 3, Appendix A) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.

2. Extend the device to the sample location and collect the sample by dipping the sampler into the substance.

3. Retrieve the sampler and transfer the sample to the appropriate sample container.

7.3.4 Direct Method

For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples from the surface directly into the sample bottle. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants is a concern.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team member collecting the sample should not get too close to the edge of the impoundment, where bank failure may cause him/her to lose his/her balance. The person performing the sampling should be on a lifeline and be wearing adequate protective equipment. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

12.0 REFERENCES

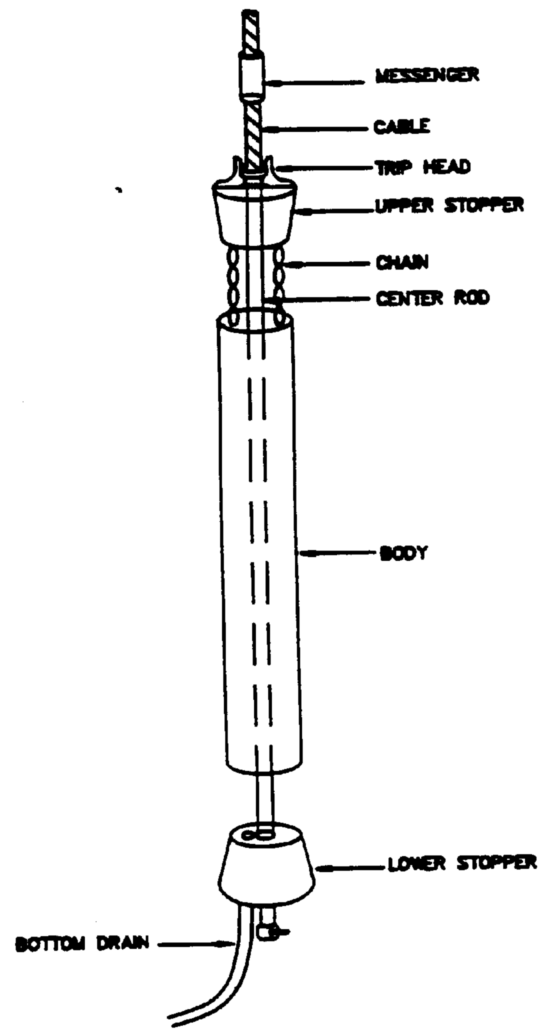
U.S. Geological Survey. 1977. National Handbook or Recommended Methods for Water Data Acquisition. Office of Water Data Coordination Reston, Virginia. (Chapter Updates available).

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

APPENDIX A

Figures

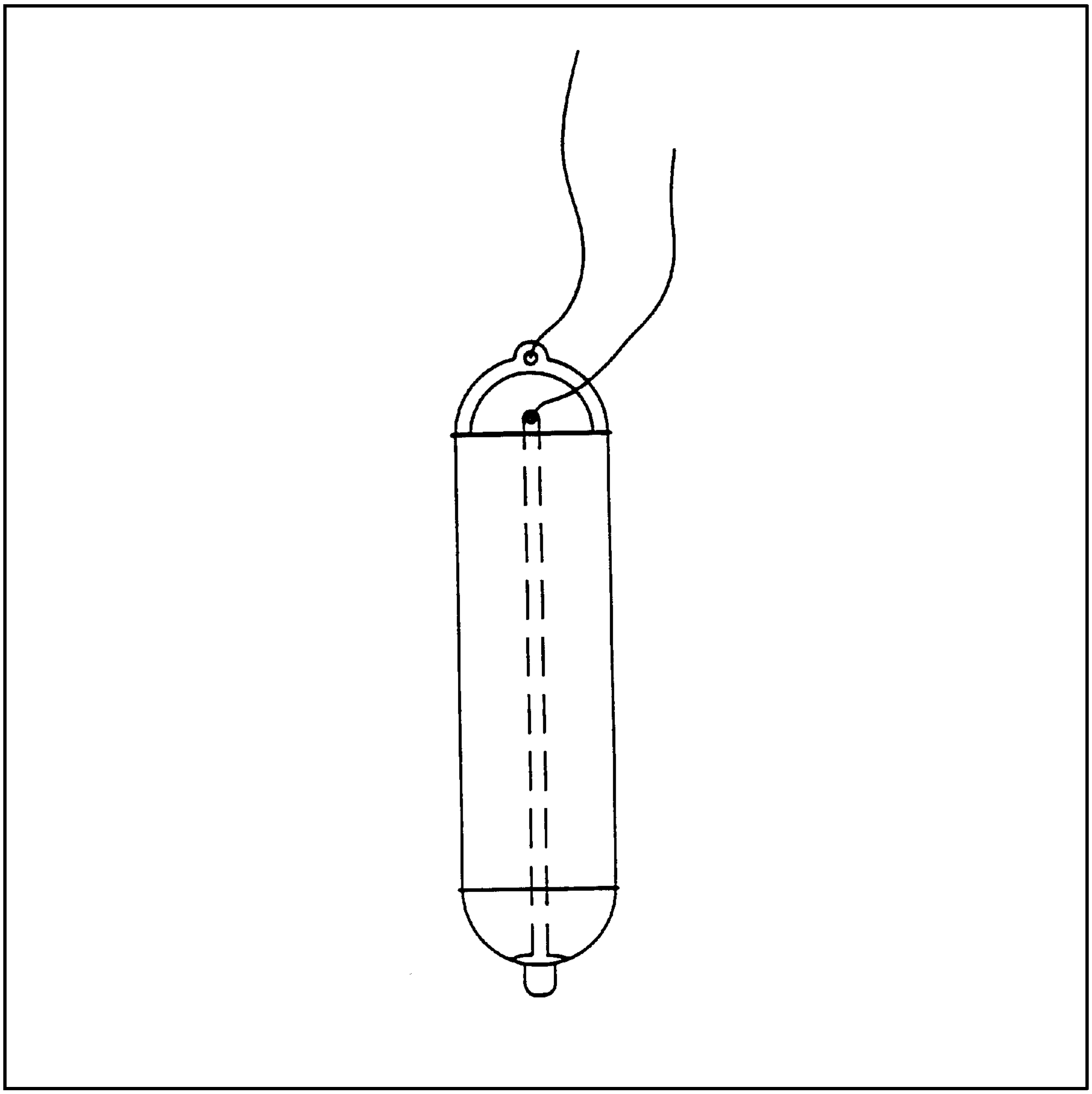
FIGURE 1. Kemmerer Bottle



APPENDIX A (Cont'd)

Figures

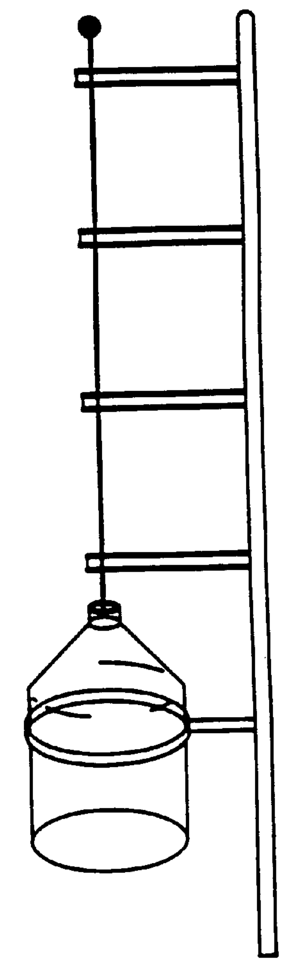
FIGURE 2. Bacon Bomb Sampler



APPENDIX A (Cont'd)

Figures

FIGURE 3. Dip Sampler



WASTE PILE SAMPLING

SOP#: 2017
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to outline the equipment and methods used in collecting representative samples from waste piles, sludges or other solid or liquid waste mixed with soil.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Stainless steel shovels, trowels, or scoops should be used to clear away surface material before samples are collected. For depth samples, a decontaminated auger may be required to advance the hole, then another decontaminated auger used for sample collection. For a sample core, thin-wall tube samplers or grain samplers may be used. Near surfaces, samples can be collected with a clean stainless steel spoon or trowel.

All samples collected, except those for volatile organic analysis, should be placed into a Teflon lined or stainless steel pail and mixed thoroughly before transfer to appropriate sample container.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is generally not recommended. Refrigeration to 4°C is usually the best approach, supplemented by a minimal holding time, depending on contaminants of concern.

Wide mouth glass containers with Teflon lined caps are typically used for waste pile samples. Sample volume required is a function of the analytical requirements and should be specified in the work plan.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are several variables involved in waste sampling, including shape and size of piles, compactness, and structure of the waste material. Shape and size of waste material or waste piles vary greatly in areal extent and height. Since state and federal regulations often require a specified number of samples per volume of waste, the size and shape must be used to calculate volume and to plan for the correct number of samples. Shape must also be accounted for when planning physical access to the sampling point and the equipment necessary to successfully collect the sample at that location.

Material to be sampled may be homogeneous or heterogeneous. Homogeneous material resulting from known situations may not require an extensive sampling protocol. Heterogeneous and unknown wastes require more extensive sampling and analysis to ensure the different components (i.e. layers, strata) are being represented.

The term "representative sample" is commonly used to denote a sample that has the properties and composition of the population from which it was collected and in the same proportions as found in the population. This can be misleading unless one is dealing with a homogenous waste from which one sample can represent the whole population.

The usual options for obtaining the most "representative sample" from waste piles are simple random sampling or stratified random sampling. Simple random sampling is the method of choice unless: (1) there are known distinct strata; (2) one wants to prove or disprove that there are distinct strata; or (3) one is limited in the number of samples and desires to statistically minimize the size of a "hot spot" that could go unsampled. If any of these conditions exist, stratified random sampling would be the better strategy.

Stratified random sampling can be employed only if all points within the pile can be accessed. In such cases, the pile should be divided into a three-dimensional grid system with, the grid cubes should be numbered, and the grid cubes to be sampled should be chosen by random number tables or generators. The only exceptions to this are situations in which representative samples cannot be collected safely or where the investigative team is trying to determine worst case conditions.

If sampling is limited to certain portions of the pile, a statistically based sample will be representative only of that portion, unless the waste is homogenous.

5.0 EQUIPMENT/APPARATUS

Waste pile solids include powdered, granular, or block materials of various sizes, shapes, structure, and compactness. The type of sampler chosen should be compatible with the waste. Samplers commonly used for waste piles include: stainless steel scoops, shovels, trowels, spoons, and stainless steel hand augers, sampling triers, and grain samplers.

Waste pile sampling equipment check list:

- Sampling plan
- Maps/plot plan
- Safety equipment, as specified in the Health and Safety Plan
- Compass
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket or bowl
- Appropriate size sample jars
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and seals
- Field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel
- Continuous flight (screw) augers
- Bucket auger
- Post hole auger
- Extension rods
- T-Handle
- Thin-wall tube sampler with cutting tips
- Sampling trier
- Grain sampler

6.0 REAGENTS

No chemical reagents are used for the preservation of waste pile samples; however, decontamination solutions may be required. If decontamination of equipment is required, refer to the Sampling Equipment Decontamination SOP, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Review all information available on the waste pile and expected or unknown contaminants.
2. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
3. Obtain necessary sampling and monitoring equipment.
4. Decontaminate or pre-clean equipment, and ensure that it is in working order.
5. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
6. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
7. Use stakes or flagging to identify and mark

all sampling locations. Specific site factors, including extent and nature of contaminant should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sample Collection

7.2.1 Sampling with Shovels and Scoops

Collection of samples from surface portions of the pile can be accomplished with tools such as spades, shovels, and scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop, or equivalent can be used to collect the sample.

Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by sample team members. Use of a flat, pointed mason trowel to cut a block of the desired material can be helpful when undisturbed profiles are required. A stainless steel scoop, lab spoon, plastic spoon, or equivalent will suffice in most other applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with implements such as garden trowels.

The following procedure is used to collect the surface samples:

1. Carefully remove the top layer of material to the desired sample depth with a pre-cleaned spade.

2. Using a pre-cleaned stainless steel scoop, plastic spoon, trowel, or equivalent remove and discard a thin layer of material from the area which came in contact with the spade.

3. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent, and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling with Bucket Augers and Thin-Wall Tube Samplers

These samplers consist of a series of extensions, a "T" handle, and a bucket auger or thin-wall tube sampler (Appendix A, Figure 1). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the bucket auger. If a core sample is to be collected, the auger tip is then replaced with a thin-wall tube sampler. The sampler is then lowered down the borehole, and driven into the pile to the completion depth. The sampler is withdrawn and the core collected from the thin-wall tube sampler.

Several augers are available. These include: bucket, continuous flight (screw), and post hole augers. Bucket augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights, which are usually at five (5) foot intervals. The continuous flight augers are satisfactory for use when a composite of the complete waste pile column is desired. Post hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy areas.

The following procedure will be used for collecting waste pile samples with the bucket augers and thin-wall tube samplers:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris. It may be advisable to remove the first three to six inches of surface material for an area approximately six inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated materials onto a plastic sheet spread near the hole. This prevents accidental brushing of loose

material back down the borehole when removing the auger or adding drill rod extensions. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the borehole. When sampling directly from the auger, collect the sample after the auger is removed from the borehole and proceed to Step 10.

5. Remove auger tip from drill rods and replace with a pre-cleaned thin-wall tube sampler. Install proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the pile. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rod extensions to facilitate coring as the vibrations may cause the borehole walls to collapse.

7. Remove the tube sampler, and unscrew the drill rod extensions.

8. Remove the cutting tip and the thin-wall tube sampler.

9. Discard the top of the core (approximately one-inch), as this represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the bucket auger to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the bucket auger and thin-wall tube sampler between samples.

7.2.3 Sampling with a Trier

This sampling device consists of a trier, and a "T" handle. The trier is driven into the waste pile and used to extract a core sample from the appropriate depth.

The following procedure will be used to collect waste pile samples with a sampling trier:

1. Insert the trier (Appendix A, Figure 2) into the material to be sampled at a 0E to 45E angle from horizontal. This orientation minimizes spillage of the sample. Extraction of the samples might require tilting of the sample containers.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are being collected, place samples from the other sampling intervals into the homogenization container and mix thoroughly. When compositing is complete, place the sample

into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling with a Grain Sampler

The grain sampler (Appendix A, Figure 3) is used for sampling powdered or granular wastes or materials in bags, fiber drums, sacks, similar containers or piles. This sampler is most useful when the solids are no greater than 0.6 cm (1/4") in diameter.

This sampler consists of two slotted telescoping brass or stainless steel tubes. The outer tube has a conical, pointed tip at one end that permits the sampler to penetrate the material being sampled. The sampler is opened and closed by rotating the inner tube. Grain samplers are generally 61 to 100 cm (24 to 40 in.) long by 1.27 to 2.54 cm (1/2 to 1 in.) in diameter and are commercially available at laboratory supply houses.

The following procedures will be used to collect waste pile samples with a grain sampler:

1. With the sampler in the closed position, insert it into the granular or powdered material or waste being sampled from a point near a top edge or corner, through the center, and to a point diagonally opposite the point of entry.

2. Rotate the sampler inner tube into the open position.

3. Wiggle the sampler a few times to allow material to enter the open slots.

4. Place the sampler in the closed position and withdraw from the material being sampled.

5. Place the sampler in a horizontal position with the slots facing upward.

6. Rotate the outer tube and slide it away from the inner tube.

7. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA/OSHA and corporate health and safety procedures.

12.0 REFERENCES

Test Methods for Evaluating Solids Waste (SW-846), Third Edition, Vol. II Field Manual U.S. EPA Office of Solid Waste and Emergency Response, Washington, D.C. November, 1986.

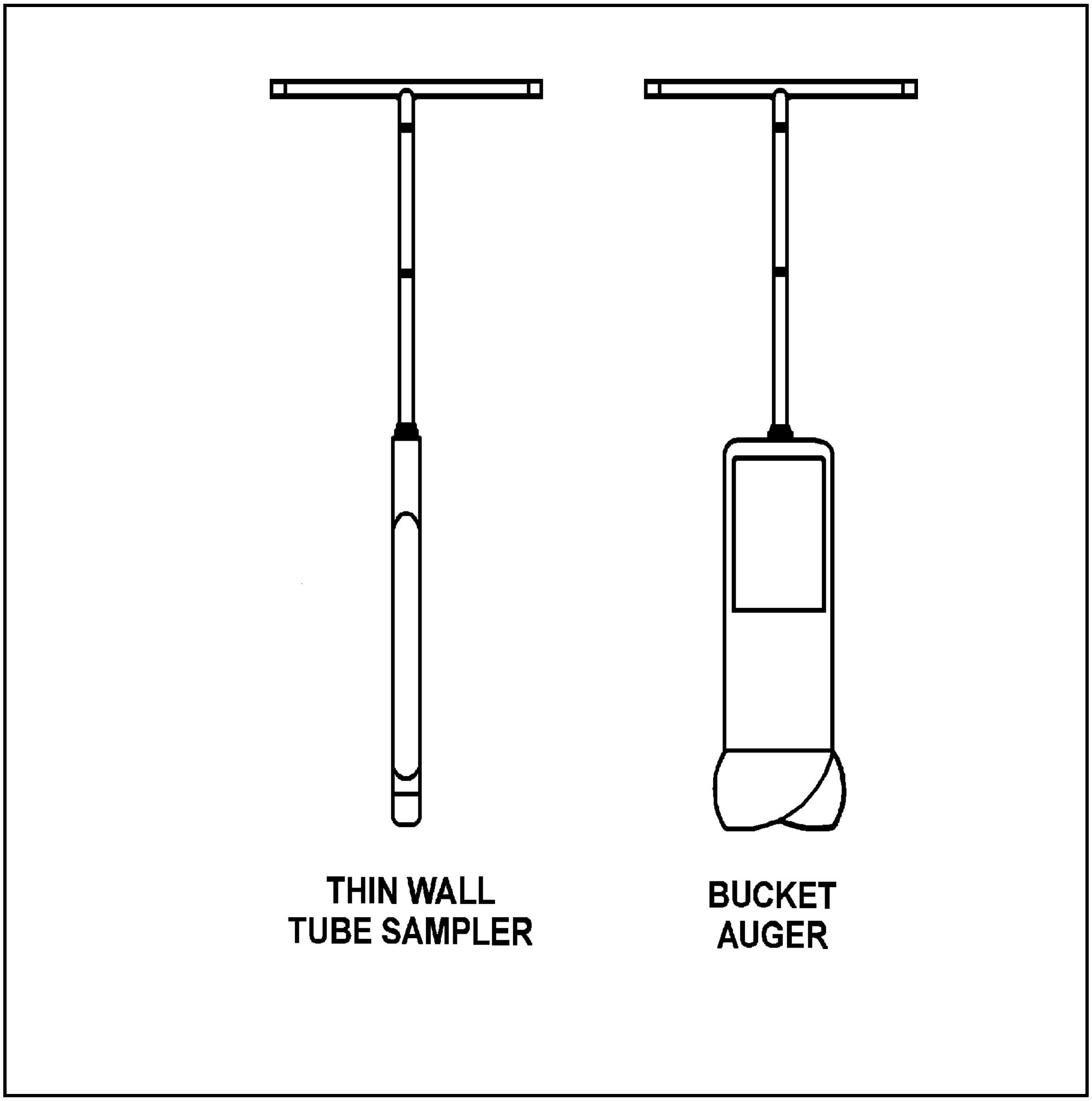
Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, April 1, 1986.

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

APPENDIX A

Figures

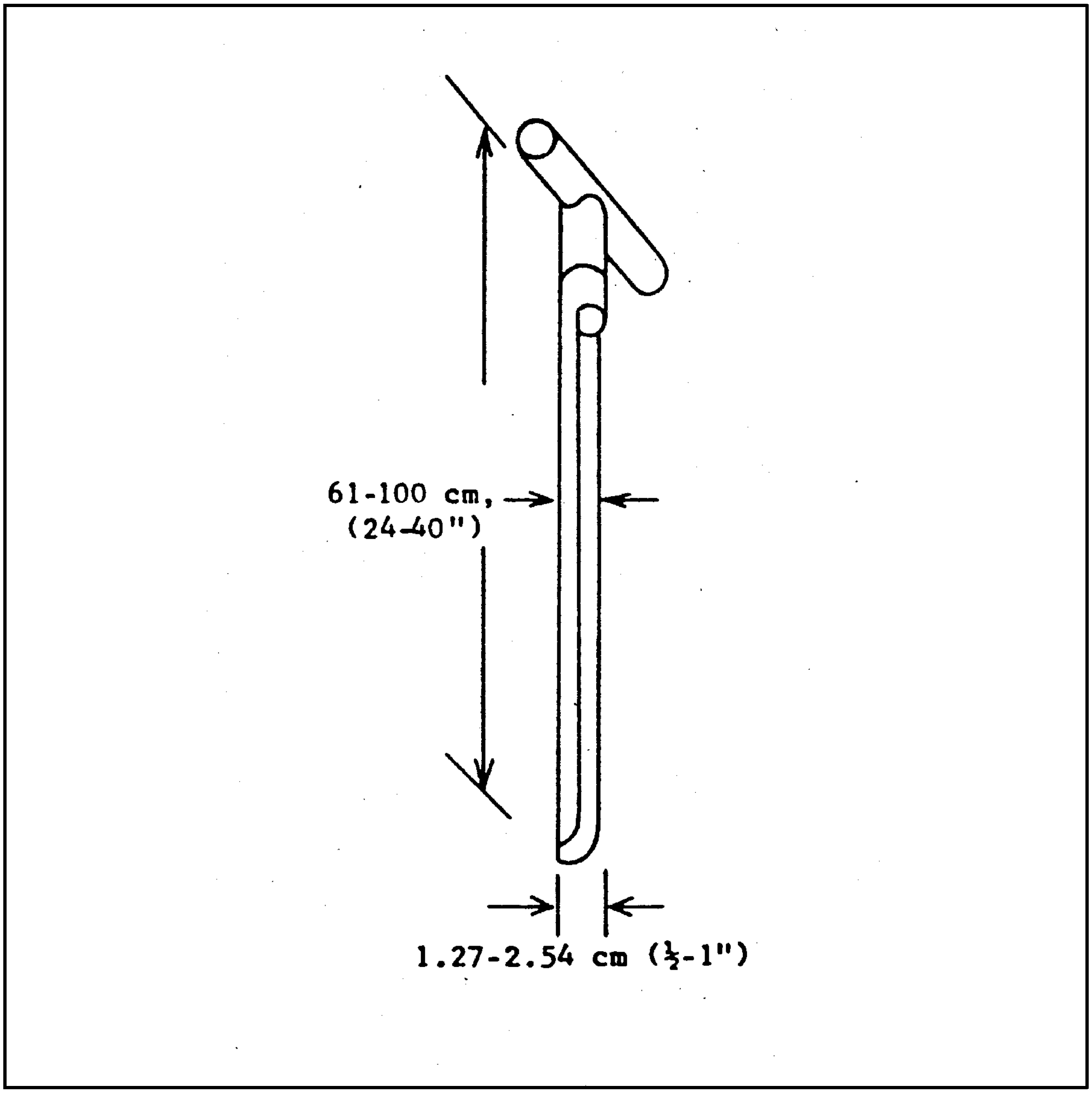
FIGURE 1. Sampling Augers



APPENDIX A (Cont'd)

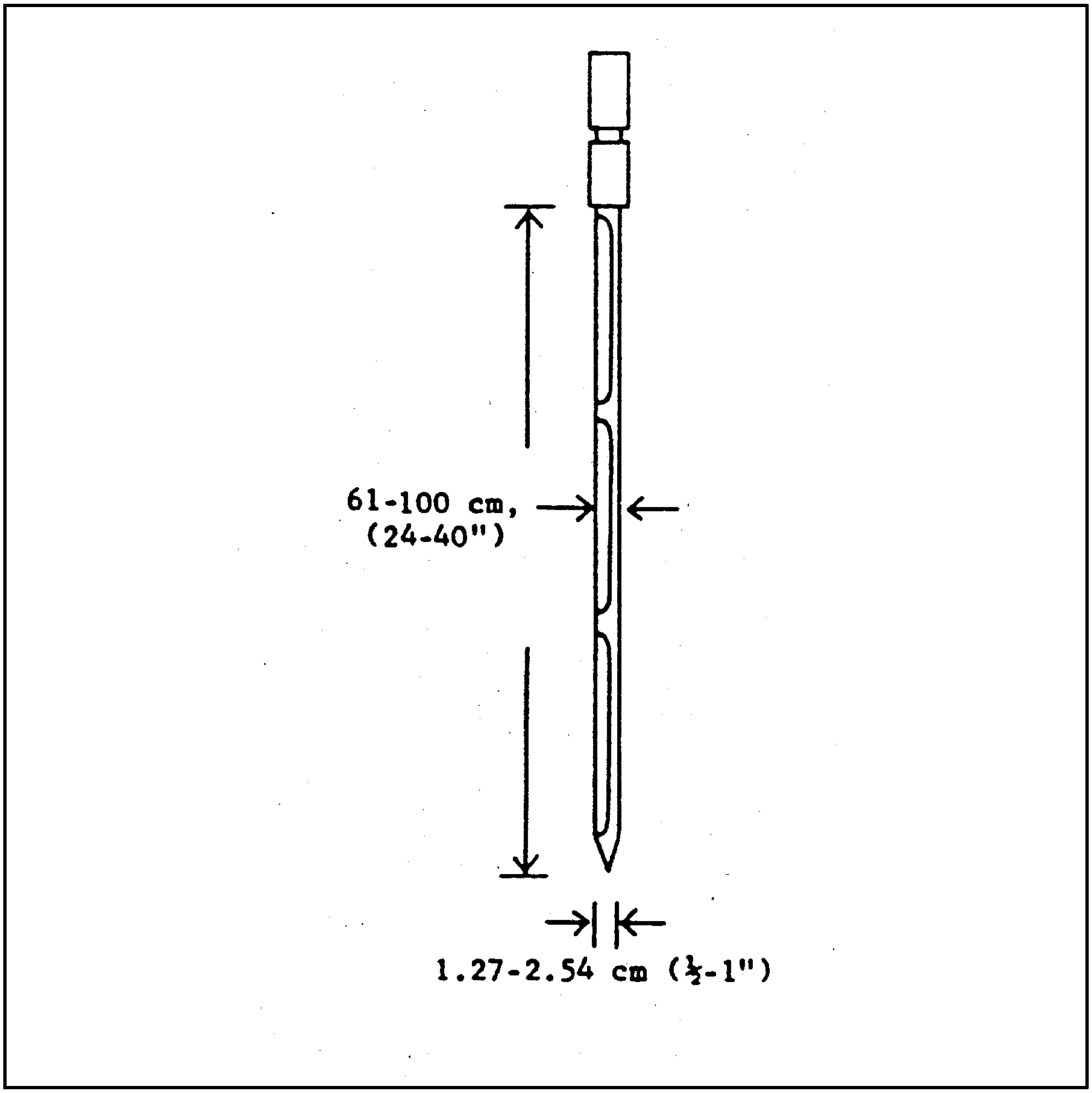
Figures

FIGURE 2. Sampling Trier



Figures

FIGURE 3. Grain Sampler



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