Humboldt Mill Aquatic Survey Report 2015

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Eagle Mine

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List of Abbreviations, Acronyms, and Symbols

AEM	Advanced Ecological Management LLC
CPUE	Catch-per-unit-effort
°C	Degrees Celcius
t	Duration of time
ft	Feet
gpm	Gallons per minute
GLEAS	Great Lakes and Environmental Assessment Section
HTDF	Humboldt Tailings Disposal Facility
KEMC	Kennecott Eagle Minerals Company
MDEQ	Michigan Department of Environmental Quality
µS/cm	Microsiemens per centimeter
mg O_2/L	Milligrams of oxygen per liter of water
ml	Milliliters
max	Maximum
min	Minimum
N	North
n.m.	Not measured
N	Number of fish caught
pH	Measure of acidity or alkalinity of a solution
P-51	Procedure Number 51
R	Range
n	Sample size
Sec	Section
s	Standard deviation
T	Township
W	West

1.0 EXECUTIVE SUMMARY

Advanced Ecological Management, LLC (AEM) conducted an aquatic survey in June 2015 at the Humboldt Mill site for Lundin Mining Corporation's Eagle Mine. The Humboldt Mill site is located in Marquette County in the Upper Peninsula of Michigan as shown on Figure 1-1. An aquatics survey at four stream stations included fish, macroinvertebrate, and habitat community ratings according to the metrics outlined in the Great Lakes and Environmental Assessment Section (GLEAS) Procedure Number 51 (P-51), a survey protocol for wadable streams and rivers. Additional aquatics surveys at Lake Lory and a wetland complex located northeast of the Humboldt Tailings Disposal Facility were also conducted. Sampling survey locations are shown on Figures 1-2 and 1-3.

A summary of the fish, macroinvertebrate, and habitat ratings for the five stream stations are displayed in the table below. All five stations were rated as "poor" fish communities and "acceptable" macroinvertebrate communities. Stream habitat was considered "excellent" in stations MBER 1 and MBER2, and was rated as "good" in Stations 1 and 5.

	Station 1	**Station 5**	**Station MBER1**	**Station MBER2**
Fish Community	Poor	Poor	Poor	Poor
Macroinvertebrate Community	Acceptable	Acceptable	Acceptable	Acceptable
Stream Habitat	Good	Good	Excellent	Excellent

No threatened or endangered species of fish or macroinvertebrates were observed within the five stream sample stations (Michigan Natural Features Inventory, 2015).

The fish community in Lake Lory was predominately comprised of warm water species such as bluegill, largemouth bass, yellow perch, and white suckers. The discharge outfalls utilized by the Humboldt Mill Water Treatment Plant (i.e. Outfall 001 and 002), during the majority of 2015, diverted water east of Wetland Complex EE. As a result, there was much less water observed in the wetland in 2015 compared to 2014, and no fish were collected or observed during the 2015 aquatic survey. No threatened or endangered fish species were observed in Lake Lory (Michigan Natural Features Inventory, 2015).

2.0 INTRODUCTION

Humboldt Mill is used to process ore that is hauled in from the nearby Eagle Mine. Eagle Mine is conducting annual aquatic surveys of waters in the vicinity of the Humboldt Mill as part of meeting requirements R 425.202 (2) (y) of Michigan's Natural Resources and Environmental Protection Act 451 of 1994 as amended Part 632. This aquatics survey was conducted by AEM in June 2015 and provides a second year of describing the aquatic communities in the waters surrounding the Humboldt Mill, while the mill has been functioning to process ore from Eagle Mine. Previous aquatic surveys of the area were conducted by AEM in 2006, 2007, and 2008 (AEM, April 2007a; AEM October 2007b; AEM October 2007c; AEM, April 2008; AEM, March 2009; AEM, December 2014). The objectives of this survey were to provide a general characterization of aquatic communities and record any threatened or endangered aquatic species encountered. This site-specific survey as well as background information, provides data intended to satisfy mine permit requirements (Permit Condition J-14). This report is based on evaluations of fish, macroinvertebrates, and aquatic habitat.

3.0 STUDY SITE

The Humboldt Mill property is a former iron-ore mine and ore processing facility located southeast of Champion, Michigan. The mill property and study area are located in Sections 1, 2, 10, 11, 12, 13, and 14 of Humboldt Township (Township 47 North, Range 29 West), in the vicinity of Highway 41 and east of County Road 95, Marquette County, Michigan (Figure 1-1).

The aquatic investigations conducted by AEM included surveys of Lake Lory, a pond located in the southern extent of a wetland complex located just northeast of the HTDF (herein referred to as Wetland Complex EE), two locations on the Middle Branch Escanaba River, a tributary to the Middle Branch Escanaba River, and one stream in the vicinity of the mill, which is a tributary to the Black River. Stream sample stations and other water body survey locations are illustrated in Figures 1-2 and 1-3.

Altogether, the aquatics sample stations included four stream locations, one lake, and one ponded wetland. These sample stations were chosen based on their proximity to

the processing facility, their ability to provide representative habitat and biological diversity information, and their potential to be impacted by the project.

The following is a description of individual sampling stations for the aquatics portion of the survey:

Station 1: Station 1 is located on the West Branch of the Black River that flows south from a former iron-ore tailings basin (Figure 1-2). The upper end of Station 1 is located approximately 30 feet downstream from an unnamed east-west road that connects to County Road 601, and the stations continue downstream (south) 100 feet. The station location was selected downstream of the road crossing to minimize the influence of beaver impoundments that are located upstream of the road crossing. Station 1 is a low-gradient reach of the Black River.

The substrate was predominantly comprised of organic matter, silt, and woody debris. The predominant riparian vegetation consisted of tussock sedge (*Carex stricta*). Woody shrubs such as sweet gale (*Myrica gale*), speckled alder (*Alnus rugosa*), and sandbar willow (*Salix exigua*) were also observed along the stream bank within the station (Photographs C-1 and C-2).

Station 5: Station 5 is located along the right-of-way of Wolf Road, (Marquette County Road FX) approximately 1,200 feet south of the Middle Branch Escanaba River. The upstream extent of the station is located approximately 20 feet downstream of an abandoned railroad grade. Station 5 is approximately 180 feet in length and flows northeast to the downstream extent, approximately 15 feet upstream of Wolf Road (Figure 1-2). Station 5 drains an adjacent wetland to the west, which is connected to Wetland EE and nearby HTDF.

The substrate of the stream was predominantly comprised of sand, silt, and organic matter. The streambanks were well vegetated with speckled alder overhanging the stream channel, and the predominant herbaceous component was reed canarygrass (*Phalaris arundinacea*; Photographs C-3 and C-4).

Station MBER1: Station MBER1 is located on the Middle Branch Escanaba River northeast of the Humboldt Mill. The downstream extent of the station is located approximately 2,680 feet upstream (north) of Highway 41 (Figure 1-2). Station MBER1 is approximately 1,000 feet long and the stream flows east at this location.

The substrate was predominantly comprised of gravel, silt, sand, and organic matter. The predominant riparian vegetation within Station MBER1 consisted of tussock sedge and speckled alder (Photographs C-5 and C-6). Submerged pondweed (*Potamogeton* sp.) was abundant throughout the stream channel.

An abandoned railroad grade comprised a portion of the south streambank along the approximately 500 feet of the station. The streambank along the railroad grade was vegetated and one culvert connects a wetland located south of the river channel to the river near the upstream extent of the station.

Station MBER2: Station MBER2 is located on the Middle Branch Escanaba River approximately 3.1 miles northeast of the Humboldt Mill and upstream of any potential water that may discharge from the surface of the Humboldt Mill area (Figure 1-2). The downstream extent of the station is located immediately upstream of the former Lake Superior and Ishpeming Railroad bridge crossing that now serves as a rails-to-trails bridge for snowmobiles and off road vehicles. Station MBER2 is approximately 1,000 feet long and the stream flows south at this location.

The substrate was predominantly comprised of gravel, sand, silt, and organic matter. The predominant riparian vegetation within Station MBER2 consisted of speckled alder and tussock sedge (Photographs C-7 and C-8).

Lake Lory: Lake Lory is approximately 128 acres in size and is located approximately 1.3 miles south of Highway 41 and approximately 1.9 miles east of County Road 95 (Figures 1-2 and 1-3). Lake Lory drains into the East Branch of the Black River (Figure 1-3) along its southwestern boundary where an earthen berm controls the hydrology of the lake. Ponds located along the northern boundary of the lake drain into the lake and

historically functioned as a tailings basin for the iron-ore mine. Photographs C-9 and C-10 display views of the lake.

Wetland Complex EE: The pond located within Wetland Complex EE is located approximately 167 feet northeast of HTDF (Figure 1-2). The hydrology of the wetland complex is influenced by the presence of Highway 41 and an abandoned railroad grade, both of which bisect the wetland from east to west and direct water movement through numerous culverts. Water generally moves through the wetland complex in a northerly direction from the vicinity of the HTDF towards Highway 41 and to the Middle Branch Escanaba River. Vegetation in the wetland complex is predominantly comprised of emergent and scrub-shrub wetland vegetation, including cattails (*Typha* sp.) and speckled alder (Photographs C-11 and C-12).

Table 3-1 provides a summary of the location information for the four stream sample stations identified above. Depiction of the sampling locations for the Lake Lory and Wetland Complex EE appear on Figures 1-2 and 1-3.

4.0 METHODS

To characterize the quality of the streams within the vicinity of the mill, flowing and wadable water bodies were sampled according to the Michigan Department of Environmental Quality's (MDEQ) Surface Water Quality Division *Procedure #51 Survey Protocols for Wadable Rivers* (P-51; MDEQ, 2008). The P-51 is a rapid bioassessment protocol that is used to evaluate stream quality based on fish, macroinvertebrates, and stream habitat characteristics.

Surface waters were sampled to characterize the fish communities and to provide a general description of the surface-water aquatic habitat. Lake Lory and Wetland Complex EE (Figures 1-2 and 1-3) were sampled using a variety of aquatic sampling methods, including the use of electroshocking gear, nets, and a sediment grabbing device to collect macroinvertebrates from unwadable water bodies.

4.1 Fish Collection

A backpack electroshocker was used in narrow (approximately ≤15 feet) or difficult-to-access stations (e.g., areas with abundant woody debris). A barge-mounted electroshocker was used to sample Stations MBER1 and MBER2, which were deep and wide enough to permit the passage of the barge unit. On Stations MBER1 and MBER2, one pass was conducted with the electroshocker in an upstream direction and the duration of electroshocking charge time was recorded for each pass. On Stations 1 and 5, a multi-pass removal was conducted (Van Deventer and Platts, 1983). For each electrofishing pass, stunned fish were placed in a live well for identification and enumeration. Following collection and fish identification of all fish in each station survey, enumerated fish were released within each station.

Stream fish data were analyzed according to P-51 metrics to produce a "fish score" that was used to rate the fish community as poor, neutral (acceptable), or excellent quality. There are ten metrics used to evaluate the fish community diversity and they are listed in the P-51 methodology (MDEQ, 2008). The score for each metric can range from –1 to +1 and are described as follows:

- -1 indicates the community is performing outside of (minus) two standard deviations from the average conditions found at excellent sites;
- 0 indicates the community is performing between the average condition and (minus) two standard deviations from the average condition found at excellent sites, and;
- +1 indicates the community is performing better than the average condition found at excellent sites.

The summation of the fish scores can range from –10 to +10 using these metrics. Stations that score from +5 to +10 are considered excellent. Stations that score from –5 to –10 or have less than 50 fish are considered poor, while stations that score from –5 to +5 (including zero) are considered acceptable in fish community structure (MDEQ, 2008).

Lake, pond, and wetland sites were not evaluated for fish using the P-51 procedure because the approach is designed for wadable streams (MDEQ, 2008). Since fish collection gear is not equally selective among sizes and species of fish, a combination of sampling gear, including a boom shocker, a backpack shocker, experimental gill nets, and fyke nets were used to capture fish within Lake Lory and Wetland Complex EE. Gear and sample locations within Lake Lory were selected to provide a broad sampling coverage of aquatic habitat and to minimize the bias created by gear selectivity and avoidance by fish.

A boat-mounted shocking unit and generator (boom shocker) were used to collect fish in shallow water, near-shore areas of Lake Lory (Figure 1-3). Pulsed direct current was used during the survey to minimize trauma to the fish. Electroshocking duration was automatically recorded as the total seconds of electricity that was discharged from the boom shocker in each transect. Boom shocking was conducted at night, which is more effective than shocking during daylight hours (Smith-Root, 2004).

Multiple panel monofilament gill nets of varying mesh size were fished in several locations throughout Lake Lory (Figure 1-3). Each gill net consisted of five, 6- by 25-foot panels ranging from 1.5- to 6-inch stretch mesh. The gill nets were set overnight and were fished for approximately 12 hours.

Fyke nets were constructed of 0.125-inch "Ace"-type nylon mesh coated with green latex net dip. The lead was 15 feet-long and 2-feet high. The frame and the cab were 10-feet long when fully extended. The frame section is formed by two rectangular spring-steel frames that are 2-feet high by 4-feet wide. The cab is constructed of two 2-feet diameter steel hoops. The fyke nets were placed throughout Lake Lory and were fished overnight for approximately 24 hours (Figure 1-3).

Wetland Complex EE was sampled in a wadable pond located approximately 450 feet south of Highway 41, and approximately 1,500 feet west of the intersection between Highway 41 and Wolf Road (Figure 1-2). Sampling was conducted with a backpack electroshocker along the south and west shoreline on the edges of dense vegetation.

Catch-per-unit-effort (CPUE) is used as an index of fish abundance. Fish sampling efforts were standardized to units consistent with the Michigan Department of Natural Resources sampling protocol (Schneider et al., 2000). CPUE for the following gear was estimated as follows:

$$\text{CPUE} = \frac{N}{t}$$

Where,

N = number of fish caught

t = sample duration in hours (boom shocker), or

t = sample duration in net nights (experimental gill net), or

t = sample duration in net nights (hoop net).

As part of the enumeration process, the species, length, weight, and number of fish captured were recorded. One representative of each species that was not identifiable in the field was placed in a voucher jar containing 10% formalin for later identification. Each voucher jar was labeled according to the sample location and date. Fish were identified to species using various taxonomic references (Bailey et al., 2003; Coon, 2001; Becker, 1983). The Marquette County Element List (Michigan Natural Features

Inventory, 2015) was reviewed to determine if any threatened, endangered, or special concern aquatic species occurred within the vicinity of the project.

4.2 Macroinvertebrates

Macroinvertebrate sampling was conducted within all stream stations. Upon completion of fish sampling, aquatic macroinvertebrates, including mussels and decapods (crayfish), were collected within each station using D-framed kick-nets (Merritt et al., 1996). Stations were sampled for 45 minutes using two kick-nets (total sample time = 1.5 hours) and samples were collected in all habitat types within each station to characterize the macroinvertebrate community. Collected specimens were stored in 500 ml plastic wide-mouth jars containing 70% ethanol, and were identified using various taxonomic references (Bright, 2015; Merritt et al., 2008; Cummings and Mayer, 1992; Pennak, 1990).

The wadable stream macroinvertebrate data were analyzed according to nine metrics identified in the P-51 methodology. The sum of the macroinvertebrate scores can range from –9 to +9; and like the fish community, are graded as excellent, acceptable (slightly impaired), or poor according to the summation of the metric scores.

Aquatic macroinvertebrate sampling was conducted along the shoreline of Lake Lory and Wetland Complex EE using a D-frame kick-net. A PONAR sediment-grabbing device was also used in Lake Lory to collect macroinvertebrates within the water basin in locations where the water was too deep to use the kick-net (Figure 1-3).

4.3 Stream Habitat Evaluation

Riparian and instream habitats were qualitatively described for each station. A description of stream morphology included run/riffle/pool/shallow pool configurations, substrate, substrate embeddedness, instream cover, vegetation, flow stability, and bank stability. Stream habitat was rated as excellent, good, marginal, or poor based on P-51 scores interpreted from 10 habitat metrics. Habitat was rated according to the following P-51 habitat scores (MDEQ, 2008):

Habitat Characterization	Total Point Score
1. Excellent	> 154
2. Good	105 – 154
3. Marginal	56 – 104
4. Poor	< 56

Wetted stream width was measured at the downstream extent, upstream extent, and middle of each sample station to describe the physical dimensions of each stream sample station at the time of the survey. The average depth of the sample station was determined from stream depth measured at 20 percent of the channel width, 80 percent of the channel width, and 50 percent of the channel width of the downstream extent, upstream extent, and middle of the station. Stream flow was measured using a Marsh McBirney FLO-MATE 2000™.

Photographs were taken at each station to illustrate the conditions during the sampling period. Water temperature, pH, conductivity, and dissolved oxygen were measured as part of the stream habitat evaluation. These water quality parameters were measured using a Yellow Springs Instrument Professional Plus water quality meter.

5.0 RESULTS AND DISCUSSION

The aquatic sampling of the Humboldt Mill vicinity was conducted from June 6, 2015 through June 9, 2015. Station 1 was sampled on June 6, 2015, Station 5 was sampled on June 7, 2015, Station MBER1 was sampled on June 7, 2015, and Station MBER2 was sampled on June 8, 2015. Sampling of Lake Lory and Wetland Complex EE were conducted from June 6, 2015 through June 9, 2015.

5.1 Streams

All streams sampled within the project vicinity are located in a region that is classified as a Northern Lakes and Forests ecoregion (MDEQ, 2008). Therefore, all P-51 scoring was based on metrics that relied on typical data from this ecoregion.

5.1.1 Station 1

A total of 18 fish representing five taxa were collected from Station 1 in 2015. The dominant species included pearl dace (*Margariscus margarita*) and northern redbelly dace (*Phoxinus eos*; Table 5-1). Although fewer fish were collected in 2015 compared to 2014 (total number = 31), the community composition was generally consistent among both years. The CPUE estimate was 0.7 fish/minute of backpack electroshocking for the reach, which was also less than was observed in 2014 (1.4 fish/minute). Because fewer than 50 fish were collected from Station 1, the fish community was rated as “poor”. No threatened, endangered, or special concern fish species were observed in Station 1.

A total of 218 macroinvertebrates were collected from Station 1 in 2015, which was more than were collected in 2014, where a total of 76 macroinvertebrates were collected. Dipterans (true flies), Amphipoda (scuds), and Trichopterans (caddisflies) were the most abundant organisms (Table 5-2) in Station 1, and community composition was consistent among 2014 and 2015. The macroinvertebrate community was rated as “acceptable” (Table 5-3), and no threatened, endangered, or special macroinvertebrates were observed.

Station 1 was classified as a glide/pool habitat based on use of the P-51 protocol. The habitat was rated as “good” based on the total habitat metric score according to the P-51 protocol (Table 5-4).

The average width of Station 1 was 8.4 feet (standard deviation; *s* = 1.8 feet; sample size; *n* = 3) and the average depth was 1.7 feet (*s* = 0.4 feet; *n* = 9; Table 5-5). The discharge within Station 1 was 545 gallons per minute on June 6, 2015. Water temperature within Station 1 was 19.7°C and lowest dissolved oxygen (4.5 mg O_2/L) among the Humboldt sample stations (Table 5-6). A small beaver dam was constructed approximately midway through Station 1 since the 2014 aquatic survey and was creating deeper water and a slightly wider channel throughout the upstream half of the station.

5.1.2 Station 5

Station 5 was sampled using a backpack electroshocker where only one Central mudminnow (*Umbra limi*) was collected in 2015, with an observed CPUE of 0.03 fish/minute of backpack electroshocking. Only one Central mudminnow was also collected from Station 5 in the 2014 aquatic survey. Because fewer than 50 fish and no salmonids were collected from Station 5, the fish community was rated as "poor". No threatened, endangered, or special concern fish species were observed in Station 5.

A total of 183 macroinvertebrates were collected from Station 5 in 2015, which were fewer than the total of 392 macroinvertebrates that were collected in the 2014 aquatic survey. Isopoda (sowbugs) were the most abundant organism followed by true flies and Ephemeropterans (mayflies; Table 5-2). The macroinvertebrate community was rated as "acceptable" (Table 5-3) and no threatened, endangered, or special concern macroinvertebrate species were observed.

Station 5 was evaluated as a glide/pool habitat and was rated as "good" based on the P-51 total habitat metric score (Table 5-4). The average width of Station 5 was 6.4 feet (*s* = 2.8 feet; *n* = 3; Table 5-5) and average depth was 0.8 feet (*s* = 0.4 feet; *n* = 9; Table 5-5). The discharge within Station 5 was 568 gallons per minute on June 07, 2015 and was much higher than the discharged measured in the 2014 aquatic survey (95 gallons per minute; Table 5-6). The increase in discharge from 2014 to 2015 is likely due to the water discharging from the water treatment facility that is responsible for treating water from the HTDF. Conductivity was higher in 2015 (413 µS/cm) compared to 2014 (230 µS/cm), and was the highest among the 2015 sample stations (Table 5-6). Consistent

with the 2014 survey, an odor of gasoline, or some other hydrocarbon-based product was noted while conducting the survey of Station 5 when sediments were disturbed from the fish and macroinvertebrate portions of the survey. However, the odor during the 2015 aquatic survey was less apparent than was noted in the 2014 survey.

5.1.3 Station MBER1

A total of seven fish representing three taxa were observed, with an estimated CPUE of 0.2 fish/minute of tote-barge electroshocking in Station MBER1 during the 2015 aquatic survey. A total of 17 fish representing 7 taxa were observed during the 2014 aquatic survey, with an estimated CPUE of 0.3 fish/minute. Golden shiners (*Notemigonus crysoleucas*) were the most abundant fish within this station in 2015 (Table 5-1).

The Middle Branch Escanaba River is classified as a designated trout stream by the State of Michigan (Michigan Department of Natural Resources Fisheries Order 210.04, 2014). Because fewer than 50 fish were collected and no salmonids were collected from Station MBER1, the fish community was rated as "poor". No threatened, endangered, or special concern fish species were observed in Station MBER1.

A total of 250 macroinvertebrates were collected from Station MBER1 in both 2014 and 2015. Blackfly larvae (Simuliidae) were most abundant followed by mayflies and scuds (Table 5-2). The total macroinvertebrate community was rated as "acceptable" (Table 5-3), and no threatened, endangered, or special concern macroinvertebrates were observed.

Station MBER1 was classified as a glide/pool habitat and was rated as "excellent" according to the P-51 total habitat metric score (Table 5-4). The average width of Station MBER1 was 34.7 feet (s = 5.6; n = 3) and average depth was 3.1 feet (s = 0.5 feet; n = 9; Table 5-5).

The discharge within Station MBER1 was 28,359 gallons per minute on June 7, 2015. Conductivity was 69 µS/cm and pH was 6.5 (Table 5-6), which were consistent with the 2014 aquatic survey. Water temperature was the lowest (12.9°C) among all stream sample stations (Table 5-6).

5.1.4 Station MBER2

Station MBER2 was also sampled using a barge-mounted electroshocker where a total of 18 fish representing six taxa were observed in 2015. A total of 19 fish representing 9 taxa were observed in 2014. Common shiners (*Notropis cornutus*), Central mudminnows, and white suckers (*Catostomus commersonii*) were the most frequently observed fish (Table 5-1). The CPUE estimate for Station MBER2 was 0.4 fish/minute of tote-barge electroshocking.

Because fewer than 50 fish and no salmonids were collected from Station MBER2, the fish community was rated as "poor". No threatened, endangered, or special concern fish species were observed in Station MBER2.

A total of 150 macroinvertebrates were collected from Station MBER2 in 2015, which were fewer than were collected in 2014 (total of 401 macroinvertebrates). Although fewer macroinvertebrates were collected, the community composition was generally consistent among 2014 and 2015 where caddisflies, mayflies, and true flies were the most abundant organisms (Table 5-2). The macroinvertebrate community was rated as "acceptable" (Table 5-3), and no threatened, endangered, or special concern macroinvertebrate species were observed.

Station MBER2 was evaluated as a glide/pool habitat and was rated as "excellent" based on the P-51 total habitat metric score (Table 5-4). The average width of Station MBER2 was 26.3 feet (s = 1.6 feet; n = 3) and average depth was 2.3 feet (s = 0.8 feet; n = 9; Table 5-5). Discharge within Station MBER2 was 19,820 gallons per minute on June 08, 2015 (Table 5-6), and was approximately 6,000 gallons per minute higher than was observed during the 2014 aquatic survey (13,828 gallons per minute on June 6, 2014). Water temperature was 13.9°C and conductivity was the lowest (33 µS/cm) among all 2015 stream sample stations (Table 5-6).

5.2 Lake Lory and Wetland Complex EE

5.2.1 Lake Lory

Six fyke nets were fished in nearshore areas throughout Lake Lory for approximately 24 hours for each net (Figure 1-3). Sampling took place from June 06, 2015 through June 09, 2015. Fyke nets were typically set mid-day and were checked at the same time the following day for fish.

Gill nets were fished in three locations throughout the lake for approximately 12 hours of soak time for each net (Figure 1-3). Gill nets were fished from June 06 through June 09, 2015.

Boom shocking was conducted along five transects that were situated parallel to the shoreline (Figure 1-3). Transect lengths ranged from a minimum of 257 feet to a maximum of 483 feet.

A total of 155 fish were collected from Lake Lory in 2015 representing 12 different taxa (Table 5-7). More fish were collected from Lake Lory in 2014 where a total 227 fish were captured. However, the community composition was generally consistent among both years, with bluegills (*Lepomis macrochirus*) represented as the most frequently observed species, followed by largemouth bass (*Micropterus salmoides*) and yellow perch (P*erca flavescens*) among all sample gear. Most of the reduction in fish collected from Lake Lory from 2014 through 2015 was observed in largemouth bass, where a total of 79 were collected in 2014, and a total of only 28 were collected in 2015. No threatened, endangered, or special concern fish species were observed in Lake Lory.

Most of the fish were collected using a boom shocker (Table 5-7). The average total CPUE for the boom shocker was 1.6 fish/minute of electrofishing in 2015 and was lower than the 2014 CPUE, which was 2.3 fish/minute of electrofishing.

The total CPUE for fyke nets varied by net location, and ranged from a minimum of 0 fish per net night in fyke net 2 to a maximum of 18 fish per net night in fyke net 5. The fyke nets were the most effective means for capturing small minnow species, such as

blacknose shiners (*Notropis heterolepis*) and bluntnose minnows (*Pimephales notatus*). The total number of fish captured in gill nets was 5 (Table 5-7), with all fish collected in gill net 1.

The average length of largemouth bass was 12.6 inches (*s* = 2.6 inches; *n* = 28) and the average weight was 1.0 pounds (*s* = 0.8 pounds; *n* = 28; Table 5-8). Bluegill ranged in length from 1.4 to 9.1 inches, with an average length of 6.4 inches (*s* = 2.0 inches; *n* = 61), and an average weight of 0.2 pounds (*s* = 0.2 pounds; *n* = 61 Table 5-8). Yellow perch ranged in length from 2.7 to 10.6 inches, with an average length of 6.6 inches (*s* = 2.1 inches; *n* = 25), and an average weight of 0.1 pounds (*s* = 0.1 pounds; *n* = 25 Table 5-8).

Many fish collected in Lake Lory appeared in good condition. However, black spot, which is caused by a parasite (larval trematode) that burrows into the skin of the fish, was observed in several of the bluegills, black crappie (*Pomoxis nigromaculatus*), largemouth bass, smallmouth bass (*Micropterus dolomieui*), and yellow perch.

Aquatic macroinvertebrate sampling was conducted on June 08, 2015 within Lake Lory where a total of 206 macroinvertebrates were collected (Table 5-9), which is a higher total than the 87 macroinvertebrates that were collected in 2014. Snails, true flies, and dragonflies were the most abundant macroinvertebrates within Lake Lory, and the 2015 community composition was generally consistent with the 2014 community composition. No threatened, endangered, or special concern macroinvertebrate species were observed in Lake Lory.

Floating, submerged, and emergent aquatic vegetation were observed in patches along the shoreline of Lake Lory. Burreed (*Sparganium* sp.), floating pondweed (*Potamogeton natans*), bigleaf pondweed (*Potamogeton amplifolius*), rushes, and water-starwort (*Callitriche* sp.) were the predominant species of aquatic vegetation that were observed along the shoreline (Photographs C-9 and C-10). Large woody debris in the form of downed trees and submerged standing timber contributed to the aquatic habitat of Lake Lory.

Water temperature, pH, dissolved oxygen, and conductivity were measured on the surface of Lake Lory near the western shoreline on June 7, 2015. The surface water temperature was 17.5 °C and conductivity of Lake Lory was low (65 µS/cm; Table 5-6). The 2014 conductivity was nearly identical (64 µS/cm) to the 2015 conductivity measurement.

5.2.2 Wetland Complex EE

Wetland Complex EE was sampled for fish using a backpack shocker. No fish were collected from Wetland Complex EE in 2015 and a total of 17 fathead minnows (*Pimephales promelas*) were collected during the 2014 aquatic survey.

Aquatic macroinvertebrate sampling was conducted on June 07, 2015, where a total of four macroinvertebrates were collected (Table 5-10). Two snails, one beetle, and one water strider (Gerridae) were collected during the 2015 aquatic survey. A total of 79 macroinvertebrates were collected during the 2014 survey, where dragonflies, scuds, and snails were the most frequently collected macroinvertebrates. No threatened, endangered, or special concern macroinvertebrate species were observed in Wetland Complex EE.

Wetland Complex EE was predominantly vegetated with cattails (Photographs C-11 and C-12). It appeared that surface water within the wetland may have temporarily disappeared prior to the 2015 survey as water was much lower than previous surveys (only ankle deep) and there was recent evidence of cracking in the substrate, which may be indicative of dry conditions (Photograph C-13). The recent lack of water would account for the lack of fish and the low macroinvertebrate numbers. The highest observed conductivity (698 µS/cm) and water temperature (21.0°C) relative to other sample stations occurred in the wetland (Table 5-6).

The discharge outfalls utilized by the Humboldt Mill Water Treatment Plant (i.e. Outfall 001 and 002), during the majority of 2015, diverted water east of Wetland Complex EE, which likely accounted for the reduction of water within the wetland in 2015. The reduction of water within the wetland likely accounted for the lack of fish and macroinvertebrates that were observed during the 2015 aquatic survey. In September

2015, a third outfall (i.e. Outfall 003) was constructed in the southern portion of Wetland Complex EE, which facilitates water distribution to the entire wetland.

6.0 REFERENCES

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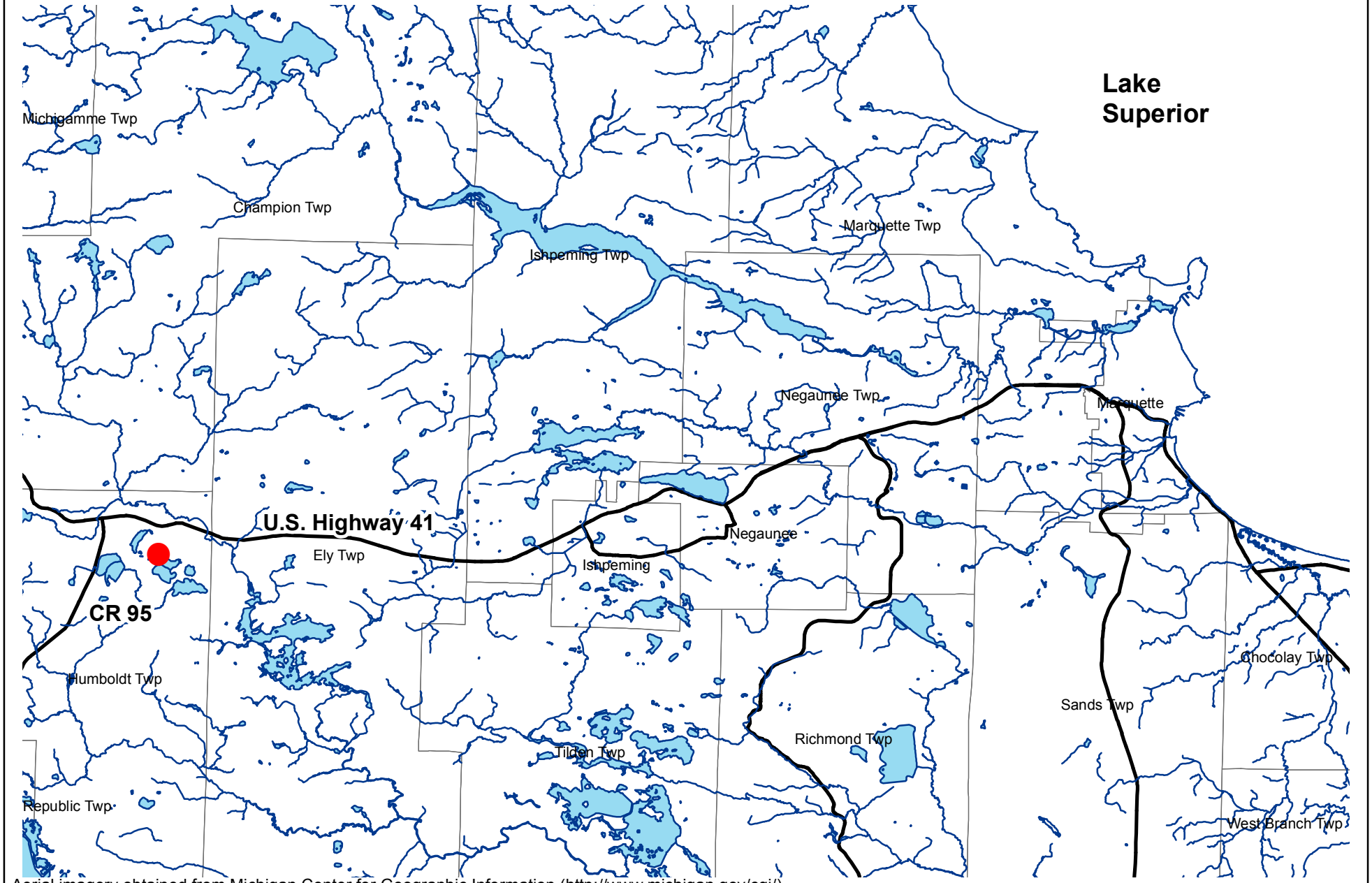
EXHIBIT A

REPORT FIGURES



Aerial imagery obtained from Michigan Center for Geographic Information (http://www.michigan.gov/cgi/)

Legend

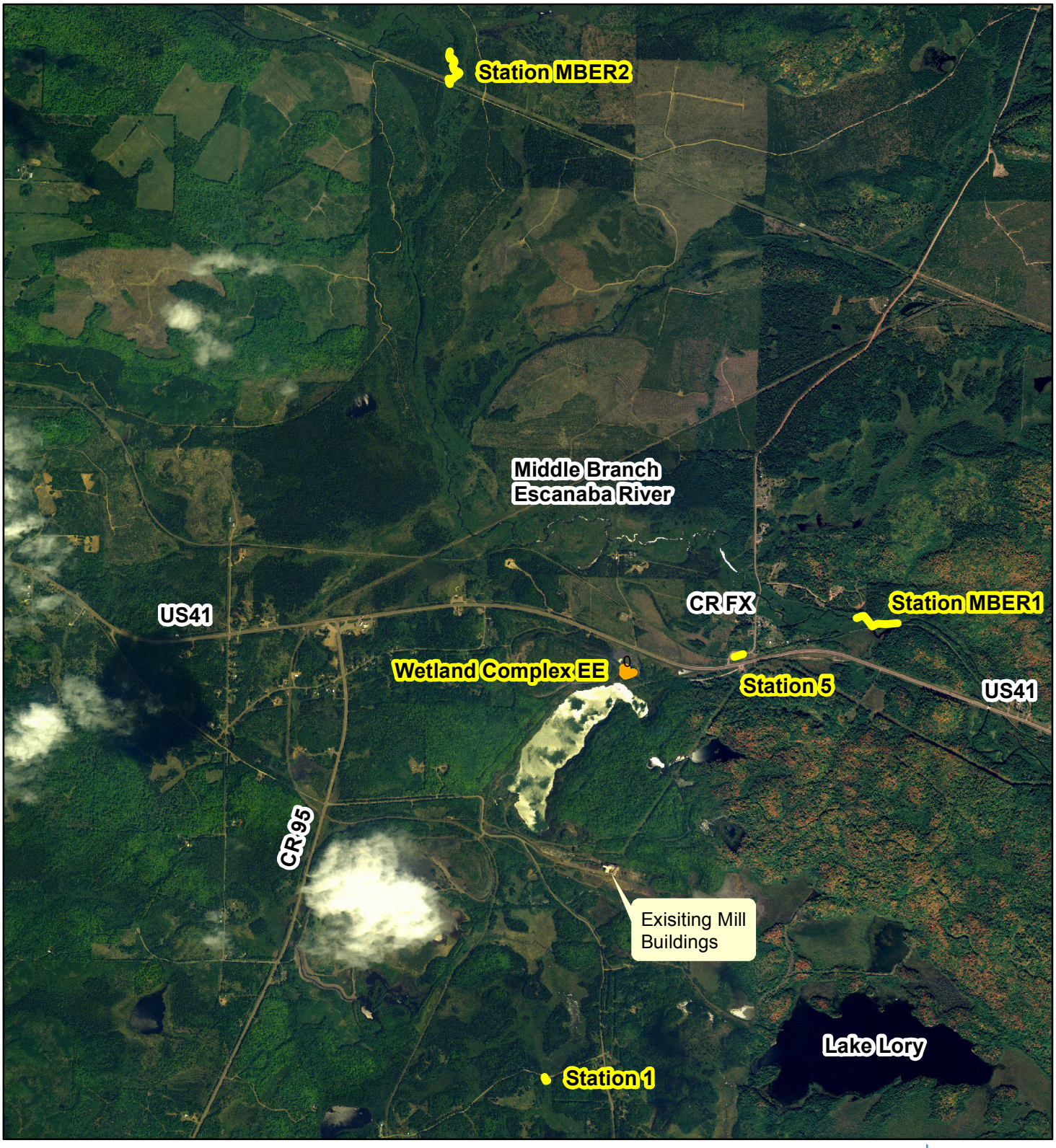
- Humboldt Mill
- Roads

N

0 1.25 2.5 5 7.5 10 Miles

AeM ADVANCED ECOLOGICAL MANAGEMENT

PROJECT	Humboldt Mill - Eagle Mine
TITLE	Humboldt Mill Location
FIGURE	1-1



Legend

- Wetland Complex EE Station
- Stream Sample Station Locations

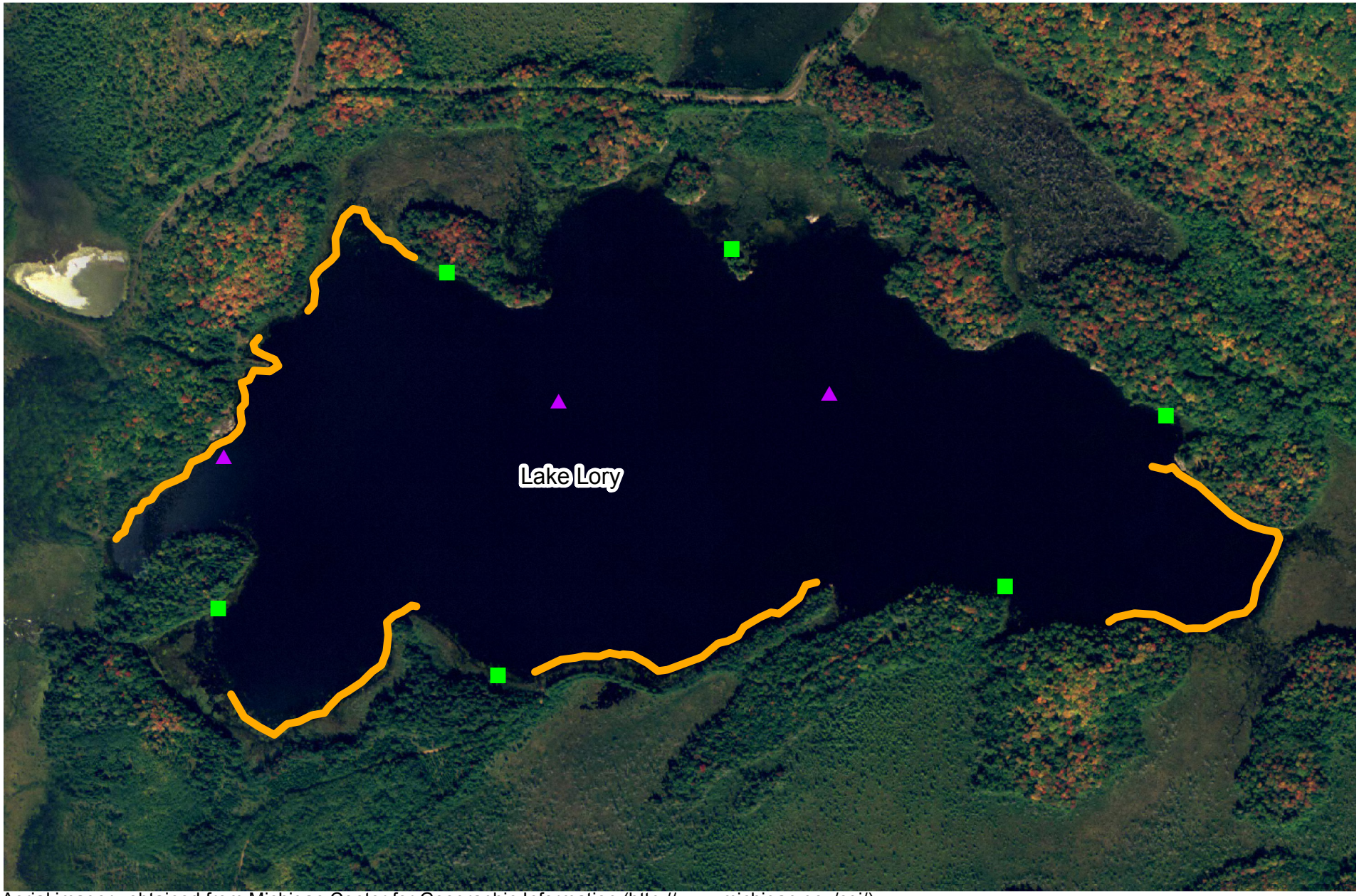
0 875 1,750 3,500 5,250 7,000 Feet

N

AeM ADVANCED ECOLOGICAL MANAGEMENT

PROJECT	Humboldt Mill - Eagle Mine
TITLE	Sample Station Locations
FIGURE	1-2

Aerial imagery obtained from Michigan Center for Geographic Information (http://www.michigan.gov/cgi/)



Aerial imagery obtained from Michigan Center for Geographic Information (http://www.michigan.gov/cgi/)

Legend

- Fyke Net Locations
- Gill Net Locations
- Electroshocker Transect Locations

0 275 550 1,100 1,650 2,200 Feet

N

AeM ADVANCED ECOLOGICAL MANAGEMENT

PROJECT	Humboldt Mill - Eagle Mine
TITLE	Lake Lory Gear Locations
FIGURE	1-3

EXHIBIT B

REPORT TABLES

Table 1-1. Summary of the Procedure 51 Macroinvertebrate and Aquatic Habitat Scores for all Stream Stations, 2015.

Station Number	1	5	MBER1	MBER2
Fish Score Rating	Poor	Poor	Poor	Poor
Macroinvertebrate Score Rating	Acceptable	Acceptable	Acceptable	Acceptable
Stream Habitat Score Rating	Good	Good	Excellent	Excellent

Table 3-1. Stream Station Location Description.

Station Number	Stream Name	Latitude/Longitude NAD 1983	Township/Range/Section	Location Description
1	Unnamed Tributary of the Black River	N 46.47222 W 87.90249	Humboldt Twp. T47N, R29W, Sec 14	Upstream extent approximately 30 feet downstream of road crossing
5	Unnamed Tributary of the Middle Branch Escanaba River	N 46.49569 W 87.88276	Humboldt Twp. T47N, R29W, Sec 1	Extends between FX road and Highway 41
MBER1	Middle Branch Escanaba River	N 46.49899 W 87.88609	Humboldt Twp. T47N, R29W, Sec 1	Downstream extent approximately 2,683 feet upstream of Highway 41
MBER2	Middle Branch Escanaba River	N 46.527053 W 87.912157	Champion Twp. T48N, R29W, Sec 27	Upstream extent approximately 1,000 feet upstream of the former L.S. & I Railroad bridge

NAD 1983 = North American Datum of 1983
N = North
W = West
T = Township
R = Range
Sec = Section

Table 5-1. Stream Fish Collection Data – Stations 1, 5, MBER1 and MBER2.

		Station			
Scientific Name	**Common name**	**MBER1**	**MBER2**	**1**	**5**
Catostomus commersonii	White sucker		3		
Culaea inconstans	Brook stickleback		1	1	
Esox lucius	Northern pike	1			
Margariscus margarita	Pearl dace			10	
Notemigonus crysoleucas	Golden shiner	5			
Notropis cornutus	Common shiner		5		
Percina flavescens	Yellow perch	1			
Phoxinus eos	Northern redbelly dace			4	
Phoxinus neogaeus	Finescale dace			2	
Rhinichthys atratulus	Blacknose dace		2		
Semolitus atromaculatus	Creek chub		2		
Umbra limi	Central mudminnow		5	1	1
	Total Captured	**7**	**18**	**18**	**1**

Table 5-2. Stream Macroinvertebrate Collection Data – Stations 1, 5, MBER1 and MBER2.

TAXA	Station 1	Station 5	Station MBER1	Station MBER2
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1	2	1	1
Oligochaeta (worms)				1
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	33	3	40	1
Decapoda (crayfish)			3	7
Isopoda (sowbugs)	21	54	27	
Insecta				
Ephemeroptera (mayflies)				
Arthropleidae	1			4
Baetidae	13	36	20	6
Caenidae	1			
Ephemerellidae	1		3	3
Ephemeridae				1
Heptageniidae	1		1	10
Siphlonuridae	4	2	16	8
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	4	7	1	
Cordulegasteridae		5		1
Corduliidae	3			
Gomphidae			1	1
Zygoptera (damselflies)				
Calopterygidae	4		13	3
Plecoptera (stoneflies)				
Perlidae				1
Perlodidae				1
Hemiptera (true bugs)				
Corixidae	1		3	
Gerridae	4		1	3
Veliidae		1		
Megaloptera				
Sialidae (alder flies)			1	5
Trichoptera (caddisflies)				
Hydropsychidae			2	
Limnephilidae	36	21	20	36
Polycentropodidae			1	
Coleoptera (beetles)				
Dytiscidae (total)	2	4		2
Gyrinidae (adults)	1		4	

Table 5-2 (Continued). Stream Macroinvertebrate Collection Data – Stations 1, 5, MBER1 and MBER2.

TAXA	Station 1	Station 5	Station MBER1	Station MBER2
Haliplidae (adults)	2	2	1	
Diptera (flies)				
Chironomidae	36	6	4	11
Culicidae				4
Simuliidae	45	37	85	16
Tabanidae			1	
MOLLUSCA				
Gastropoda (snails)				
Physidae			1	
Planorbidae	3			
Pelecypoda (bivalves)				
Pisidiidae	1	3		24
Total	**218**	**183**	**250**	**150**

Table 5-3. Stream Macroinvertebrate Scores and Community Ratings – Stations 1, 5, MBER1 and MBER2

	Station 1		Station 5		Station MBER1		Station MBER2	
METRIC	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
TOTAL NUMBER OF TAXA	22	1	14	0	23	0	23	0
NUMBER OF MAYFLY TAXA	5	1	2	0	4	0	5	1
NUMBER OF CADDISFLY TAXA	1	-1	1	-1	3	0	1	-1
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	2	1
PERCENT MAYFLY COMP.	9.17	0	20.77	0	16.00	0	18.67	0
PERCENT CADDISFLY COMP.	16.51	0	11.48	0	9.20	0	24.00	0
PERCENT CONTR. DOM. TAXON	20.64	0	29.51	-1	34.00	-1	24.00	0
PERCENT ISOPOD, SNAIL, LEECH	11.47	0	30.60	-1	11.60	0	0.67	1
PERCENT SURF. AIR BREATHERS	4.59	1	3.83	1	3.60	1	6.00	0
TOTAL SCORE		**1**		**-3**		**-1**		**2**
COMMUNITY RATING	**ACCEPTABLE**		**ACCEPTABLE**		**ACCEPTABLE**		**ACCEPTABLE**	

Table 5-4. Stream Habitat Scores and Ratings – Stations 1, 5, MBER1 and MBER2.

HABITAT METRIC	Station 1 glide/pool	Station 5 glide/pool	Station MBER1 glide/pool	Station MBER2 glide/pool
Substrate and Instream Cover				
Epifaunal Substrate/Avail. Cover	10	12	16	17
Pool Substrate Characterization	10	13	16	17
Pool Variability	11	5	16	15
Sediment Deposition	12	12	17	17
Channel Morphology				
Maintained Flow Volume	8	6	9	8
Flashiness	8	5	7	8
Channel Alteration	18	9	15	18
Channel Sinuosity	17	5	16	19
Riparian and Bank Structure				
Bank Stability (L)	9	9	10	9
Bank Stability (R)	9	9	8	9
Vegetative Protection (L)	10	9	10	10
Vegetative Protection (R)	10	9	8	10
Riparian Veg. Zone Width (L)	10	8	10	10
Riparian Veg. Zone Width (R)	10	9	8	9
Total Score	**152**	**120**	**166**	**176**
Habitat Rating	**Good**	**Good**	**Excellent**	**Excellent**

L = Left bank facing downstream
R = Right bank facing downstream

Table 5-5. Stream Station Dimensions

Station	Length	Width (ft)		Depth (ft)	
		Average*	*s*	Average *	*s*
1	100	8.4 (3)	1.8	1.7 (9)	0.4
5	180	6.4 (3)	2.8	0.8 (9)	0.4
MBER1	1,000	34.7 (3)	5.6	3.1 (9)	0.5
MBER2	1,000	26.3 (3)	1.6	2.3 (9)	0.8

***sample size is indicated within ()**
***s* = standard deviation**
ft = feet

Table 5-6. Average Water Quality Parameters –Stations 1, 5, MBER1, MBER2 and Surface Water Bodies.

Station	Date	Time	Temperature °C	pH	Conductivity µS/cm	Percent Dissolved Oxygen	Dissolved Oxygen mg O_2/L	Discharge gpm
1	6/06/2015	18:30	19.7 (0.1)	6.2 (0.2)	161 (0.9)	49.0 (1.8)	4.5 (0.1)	545
5	6/07/2015	17:23	17.3 (0.1)	6.8 (0.3)	413 (0.4)	86.0 (0.6)	8.3 (0.1)	568
MBER1	6/07/2015	9:38	12.9 (0.2)	6.5 (0.2)	69 (0.8)	73.5 (1.8)	7.8 (0.2)	28,359
MBER2	6/08/2015	10:44	13.9 (0.0)	6.8 (0.4)	33 (0.1)	73.6 (1.5)	7.6 (0.2)	19,820
Lake Lory (Surface Water)	6/07/2015	12:19	17.5 (n.a.)	7.3 (n.a.)	65 (n.a.)	91.4 (n.a.)	8.8 (n.a.)	n.a.
Wetland Complex EE	6/07/2015	15:35	21.0 (n.a.)	6.6 (n.a.)	698 (n.a.)	85.5 (n.a.)	7.6 (n.a.)	n.a.

°C = degrees Celsius
µS/cm = microsiemens per centimeter
mg O_2/L = milligrams of oxygen per liter
gpm = gallons per minute
n.a. = not applicable – one sample point
standard deviation is indicated within ()

Table 5-7. Lake Lory Fish Collection Data.

		Number of Taxa by Sample Gear			
Scientific Name	**Common Name**	**Fyke Nets**	**Gill Nets**	**Boom Shocker**	**Total**
Catostomus commersonii	White sucker		4	3	7
Etheostoma caeruleum	Rainbow darter			1	1
Lepomis gibbosus	Pumpkinseed sunfish	2		1	3
Lepomis macrochirus	Bluegill	19		42	61
Micropterus dolomieui	Smallmouth bass			6	6
Micropterus salmoides	Largemouth bass			28	28
Notropis cornutus	Common shiner	1			1
Notropis crysoleucas	Golden shiner	4			4
Notropis heterolepis	Blacknose shiner	4			4
Pimephales notatus	Bluntnose minnow	9			9
Perca flavescens	Yellow perch	1	1	23	25
Pomoxis nigromaculatus	Black crappie			6	6
Total Collected by Gear		**40**	**5**	**110**	
Total Number of Fish Collected					**155**

Table 5-8. Lake Lory Fish Size.

	Length (inches)				Weight (pounds)			
Common Name	**min**	**max**	**average***	***s***	**min**	**max**	**average***	***s***
Black crappie	8.6	11.9	10.3(6)	1.5	0.31	0.84	0.58(6)	0.23
Blacknose shiner	1.5	2.6	2.1(4)	0.6	0.003	0.006	0.00(4)	0.001
Bluegill	1.4	9.1	6.4(61)	2.0	0.003	0.54	0.23(61)	0.16
Bluntnose minnow	2.0	2.8	2.5(9)	0.3	0.003	0.006	0.00(9)	0.001
Common shiner	2.6	2.6	n.a.(1)	n.a.	0.005	0.005	n.a.(1)	n.a.
Golden shiner	3.1	3.4	3.3 (4)	0.1	.008	.010	.009(4)	.001
Largemouth bass	6.9	18.7	12.6(28)	2.6	0.13	3.68	0.95(28)	0.82
Pumpkinseed sunfish	3.8	8.3	5.4(3)	2.6	0.04	0.49	0.19(3)	0.26
Rainbow darter	1.8	1.8	n.a.(1)	n.a.	0.003	0.003	n.a.(1)	n.a.
Smallmouth bass	9.1	14.0	11.9(6)	1.7	0.33	0.97	0.69(6)	0.22
White sucker	3.1	16.5	12.2(7)	5.0	0.12	1.89	1.07(7)	0.77
Yellow perch	2.7	10.6	6.6(25)	2.1	0.006	0.494	0.14(25)	0.13

*** sample size is indicated within ()**
***s* = standard deviation**
min = minimum
max = maximum
n.a. = not applicable

Table 5-9. Lake Lory Macroinvertebrates.

Order	Family	Genus	Taxa Count
Amphipoda (scuds)	Hyalellidae	*Hyalella*	13
Basommatophora (snails)	Lymnaeidae	*Stagnicola*	1
Basommatophora	Planorbidae	*Helisoma*	8
Coleoptera (beetles)	Gyrinidae	*Dineutus*	1
Coleoptera	Gyrinidae	*Gyrinus*	1
Coleoptera	Haliplidae	*Peltodytes*	4
Diptera (true flies)	Chaoboridae	*Chaoborus*	16
Diptera	Chironomidae		19
Ephemeroptera (mayflies)	Caenidae	*Caenis*	15
Ephemeroptera	Ephemerellidae	*Eurylophella*	11
Ephemeroptera	Ephemeridae	*Ephemera*	2
Ephemeroptera	Heptageniidae	*Heptagenia*	1
Mesogastropoda (snails)	Hydrobiidae	*Amnicola*	74
Odonata (damselflies and dragonflies)	Aeshnidae	*Aeshna*	1
Odonata	Coenagrionidae	*Coenagrion,Enallagma*	29
Odonata	Gomphidae	*Gomphus*	1
Trombidiformes (water mites)	Hydrachnidiae	*Hydracarina*	6
Veneroida (freshwater bivalves)	Pisidiidae	*Pisidium*	3
		Total	**206**

Table 5-10. Wetland Complex EE Macroinvertebrates.

Order	Family	Genus	Taxa Count
Basommatophora (snails)	Physidae	*Physa*	2
Coleoptera (beetles)	Dytiscidae	*Agabetes*	1
Hemiptera (true bugs)	Gerridae	*Aquarius*	1
		Total	**4**

EXHIBIT C

PHOTOGRAPHS

Photograph C-1. Station 1 – Upstream Extent. View looking south, downstream.

Photograph C-2. Station 1 – Downstream Extent. View looking west, upstream.

Photograph C-5. Station MBER1– Upstream Extent. View to east, downstream.

Photograph C-6. Station MBER1 – Downstream Extent. View to west, upstream.

Photograph C-7. Station MBER2 – Upstream Extent. View to south, downstream.

Photograph C-8. Station MBER2 – Downstream Extent. View to north, upstream.

Photograph C-9. Lake Lory. View to north.

Photograph C-10. Lake Lory. View to south.

Photograph C-11. Wetland Complex EE North of HTDF. View to northwest.

Photograph C-12. Wetland Complex EE North of HTDF. View to north.

Photograph C-13. Wetland Complex EE North of HTDF. View to east. Arrow indicates location of cracking in sediment, which may be evidence of recent dry conditions.