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Development of Site-Specific Aquatic Life Values for Total Copper for Water Bodies in the Upper Peninsula of Michigan

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List of Acronyms

AMV	Acute Maximum Value
DOC	Dissolved Organic Carbon
FCV	Final Chronic Value
MDEQ	Michigan Department of Environmental Quality
mg/L	Milligrams per liter
NOAA	National Oceanic and Atmospheric Administration
SMAV	Species Mean Acute Value
TOC	Total Organic Carbon
ug/L	Micrograms per liter
USEPA	United States Environmental Protection Agency
WER	Water Effect Ratio
WQS	Water Quality Standards
U.P.	Upper Peninsula

SECTION 1.0 COPPER ISSUES IN THE UPPER PENINSULA (U.P.) OF MICHIGAN

Figure 1. Stamp sands in the Owl Creek watershed. Photo by: Bill Taft, MDEQ.

The Keweenaw Peninsula is located in the northwestern portion of Michigan's U.P. and is known locally as "copper country" due to the extensive elemental, mass copper deposits ("native copper") throughout the area. The area has a unique, complex geology that includes a large igneous uplifted fault line that bisects the peninsula. The largest copper mining operations in the world were located along this fault line during the 19th century. Early Native Americans mined copper from small pits along the Keweenaw Fault, and the first systematic copper mining operation started in 1846 near Eagle River, Michigan. By the late 1880s, mining operations deforested most of the Keweenaw Peninsula and numerous stamp mills were constructed in the headwaters of several Keweenaw Peninsula streams for processing copper ore. The byproduct of the stamp mills' rock crushing activities was a coarse, dark aggregate called stamp sands. Extensive copper stamp sand piles are found throughout the woods, along streambeds, and the Lake Superior shoreline (Figure 1). Stamp sand deposits affect stream biota by burying in-stream habitat and leaching cupric ions into the water column. Groundwater that flows through stamps sands may also be a significant source of copper to surface water because copper ions are released from the stamp sands more readily in the acidic, anoxic conditions underground (Kotke, 2011). When the groundwater reaches surface waters, the dissolved copper remains mobile in the less stable oxygenated surface water conditions, due to dissolved organic carbon (DOC) complexes, and their ability to bind and transport dissolved copper (Ford et al., 2007). There are countless abandoned mines throughout the Keweenaw Peninsula that serve as conduits for venting groundwater that may contain high concentrations of copper.

As a result of the stamp sand deposits, there are increased water column copper concentrations in several water bodies with low hardness. Hardness affects copper toxicity because major hardness ions (calcium, magnesium) compete with copper for binding sites on the gills of aquatic life, reducing copper bioavailability and resultant toxicity. At low hardness levels, copper toxicity increases. The statewide copper water quality values address this relationship by restricting allowable copper as hardness decreases.

The statewide copper aquatic life values protect the other indigenous aquatic life and wildlife designated use. The aquatic life values protect from adverse effects resulting from chronic exposures (Final Chronic Value [FCV]) and acute exposures (Acute Maximum Value [AMV]).

Copper concentrations in several water bodies in the U.P. exceed the FCV aquatic life value. No AMV exceedances have been observed. These water bodies are listed on the Clean Water Act Section 303(d) list (Goodwin et al., 2012) and are scheduled for Total Maximum Daily Load

development. However, in many cases, the macroinvertebrate communities are meeting the biological integrity requirements of the Michigan Water Quality Standards (WQS) suggesting copper levels may not be having severe adverse impacts on macroinvertebrates. Therefore, we initiated studies in several streams in Michigan's U.P. to further investigate whether chemical water quality characteristics affect the bioavailability and toxicity of copper in these water bodies.

SECTION 2.0 OVERVIEW: WATER EFFECT RATIO (WER) DEVELOPMENT FOR U.P. COPPER-IMPACTED STREAMS

2.1 Current WQS

Michigan's Part 4 Rules, Water Quality Standards, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, include aquatic life value calculations that were to be consistent with Title 40 of the Code of Federal Regulations, Part 132, Water Quality Guidance for the Great Lakes System. At a minimum, all surface waters of the state are designated and protected for all of the following designated uses: agriculture, navigation, industrial water supply, warmwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and fish consumption (R 323.1100[1][a]-[g] of the Part 4 Rules). In addition, all surface waters of the state are designated and protected for total body contact recreation from May 1 to October 1 (R 323.1100[2]). Specific rivers and inland lakes as well as all Great Lakes and specific Great Lakes connecting waters are designated and protected for coldwater fisheries (R 323.1100[4]-[7]). Several specific segments or areas of inland waters, Great Lakes, Great Lakes bays, and connecting channels are also designated and protected as public water supply sources (R 323.1100[8]).

Aquatic life values are the water quality values used to determine attainment of the other indigenous aquatic life and wildlife designated use and warmwater and coldwater fisheries designated uses. There are two aquatic life values that are calculated to protect aquatic life in ambient waters. The AMV represents the highest concentration of a material in the ambient water column to which an aquatic community can be exposed to briefly without resulting in unacceptable effects, calculated according to the methodology specified in R 323.1057(2) of the Part 4 rules. The FCV is the level of a substance that does not allow injurious or debilitating effects in an aquatic organism resulting from repeat long-term exposure to a substance relative to the organisms lifespan, calculated using the methodology specified in R 323.1057(2). The FCV is the more conservative of the two aquatic life values.

The FCV is also the most conservative of all water quality values available for total copper. The human non-cancer values for the protection of drinking water and non-drinking water are several orders of magnitude greater than the aquatic life values. Michigan has not developed a human cancer value because copper is not a carcinogen. There is no wildlife value because copper does not bioaccumulate in fish tissue, which would result in population-level impacts to mammalian and avian wildlife populations. Copper is not a factor when determining total or partial body contact recreation, agricultural use, or navigation designated use attainment. Therefore, the FVC is protective of all designated uses.

Rule 323.1057(2)(r)(ii) allows the aquatic life values to be modified on a site-specific basis to reflect local environmental conditions. Under this rule, site-specific aquatic life values may be derived using the recalculation procedure, WER procedure, or resident species procedure described in Section 3.7 ("Site-Specific Aquatic Life Criteria") in Chapter 3 of the United States Environmental Protection Agency (USEPA) Water Quality Standards Handbook, second edition (USEPA, 1994).

The rule is consistent with federal regulations and does not preclude the use of other methods for deriving site-specific aquatic life criteria.

The current aquatic life values for copper in Michigan are expressed as a function of water hardness (expressed as calcium carbonate). Historically, data have indicated that the toxicity of dissolved metals is impacted by the cationic competition with calcium and magnesium. However, more recently, aquatic assays have shown that the toxicity of copper is also dramatically affected by other water quality parameters, such as suspended solids and DOC. Toxicity of copper dramatically decreases with increasing suspended solids and DOC (Michigan Department of Environmental Quality [MDEQ], 2007).

Under the current procedures that use hardness alone, the aquatic life values may be overly protective for some streams in the U.P. Several water bodies in the U.P. are currently on the Section 303(d) list due to exceedances of the aquatic life FCV for copper. However, macroinvertebrate communities often score acceptable or better, indicating the other indigenous aquatic life and wildlife designated use is being met when using biological condition for assessing attainment with WQS (Appendix 1). Michigan uses the principle of independent applicability when making a support determination for each designated use for each water body. If any one type of data indicates that the designated use is not supported, then generally, the water body is listed as not supporting that designated use (Goodwin et. al, 2012). An overly protective aquatic life value may be masking other factors that impact the ecological integrity of a water body such as discharges of other substances, habitat modifications, and altered hydrology.

Several copper stamp sands areas are currently being remediated in the Keweenaw Peninsula and nearby areas in the U.P. at a cost of millions of dollars per site with the ultimate goal for water bodies to meet WQS. The development of site-specific aquatic life values would allow for the establishment of WQS that reflect local water chemistry conditions and ensure cost effective restoration activities.

2.2 Studies to Develop WERs

In 2005 and 2006, the MDEQ initiated a study (MDEQ, 2007) with the Great Lakes Environmental Center to evaluate the bioavailability of copper in surface water across Michigan's U.P., and to develop a procedure for modifying the aquatic life values for copper throughout the entire region if appropriate. Water was collected from 18 stations in 17 different water bodies across the U.P. (15 rivers and streams; two lakes) for chemical analysis and site-specific WER determination using 48-hour static exposures to *Ceriodaphnia dubia*. The data indicate that copper toxicity in U.P. waters is highly dependent on DOC concentrations and is poorly correlated with water hardness, which is the water quality characteristic used in the derivation of Michigan's current aquatic life values for copper. Total suspended solids were extremely low (< 0.05 milligrams per liter [mg/L]) throughout the study area and thus were not relevant to copper toxicity. The report concludes that DOC is the only water quality characteristic of significance for adjusting the aquatic life values for copper in U.P. streams and that modification of the aquatic life values would best be achieved by linear graphic interpolation of the WER from DOC concentrations.

The MDEQ believes the studies presented in the 2007 report were well designed and that results are scientifically valid for deriving site-specific aquatic life values for copper in U.P. waters. MDEQ staff used the 2007 study's linear graphic interpolation of the Species Mean Acute Value (SMAV) WER calculated using DOC concentrations in mg/L as shown in Equation 1. Use of the SMAV WER is necessary to avoid a non-protective bias inherent to the copper aquatic life value. The

unexpected presence of toxicity-mitigating substances in lab water toxicity tests used to develop the aquatic life values caused the non-protective bias. The SMAV mitigates the bias by conceptually dividing the aquatic life value (in lab water) toxicity by the fundamental toxicity of copper in pure water. This practice is included in the USEPA's Streamlined Water-Effect Ratio Procedure for Discharges of Copper document (USEPA, 2001).

(Equation 1)

$$\text{SMAV WER} = 0.6001(\text{DOC})-0.6019$$

DOC values are expressed in mg/L.

The SMAV WER is applied to the current aquatic life values for copper in order to calculate more appropriate site-specific water quality criteria values. The site-specific FCV can be derived from Equation 2:

(Equation 2)

$$\text{Site-Specific FCV}_{(\mu g/L)} = e^{(0.8454 * \text{LN (Hardness)}-1.702)} *(\text{SMAV WER})$$

Hardness is expressed in mg/L as calcium carbonate.

Based on current data, this methodology would be only applicable for use in water bodies in the U.P. of Michigan.

Site-specific criteria are developed site-by-site. We defined a "site" based on available water quality data and landscape characteristics including geology and water body confluences. Details of site-specific WER and subsequent aquatic life value development is detailed on a watershed-by-watershed basis below.

2.3 2011 Data Collection

2.3.1 Overview

In 2011, water chemistry samples were collected from 25 stream stations in Keweenaw, Houghton, and Ontonagon Counties, Michigan (Figure 2). Monthly samples were collected from June through September 2011. Total copper, total organic carbon (TOC), DOC, and total hardness (as measured by total calcium and total magnesium ions) were measured in water samples. Results of this sampling can be found in Appendix 2.

2.3.2 Water Bodies Sampled

Many of the water bodies that were sampled are currently included on the 2012, Section 303d list because of nonattainment of the WQS for the "other indigenous aquatic life and wildlife" designated use due to exceedances of the total copper aquatic life values (Goodwin et. al, 2012). There are additional water bodies on the Section 303(d) list that are not meeting the "other indigenous aquatic life and wildlife" designated use due to exceedances of the total copper aquatic life values; however, these water bodies were not included in the 2011 sampling because remediation is planned for those water bodies and water quality samples taken in 2011 would not be representative after the remediation. Of the water bodies that were sampled, we selected the minimum number of samples needed to give a good representation of water quality throughout the impaired reach and contributing tributaries.

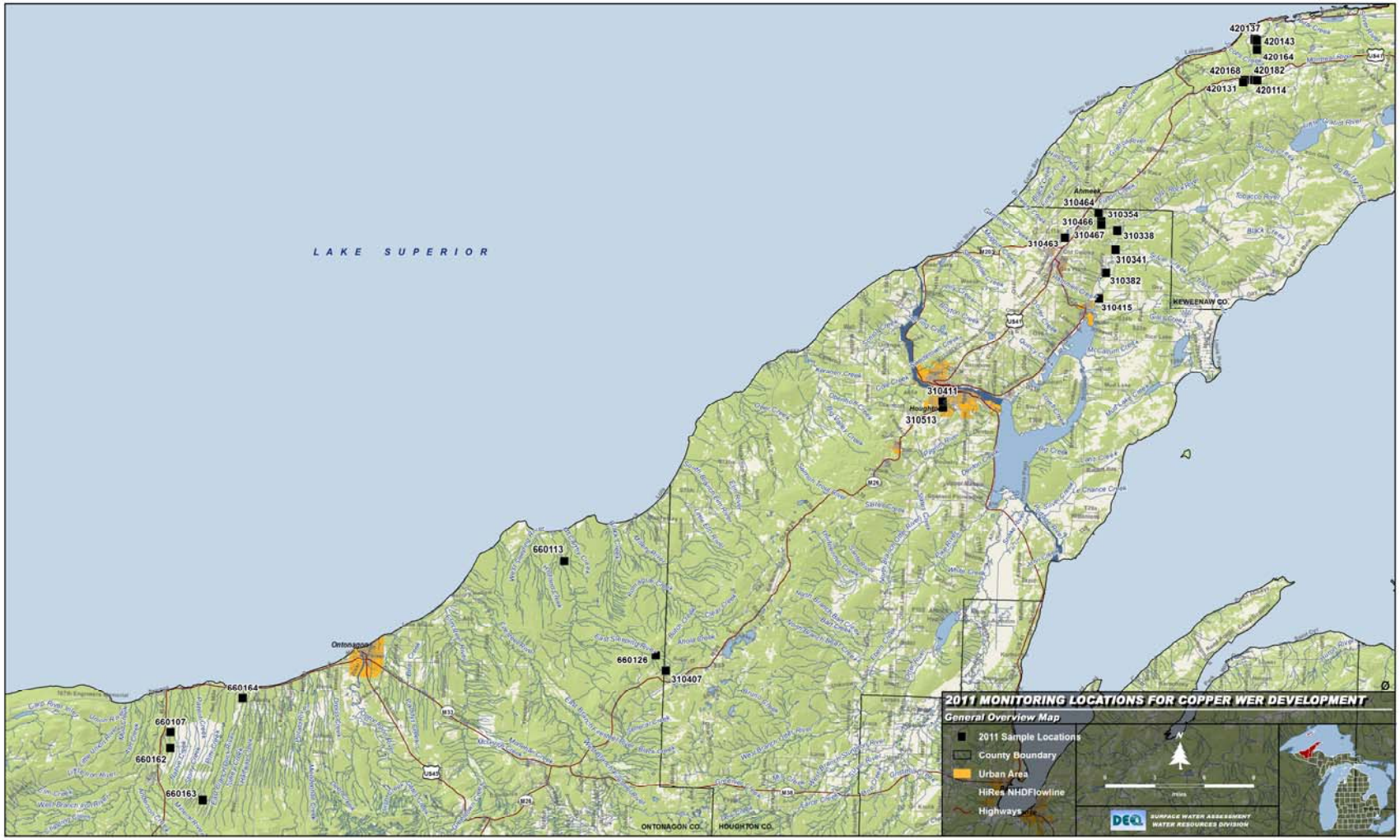

Figure 2. 2011 sampling stations for collection of water quality data to develop site-specific aquatic life values for total copper. Houghton, Keweenaw, and Ontonagon Counties, Michigan.

2.3.3 Sampling Time Frame and Frequency

A four-month sampling protocol was selected to be consistent with our current listing methodology for determining if ambient waters meet WQS. This methodology states that the geometric mean of four water samples will be compared to the water quality values to determine attainment (Goodwin et. al, 2012). Monthly sampling gave some idea of variation in water quality from late spring to early fall.

2.3.4 Parameters

Total hardness was analyzed and used to calculate total copper aquatic life values using the methodology as described in the Part 4 rules. DOC was analyzed to develop the SMAV WER using Equation 1 above. TOC was analyzed to compare with DOC levels to determine if there was a relationship between the two water quality characteristics. Historic water quality data collected in copper-impacted water bodies included analyses of TOC but not DOC.

2.3.5 TOC vs DOC

A simple regression analysis of TOC vs DOC was completed. One outlier reported a TOC number of 191 mg/L. The expected TOC values for domestic waste from weak to strong are 80-290 mg/L (Metcalf and Eddy, 1979). Therefore, the 191 mg/L number is likely an error for an ambient water measurement. Using the remaining data, including a slight outlier of 49 micrograms per liter (µg/L), a linear relationship was found with an r^2 = 0.6149 (Figure 3).

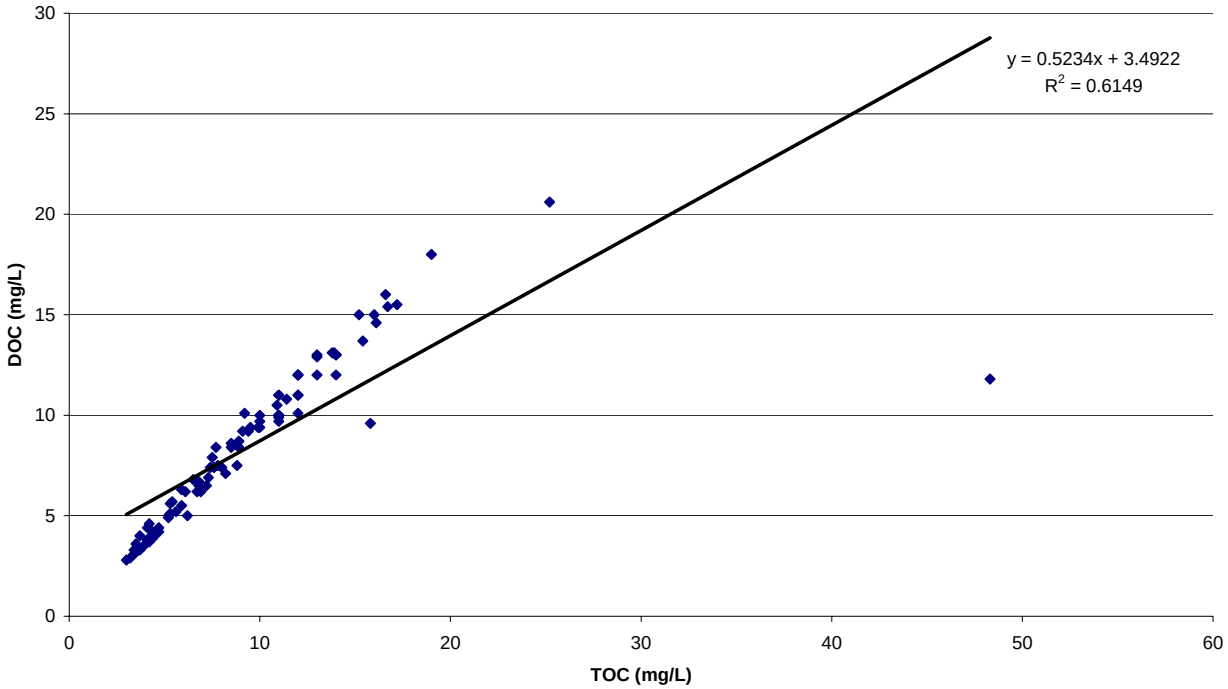

Figure 3. DOC and TOC relationship for stations sampled in Houghton, Keweenaw, and Ontonagon Counties, Michigan. June-September 2011. One Outlier Subtracted.

This relationship is based on a limited data set, with four samples collected within one year. Using National Oceanic and Atmospheric Administration (NOAA) precipitation data, it was determined that 2011 was a rather dry year with average accumulative precipitation being two to four inches below normal at the Marquette weather station (NOAA, 2012a). Using the NOAA data for the western U.P. region, the average accumulative precipitation from January to September 2011, was three inches below the average (NOAA, 2012b). TOC and DOC would be expected to be more similar during dry conditions, due to a lack of undissolved organic material reaching the stream via land runoff. The relationship found between TOC and DOC during this dry year may not hold true during a wet year. Therefore, MDEQ staff decided to only use DOC data when determining a site-specific SMAV WER. We feel that it is a conservative approach, considering our limited data set, and it is the most straightforward approach, considering the SMAV WER development equation is based on DOC rather than TOC. However, TOC data was used to predict DOC values and estimate a site-specific aquatic life value in the determination of how much of a stream segment should be defined as the "site."

2.4 Macroinvertebrate Community Data

The macroinvertebrate community and physical habitat were qualitatively assessed at several stations within copper impacted water bodies, using the Surface Water Assessment Section Procedure 51 (MDEQ, 1990 and Creal et al., 1996). Results are listed in Appendix 1.

SECTION 3.0 GENERAL PROCEDURE FOR DEVELOPING SITE-SPECIFIC CHRONIC AQUATIC LIFE VALUES

3.1 Values Used to Develop Site-Specific SMAV WER

The minimum DOC value of the four samples analyzed from each site during 2011 was used for development of the SMAV WER using Equation 1.

$$\text{SMAV WER} = 0.6001(\text{DOC})-0.6019. \qquad \text{(Equation 1)}$$

It was determined that the minimum DOC value (mg/L) would be the most conservative value for use in developing site-specific aquatic life values since data was limited (i.e., four points collected monthly from June-September 2011) and the variability of DOC values between seasons and years is unknown. If two of the four samples had the minimum DOC value, we chose the sample that had the minimum hardness value. This would be the most conservative approach since the toxicity of total copper increases as hardness decreases.

A geometric mean of all available hardness data considered representative of current conditions was used to calculate the site-specific FCV using Equation 2, consistent with standard practice.

$$\text{Site-Specific FCV}_{(\mu g/L)} = e^{(0.8454 * \text{LN (Hardness)}-1.702)} * (\text{SMAV WER}) \qquad \text{(Equation 2)}$$

Hardness is expressed in mg/L as calcium carbonate.

Geometric means are used in development of Michigan's Part 4 WQS (R 323.1057), and therefore, the resultant FCV was compared with the geometric mean of all available total copper data for a station to determine if aquatic life values are being exceeded. A minimum of four total hardness and total copper data points were available for stations sampled in 2011. Additional samples dated earlier than 2011 were included if conditions at a station were determined to be similar during the collection of historic data. Most historic data were collected between 2001 and 2010.

Total copper data were compared with the current aquatic life values to determine if total copper WQS were being met. If current aquatic life values were being met at a station, site-specific aquatic life values were not developed for the station, unless it was determined that the station should be included when defining the extent of the water body to which an upstream or downstream site-specific value would be applied. If the current aquatic life values were not being met, and DOC data was available to calculate and then apply a SMAV WER, site-specific aquatic life values were developed. In most cases, the site-specific aquatic life values were less restrictive when a SMAV WER was applied; however, in cases where the DOC was very low (e.g., 3 mg/L) the site-specific aquatic life values were more restrictive. The final step was to determine the extent of the water body to which the site-specific aquatic life value should be applied.

3.2 Determination of a Site

All stations with copper data were plotted using Arcview Geographic Information System mapping software. Stations were labeled using the USEPA's national STOrage and RETrieval (STORET) Data Warehouse. Station numbers mentioned in this report are STORET numbers. Stations meeting either the original aquatic life values or site-specific aquatic life values for copper were indicated in green; stations exceeding site-specific aquatic life values were indicated in red, stations exceeding the original aquatic life values but not having DOC data to determine site-specific aquatic life values were indicated in yellow (Example: Figure 4). Stamp sand deposits (a source of copper), poor rock piles (low grade native copper bearing waste), and wetlands (source of DOC) were also mapped. In some cases, additional sources of copper (such as old mine discharges or additional stamp sands) did not show up on maps, but staff knowledge, local hydrology, geology, and historic remediation activities aided in determining application of site-specific aquatic life values.

Decision criteria for use in determining the extent (distance of stream reach included) to which a site-specific aquatic life value was applied included:

- Availability of DOC data
- Landscape features
    - presence of wetlands that might alter DOC concentrations
    - confluences of additional water bodies that may contribute additional flow
    - changes in geology
- Water quality data (hardness, DOC, copper, TOC)

For closely-located stations within the same water body having similar water quality, and not separated by other water body confluences, the most conservative site-specific aquatic life value was used and applied to the entire stream reach. In a few cases, site-specific aquatic life values were calculated for a station that met current aquatic life values because it made more sense to include the station in the definition of the stream reach because of landscape features and water quality value than to further divide the stream reach.

Maps, summary tables of water quality data, site-specific aquatic life values, and narratives for developing site-specific aquatic life values for water bodies impacted by copper are presented in the following section.

SECTION 4.0 SITE-SPECIFIC AQUATIC LIFE VALUE DETERMINATIONS BY WATER BODY

4.1 Trap Rock River Watershed (including Slaughterhouse, Kearsarge, and Scales Creeks)

4.1.1 Watershed Description

Calumet Lake forms the headwaters of Slaughterhouse Creek. Slaughterhouse Creek flows approximately three miles before it reaches a pond that is a historic mine pond, immediately south of Copper City (Figure 4). This pond is likely fed by groundwater that travels through miles of historic mine workings. The creek then flows a little over a mile and over Queen Anne Falls to the confluence of Kearsarge Creek. Kearsarge Creek is an intermittent tributary and flows over the Keweenaw fault and through a short, deeply incised valley segment. Downstream of the Kearsarge Creek confluence, Slaughterhouse Creek continues 0.2 miles after which it meets up with and becomes Scales Creek. Scales Creek flows 1.7 miles to the confluence with the Trap Rock River. The Trap Rock River begins approximately 10 miles upstream of the confluence with Scales Creek and then flows 8 miles to Torch Lake. The watershed map and corresponding STORET locations can be found in Figure 4.

4.1.2 Site-Specific WQS

A summary of data collected and site-specific aquatic life values to be applied in the Trap Rock River watershed can be found in Table 1. Individual data points and station locations can be viewed in Appendices 2 and 3.

4.1.3 Extent of Sites

The extent of the first “site” for Slaughterhouse Creek was defined as the Calumet Lake outlet downstream to the mining pond designated in Figure 4. A site-specific aquatic life value of 62 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 310463. DOC data was not collected at the next downstream sampling station (310345). Copper data collected at this station had a geometric mean of 4 µg/L and did not exceed the current aquatic life value. However, hardness values were comparable at each station and there were no additional water body confluences between Stations 310463 and 310345 or downstream of Station 310345 until the mining pond was reached and an additional tributary joins the pond. There was no information that would suggest the DOC value would change greatly between the two stations. Therefore, the “site” was extended beyond Station 310463 to the mine pond.

The extent of the second “site” for Slaughterhouse Creek includes the mine pond downstream to the confluence of Fulton Creek (Figure 4). No additional tributaries join this short segment of stream. A site-specific aquatic life value of 7 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 310464. DOC data was not collected for Fulton or Mud Creek tributaries and it is unknown how the bogs and wetlands in their upstream reaches may impact DOC; therefore, site-specific aquatic life values were not developed for those tributaries.

The extent of the third “site” for Slaughterhouse Creek is from the confluence of Fulton Creek downstream to the confluence of Kearsarge Creek (Figure 4). A site-specific aquatic life value of 16 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 310466. This station is downstream of Queen Annie Falls and just upstream of the confluence of Kearsarge Creek. The segment was stopped at this point because of the confluence of Kearsarge Creek and because DOC concentrations are slightly lower in Kearsarge Creek.

The last portion of Slaughterhouse Creek from the confluence with Kearsarge Creek to the confluence of Scales Creek, Scales Creek from this confluence to the confluence of the Trap Rock River, and Kearsarge Creek are all combined to be considered as a “site” (Figure 4). A site-specific aquatic life value of 12 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 310338. Station 310354 on Kearsarge Creek is included in this reach and has DOC data available. A site-specific aquatic life value of 14 µg/L was calculated for that station. DOC and hardness values were similar between the two stations, and thus the most conservative site-specific aquatic life value was chosen for the entire reach to avoid unnecessarily dividing up the reach further. Total copper, total hardness, and TOC data were available at one additional station (310353) on Scales Creek. This station was just downstream of Station 310338, and thus DOC values are expected to be similar resulting in similar site-specific aquatic life values. Station 310392 on Kearsarge Creek was also sampled and the total hardness and total copper data was similar to Station 310354.

The final site-specific aquatic life value of 7 µg/L calculated for the Trap Rock River watershed was for the Trap Rock River from the confluence with Scales Creek to its confluence with Torch Lake. It does not include any of the tributaries within this reach of river. We do not have water quality data for these tributaries. The site-specific aquatic life value was calculated using the minimum DOC and geometric mean hardness values from Station 310341. Two other stations (310382 and 310415) were in this stretch of stream and a site-specific aquatic life value of 8 was calculated for each station. Total hardness, total copper, and DOC values were very similar or the same for all stations and thus the most conservative site-specific value was chosen.

Table 1. Data summary, site-specific WERs, and Aquatic Life Values to be applied to tributaries within the Trap Rock River watershed.

STORET #	Water Body Name	Station Location	TOC (mg/L) if no DOC available	**Est. DOC (mg/L)	min DOC (mg/L)	Geomean Hardness all available data (mg/L)	Original ALV (µg/L)	SMAV WER based on min DOC	ALV with WER (µg/L)	Geomean Copper all available data (µg/L)	n	Site-Specific ALV to be applied (µg/L)
310463	Slaughterhouse Creek	Calumet Lake Outlet			12	101	14	7	**62**	27	8	**62**
310345	Slaughterhouse Creek	Philipsville	9	8	Na	114	15	est. =4	**est. =42	4	5	
310464	Slaugtherhouse Creek	upstream of Fulton Creek			3	55	8	1	**7**	18	8	**7**
310466	Slaughterhouse Creek	below Queen Ann Falls			5	69	10	2	**16**	11	8	**16**
310338	Scales Creek	u/s Valley Road crossing			4	69	10	2	**12**	22	16	**12**
310353	Scales Creek	50 yds d/s Valley Road	6	6	Na	70	10	est. =3	**est. =21	25	2	
310392	Kearsarge Creek	d/s remediation site	na	na	Na	86	12	na	na	34	1	
310354	Kearsarge Creek	upstream of Slaughterhouse Creek confluence			4	80	11	2	14	46	9	
310341	Trap Rock River	Valley Road			3	57	8	1	**7**	14	12	**7**
310382	Trap Rock River	Angman Road			3	66	9	1	8	12	8	
310415	Trap Rock River	Rimfetti Road			3	69	10	1	8	14	8	

** Estimation of DOC and subsequent WER and site-specific ALV is merely for evaluation purposes. The DOC value is derived from an equation DOC=.5234(TOC)+3.4922
SMAV = Species Mean Acute Value
n = number of hardness and copper values used for geometric mean. na = not available
u/s = upstream d/s = downstream min = minimum mg/L = milligram per liter µg/L = microgram per liter
ALV = Aquatic Life Values

4.2 Owl Creek Watershed

4.2.1 Watershed Description

Owl Creek is located southwest of the village of Eagle Harbor. The headwaters of this small watershed originate near Owl Lake on a large bluff known as Petherick Hill. Owl Creek flows downhill for approximately 0.7 miles where it reaches a waterfall know as Copper Falls. The flow here is very minimal (Station 420164; Figure 5). Where it flows beyond this point is unclear. According to National Hydrography data, Owl Creek continues 0.7 miles until it reaches and flows through a large (approximately 100 acres) stamp sand deposit. The stream was observed in the stamp sand area, but was only a series of pools (Bill Taft, MDEQ, personal communication). Owl Creek then discharges to a large (approximately 48 acres) wetland complex. Another tributary with a much higher flow volume was sampled at Stations 420143 and 420137. It is thought that this water may be coming from the nearly one-mile long Owl Creek adit (a horizontal mine shaft), which drains water from the several mining areas on Penthrick Hill (CCM, 2012). This tributary flows through the large stamp sand area and then to a sand dune wetland complex. Water from this wetland complex eventually discharges to Lake Superior. National Hydrography maps estimate that Owl Creek discharges at the northeast side of Great Sand Bay (Station 420133).

4.2.2 Site-Specific WQS

A summary of data collected and site-specific aquatic life values to be applied in the Owl Creek watershed can be found in Table 2. Individual data points can be viewed in Appendices 2 and 3.

4.2.3 Extent of Sites

The extent of the first “site” for Owl Creek was defined to be from the Owl Lake outlet downstream to the base of Pentherick Hill where the bedrock geology changes to a shore-dune wetland complex (Figure 5). A site-specific aquatic life value of 12 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 420164.

The extent of the second “site” for Owl Creek was defined to be the second tributary likely flowing out of the Owl Creek adit, through the stamp sands, and to the wetland complex (Figure 5). A site-specific aquatic life value of 21 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 420143. DOC data was also collected at the next downstream sampling station (420137) located directly in the center of the stamp sand deposit. The resultant site-specific aquatic life value is 23 µg/L. Total hardness and DOC values were similar between these two stations and thus the most conservative site-specific aquatic life value was chosen.

Table 2. Data summary, site-specific WERs, and Aquatic Life Values to be applied to tributaries within the Owl Creek watershed.

STORET #	Water Body Name	Station Location	TOC (mg/L) if no DOC available	**Est. DOC (mg/L)	min DOC (mg/L)	Geomean Hardness all available data (mg/L)	Original ALV (µg/L)	SMAV WER based on min DOC	ALV with WER (µg/L)	Geomean Copper all available data (µg/L)	n	Site-Specific ALV to be applied (µg/L)
420164	Owl Creek	Copper Falls			4	65	9	2	**12**	20	8	**12**
420143	Owl Creek	u/s edge of stamp sands			8	49	7	4	**21**	103	8	**21**
420137	Owl Creek	in stamp sands			7	65	9	4	23	108	7	
420172	Owl Creek	Marsh area downstream of stamp sand deposit	12	9	na	57	8	** est.= 5	** est.= 28	137	2	**NA**

** Estimation of DOC and subsequent WER and site-specific ALV is merely for evaluation purposes. The DOC value is derived from an equation DOC=.5234(TOC)+3.4922
SMAV = Species Mean Acute Value
n = number of hardness and copper values used for geometric mean. na = not available NA = not applicable
u/s = upstream min = minimum mg/L = milligram per liter µg/L = microgram per liter
ALV = Aquatic Life Values

4.3 East Sleeping River Watershed (includes Sleepy Creek and Red Creek)

4.3.1 Watershed Description

Sleepy Creek and the East Sleeping River are located in Ontonagon County, northeast of the city of Ontonagon and south of the city of Houghton (Figure 6). Sleepy Creek is a tributary to the East Sleeping River. Sleepy Creek is joined by Red Creek just upstream of the confluence with the East Sleeping River. The Winona Mine operated near the headwaters of Red Creek and historic stamp sands are located in an unnamed tributary of Red Creek. Both the unnamed tributary and Red Creek are intermittent streams. Stations sampled in 2011 in this watershed include Sleepy Creek at Sleepy Dam Road (310407), one station on Sleepy Creek just downstream of the confluence of Red Creek (660126), and one station on the East Sleeping River several miles downstream accessible by a snowmobile trail (660113).

4.3.2 Site-Specific WQS

A summary of data collected and site-specific aquatic life values to be applied in the East Sleeping River watershed can be found in Table 3. Individual data points can be viewed in Appendices 2 and 3.

Table 3. Data summary, site-specific WERs, and Aquatic Life Values to be applied to tributaries within the Sleepy Creek and East Sleeping River watershed.

STORET #	Water Body Name	Station Location	min DOC (mg/L)	Geomean Hardness all available data (mg/L)	Original ALV (µg/L)	SMAV WER based on min DOC	ALV with WER (µg/L)	Geomean Copper all available data (µg/L)	n	Site-Specific ALV to be applied (µg/L)
660126	Sleepy Creek	dowstream Red Creek	3	73	10	1	**9**	30	4	**9**
660113	East Sleeping River	Snowmobile Trail	6	87	12	3	**25**	13	4	**25**

SMAV = Species Mean Acute Value
n = number of hardness and copper values used for geometric mean
min = minimum mg/L = milligram per liter µg/L = microgram per liter
ALV = Aquatic Life Values

4.3.3 Extent of Sites

The extent of the first "site" for the headwaters of the East Sleeping River was defined to be from the headwaters of Red Creek downstream to the confluence of Sleepy Creek. This includes a small section of the East Sleeping River (Figure 6). A site-specific aquatic life value of 9 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 660126.

The extent of the second "site" for the East Sleeping River was defined to be from the confluence with Lake Superior upstream to the confluence of Sleepy Creek (Figure 6). A site-specific aquatic life value of 25 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 660113. Access to the East Sleeping River is limited due to its remoteness and lack of roads within the lower part of the watershed. If water quality data are collected in the future between the current stations, the length of reach to which the site-specific criteria apply may be modified.

4.4 Portal Creek

4.4.1 Watershed Description

Portal Creek is a small creek located in Ontonagon County, southwest of the city of Ontonagon, near the village of White Pine, and east of Porcupine State Park (Figure 7). It flows along the western edge of the White Pine Mine tailings basins, which was operated by the Copper Range Company and closed in 1995. Stations sampled in this watershed include two stations on Portal Creek. One is at the confluence of the Mineral River (Station 660107) and the second is further upstream (Station 660162). The flows in Portal Creek are very low during the summer months and it likely becomes intermittent at the lowest flows. The soils in this watershed are mostly dark red lacustrine clay. This clay soil is generally impervious and allows surface runoff to quickly reach the streams causing them to be turbid, warm, and intermittent (Taft, 1999). The fine particles are easily suspended when disturbed. As of 2008, beaver ponds have impounded the upper portions of the watershed (Taft et al., 2011).

4.4.2 Site-Specific WQS

A summary of data collected and site-specific aquatic life values to be applied in the Portal Creek watershed can be found in Table 4. Individual data points can be viewed in Appendices 2 and 3.

Table 4. Data summary, site-specific WERs, and Aquatic Life Values to be applied to tributaries within the Portal Creek watershed.

STORET #	Water Body Name	Station Location	min DOC (mg/L)	Geomean Hardness all available data (mg/L)	Original ALV (µg/L)	SMAV WER based on min DOC	ALV with WER (µg/L)	Geomean Copper all available data (µg/L)	n	Site-Specific ALV to be applied (µg/L)
660107	Portal Creek	Confluence with Mineral River	10	181	22	5	**84**	25	5	**84**
660162	Portal Creek	Upper road crossing near tailings basin	13	190	23	7	**116**	25	5	

SMAV = Species Mean Acute Value
n = number of hardness and copper values used for geometric mean
min = minimum mg/L = milligram per liter µg/L = microgram per liter
ALV = Aquatic Life Values

4.4.3 Extent of Sites

All of Portal Creek from its headwaters to its confluence with the Mineral River is considered as one "site" when developing site-specific aquatic life values (Figure 7). An aquatic life value of 84 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 660107. Total hardness, DOC, and total copper information were collected from the upstream station (660162) and were similar to the downstream station (660107) and there were no hydrologic connections between the two stations. The more conservative site-specific aquatic life value was chosen for the entire reach.

4.5 Huron Creek Watershed

4.5.1 Watershed Description

Huron Creek is a small watershed (3.4 square miles) located primarily in the city of Houghton and Portage Township (MTU, 2009) (Figure 8). It is located in a growing retail development area. The headwaters begin in wetland and pond drainage areas that had historic deposits of stamp sands. The entire channel in the upper portion of the watershed was relocated in 2005 for retail expansion (Kohlhepp et al., 2007). The relocation has caused changes in the drainage patterns and the amount of storm water flowing to the channel. At one point, the bedrock was fractured, and the stream was lost underground for a distance before it resurfaced. In 2006, several plumes of iron bacteria were observed upstream of Sharon Road (Station 310411) where venting groundwater from a buried landfill appeared to be reaching the creek (Kohlhepp et al., 2007). In 2006, the city of Houghton installed a groundwater collection system to mitigate the impacts caused by the contaminated venting groundwater. The collection system directs the landfill drainage to the local Wastewater Treatment Plant. The effectiveness of this system has not yet been determined. Huron Creek continues to flow north from Sharon Road for approximately 0.5 miles to the Portage River. One additional water chemistry monitoring station (310513), which is located upstream of Razorback Road, was sampled on Huron Creek.

4.5.2 Site-Specific WQS

A summary of data collected and site-specific aquatic life values to be applied in the Huron Creek watershed can be found in Table 5. Individual data points can be viewed in Appendices 2 and 3. Only data from 2011 was used in development of site-specific aquatic life values due to uncertainty of timing of mitigation activities with former sampling in the watershed.

Table 5. Data summary, site-specific WERs, and Aquatic Life Values to be applied within the Huron Creek watershed.

STORET #	Water Body Name	Station Location	min DOC (mg/L)	Geomean Hardness all available data (mg/L)	Original ALV (µg/L)	SMAV WER based on min DOC	ALV with WER (µg/L)	Geomean Copper all available data (µg/L)	n	Site-Specific ALV to be applied (µg/L)
310513	Huron Creek	Upstream of Razorback Rd.	8	123	16	4	**47**	12	4	**32**
310411	Huron Creek	Sharon Rd.	5	153	19	2	**32**	39	4	

SMAV = Species Mean Acute Value
n = number of hardness and copper values used for geometric mean
min = minimum mg/L = milligram per liter µg/L = microgram per liter
ALV = Aquatic Life Values

4.5.3 Extent of Sites

Huron Creek from the confluence with the Portage River upstream to its headwaters is defined as a site (Figure 8). A site-specific aquatic life value of 32 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 310411. DOC and hardness data were collected at the upstream sampling station (310513) and a site-specific aquatic life value of 47 µg/L was calculated. The hardness data was slightly different between stations and the DOC value was higher at the upstream station. However, there are no additional water bodies joining Huron Creek, it has uniform land use throughout (urban), and it is a small water body (approximately

3.0 river miles), with average width and depth of 6 feet and 0.5 feet, respectively; therefore, the most conservative site-specific aquatic life value was applied.

4.6 East Branch Eagle River Watershed

4.6.1 Watershed Description

The Eagle River watershed is located in Keweenaw County. It has two large branches (East and West) that flow from the northeast and southwest, respectively, along the Cliff Hills escarpment (MDEQ, 2007) and meet the main branch near the historic mining village of Phoenix. The headwaters of the East Branch begin at a beaver pond. It then flows southwest for 6.5 miles before joining the Eagle River. The Central Mine operated near the village of Central. The East Branch Eagle River was dammed and used to dispose of processed copper ore (i.e., stamp sands). The river flowed through a large deposit of stamp sands before remediation. Remediation activities occurred upstream and downstream of Gratiot Lake Road. Stations sampled in 2011 in this watershed include one station upstream of the stamp sands area (420114), one at Gratiot Lake Road (420182), one 0.6 miles downstream of Gratiot Lake Road (420168), and one on Buffalo Creek (420131), which is a tributary to the East Branch Eagle River (Figure 9).

4.6.2 Site-Specific WQS

A summary of data collected and site-specific aquatic life values to be applied in the East Branch Eagle River watershed can be found in Table 6. Individual data points can be viewed in Appendices 2 and 3.

4.6.3 Extent of Sites

The extent of the “site” for the East Branch Eagle River was defined to be from the headwaters of downstream to the confluence of Buffalo Creek (Figure 9). A site-specific aquatic life value of 29 µg/L was calculated for this stretch of stream using the minimum DOC and geometric mean hardness values from Station 420168. A site-specific aquatic life value of 32 µg/L was calculated for Station 420114. A site-specific aquatic life value of 35 µg/L was calculated for the Gratiot Road crossing station (420182). Total hardness and DOC values varied between these sites; however, the overall resultant site-specific aquatic life values were very similar and there are no additional tributaries joining the East Branch Eagle River between these three stations, so we selected the most conservative site-specific aquatic life value.

SECTION 5.0 CONCLUSION

The MDEQ plans to modify the original aquatic life values for total copper with site-specific aquatic life values using the procedures noted above in selected water bodies throughout the U.P. of Michigan. Currently, site-specific aquatic life values are calculated for water bodies not meeting current aquatic life criteria. Site-specific criteria will be used when appropriate.

Following R 323.1057(2)(r), the site-specific aquatic life values modifications were based on sound scientific rationale. The site-specific aquatic life values are protective of all designated uses because they are based on the most conservative of all water quality values available for total copper (a site-specific FCV; see page 2). They will not jeopardize the continued existence of endangered or threatened species listed under Section 4 of the Endangered Species Act, nor will they result in the destruction or adverse modification of the species’ critical habitat. Currently, the Hine’s Emerald dragonfly (*Somatochlora hineana*) is the only federally endangered or threatened

aquatic species found in the U.P. of Michigan. This dragonfly has only been found in two counties (Mackinac and Menominee) in the southern U.P. and has not been found in areas that have copper aquatic life value exceedances. The aquatic life toxicity database used to derive the current aquatic life values for copper includes toxicity data for 43 genera, but does not include toxicity data for dragonflies. However, the toxicity data for midges, damselflies, caddisflies, and stoneflies are ranked 26th, 40th, 41st, and 43rd in magnitude suggesting that insects are less sensitive to the effects of copper than many of the other species used to derive criteria (Dennis Bush, MDEQ, personal communication).

Table 6. Data summary, site-specific WERs, and Aquatic Life Values to be applied within the East Branch Eagle River watershed.

STORET #	Water Body Name	Station Location	TOC (mg/L) if no DOC available	**Est. DOC (mg/L)	min DOC (mg/L)	Geomean Hardness all available data (mg/L)	Original ALV (µg/L)	SMAV WER based on min DOC	ALV with WER (µg/L)	Geomean Copper all available data (µg/L)	n	Site-Specific ALV to be applied (µg/L)
420209	Eagle River, East Branch	CM-1-1	16	12	na	51	8	**est.=7	**** est. =34**	23	1	
420210	Eagle River, East Branch	CM-1-2	16	12	na	54	8	**est.=7	****est =36**	16	1	
420211	Eagle River, East Branch	CM-1-2	13	10	na	77	11	**est.=6	****est =42**	79	1	**29**
420114	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)			13	42	6	7	**32**	3	16	
420182	Eagle River, East Branch	Gratiot Lake Road (ER-C)			10	66	9	5	**35**	17	18	
420168	Eagle River, East Branch	Site F(ER-F) (SS 4)			8	71	10	4	**29**	111	17	

** Estimation of DOC and subsequent WER and site-specific ALV is merely for evaluation purposes. The DOC value is derived from an equation DOC=.5234(TOC)+3.4922
SMAV = Species Mean Acute Value CM=Central Mine
n = number of hardness and copper values used for geometric mean. na = not available
u/s = upstream min = minimum mg/L = milligram per liter µg/L = microgram per liter
ALV = Aquatic Life Values

SECTION 6.0 REFERENCES

CCM, 2012. Copper Country Explorer. http://www.coppercountryexplorer.com. Copper County Media, LLC. Calumet, Michigan.

Creal, W., S. Hanshue, S. Kosek, M. Oemke, and M. Walterhouse. 1996. Update of GLEAS Procedure 51 Metric Scoring and Interpretation. MDEQ Staff Report. MI/DEQ/SWQ-96/068. Revised May 1998.

Edly, K. 2012. A Biological Survey of Select Locations in the Trap Rock and Eagle River Watersheds, Houghton and Keweenaw Counties, Michigan. June 2007. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WRD-12/027.

Ford R.G., R.T. Wilkin, and R.W. Puls. 2007. "Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 2" (online), EPA/600/R07/140 October 2007. Available: http://www.epa.gov/nrmrl/pubs/600R07140/600R07140.pdf. July 26, 2010.

Goodwin, K., S. Noffke, J. Smith. 2012. Water Quality and Pollution Control in Michigan: 2012 Sections 303(d) and 305(b) Integrated Report. MI/DEQ/WB-12/001.

Kohlhepp. G., K. Edly, and W. Taft. 2007. A Biological Survey of Lake Superior Tributaries from the Keweenaw Peninsula to the Carp River: Baraga, Houghton, Iron, Marquette, and Ontonagon Counties, Michigan. June-August, 2006. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WB-07/080.

Kotke, C. 2011. Geological Investigation at Central Mines 31, 31.5, and 32 Stamp Sand Remediation Project. East Branch Eagle River, Keweenaw County, Michigan. August and October 2010. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WRD-11/025.

MTU. 2009. The Huron Creek Watershed Management Plan. Center for Water and Society. Department of Civil and Environmental Engineering. Michigan Technological University. Houghton, Michigan.

MDEQ. 1990. Surface Water Assessment Section Procedure 51 - Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers, April 24, 1990. Revised June 1991, August 1996, January 1997, May 2002, and December 2008.

MDEQ. 2007. Development of a Copper Criteria Adjustment Procedure for Michigan's Upper Peninsula Waters. Prepared by Great Lakes Environmental Center for the MDEQ. Lansing, Michigan. Report # MI/DEQ/WB-07/001.

Metcalf and Eddy Inc. 1979. Wastewater Engineering: Treatment/Disposal/Reuse, 2nd Ed. P. 64, Table 3-5. McGraw-Hill Inc. Boston.

Noffke, S.T. 2012. Biological Survey of the Keweenaw Watershed Group in Baraga, Houghton, Keweenaw, Marquette, and Ontonagon Counties. June and August 2011. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WRD-12/018.

NOAA 2012a http://www.crh.noaa.gov/images/mqt/KMQT2011plot.png.

NOAA, 2012b. http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=pcp&month=9&year=2011&filter=ytd&state=20&div=1.

Rathbun, J. 2010. Prerestoration data from the Central Mines #1 and #2 Stamp Sand Remediation Project East Branch Eagle River, Keweenaw County, Michigan. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WB-10/015.

Taft, W., K. Edly, M. Wesener, and S. Wright. 2011. A Biological Survey of the Ontonagon, Presque Isle, Iron, Montreal, and Upper Wisconsin River Watersheds and Other Selected Nonbasin Year Watersheds. Gogebic, Houghton, Iron, and Ontonagon Counties, Michigan. June 2008. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WRD-11/023.

Taft, W. and M. Wesener. 2009. A Biological Survey of Huron Creek. Houghton County, Michigan. June 14, 2007 and June 21, 2008. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WB-09/037.

Taft, W. 2004. A Biological Survey of Selected Streams within the Presque Isle, Black, Montreal, and Western Lake Superior Coastal Watersheds. Ontonagon and Gogebic Counties, Michigan. June 2003. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/WD-04/064

Taft, W. 2002a. A Biological Survey of Selected Tributaries Located North of the Portage Ship Canal Along the Keweenaw Peninsula. Houghton and Keweenaw Counties. June 6, 2000 and June 18-27, 2001. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/SWQ-02/005.

Taft, W. 2002b. A Biological Survey of Selected Water Bodies Located on the Keweenaw Peninsula South of the Portage Ship Canal. Houghton, Ontonagon, and Baraga Counties. June 18-27, 2001. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/SWQ-02/122.

Taft, W. 1999. A Biological Survey of Selected Coastal Lake Superior Tributaries in Western Ontonagon and Gogebic Counties, June and July 1998. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DEQ/SWQ-99/087.

Taft, W. 1992. A Biological Survey of the Trap Rock River and its Tributaries, July 29-10, 1991. Houghton County, Michigan. MDEQ, Water Resources Division. Lansing, Michigan. Report #MI/DNR/SWQ-92/040.

USEPA. 2001. Streamlined Water-Effect Ratio Procedure for Discharges of Copper. United States Environmental Protection Agency. EPA-822-R-01-005.

USEPA. 1994. Interim Guidance on Determination and Use of Water-Effect Ratios for Metals. United States Environmental Protection Agency. EPA-823-B-94-001.

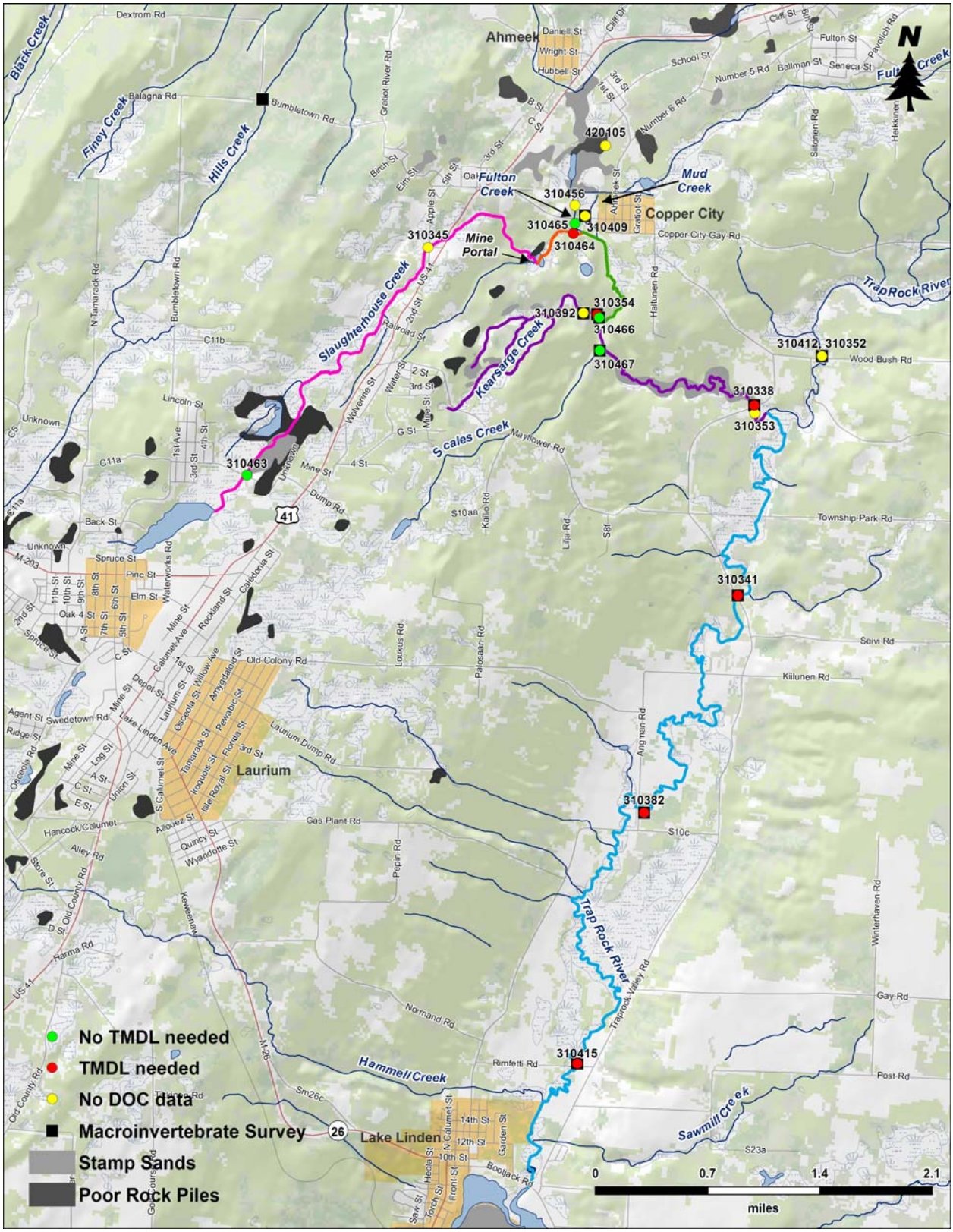

Figure 4. Trap Rock River watershed sampling stations for collection of water quality and macroinvertebrate community data to develop site-specific aquatic life values for total copper. Houghton County, Michigan.

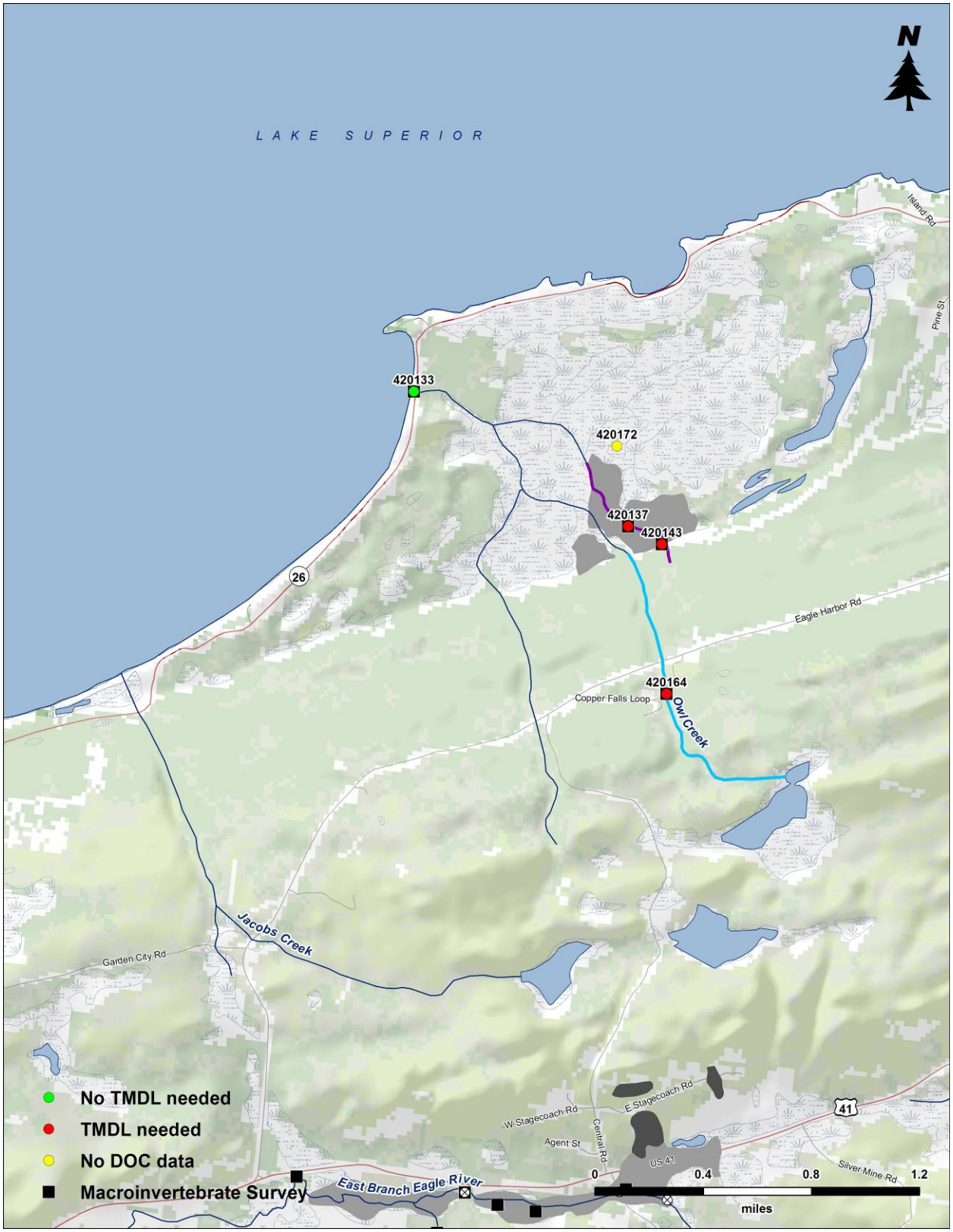

Figure 5. Owl Creek watershed sampling stations for collection of water quality and macroinvertebrate community data to develop site-specific aquatic life values for total copper. Keweenaw County, Michigan.

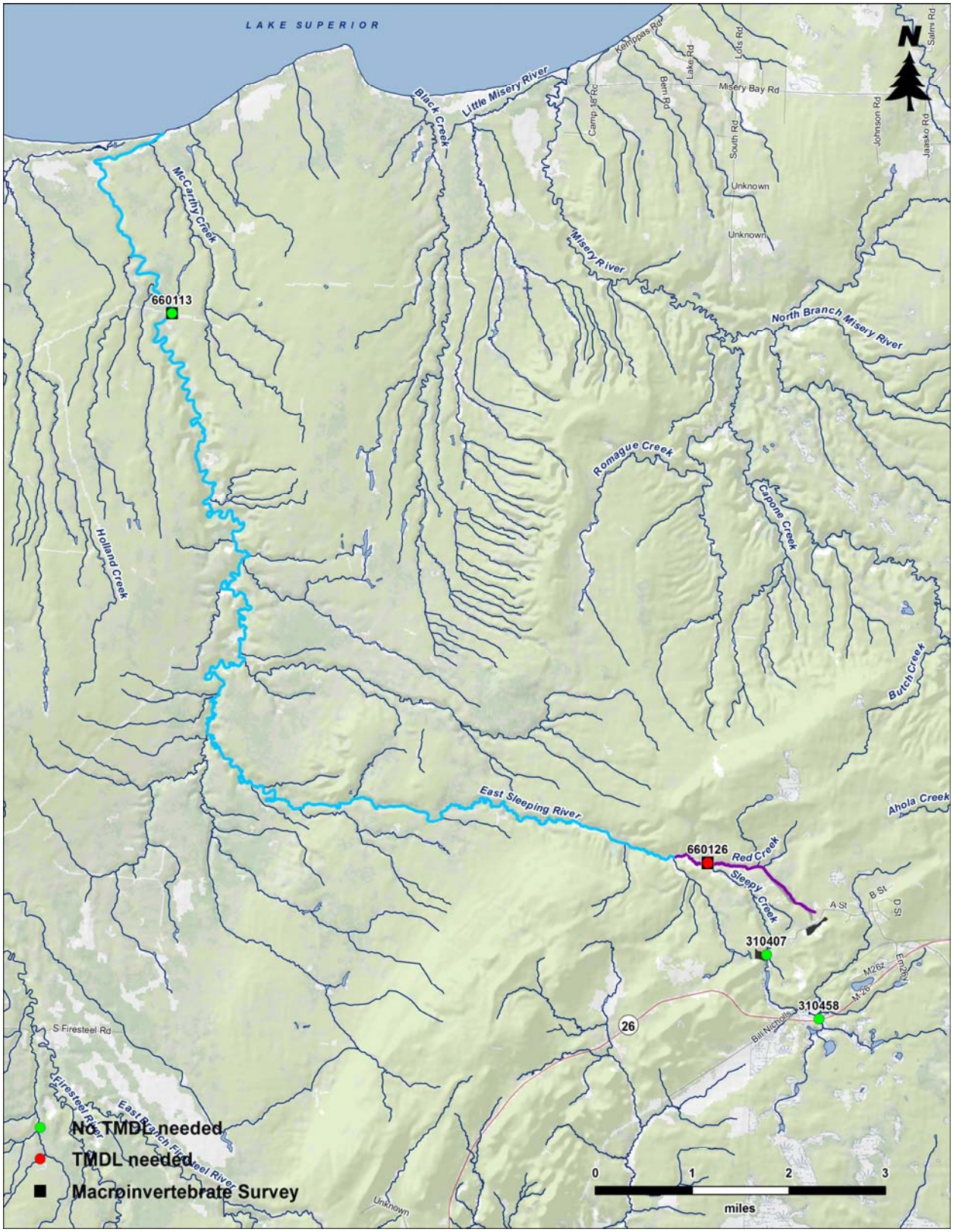

Figure 6. East Sleeping River watershed sampling stations for collection of water quality and macroinvertebrate community data to develop site-specific aquatic life values for total copper. Houghton and Ontonagon Counties, Michigan.

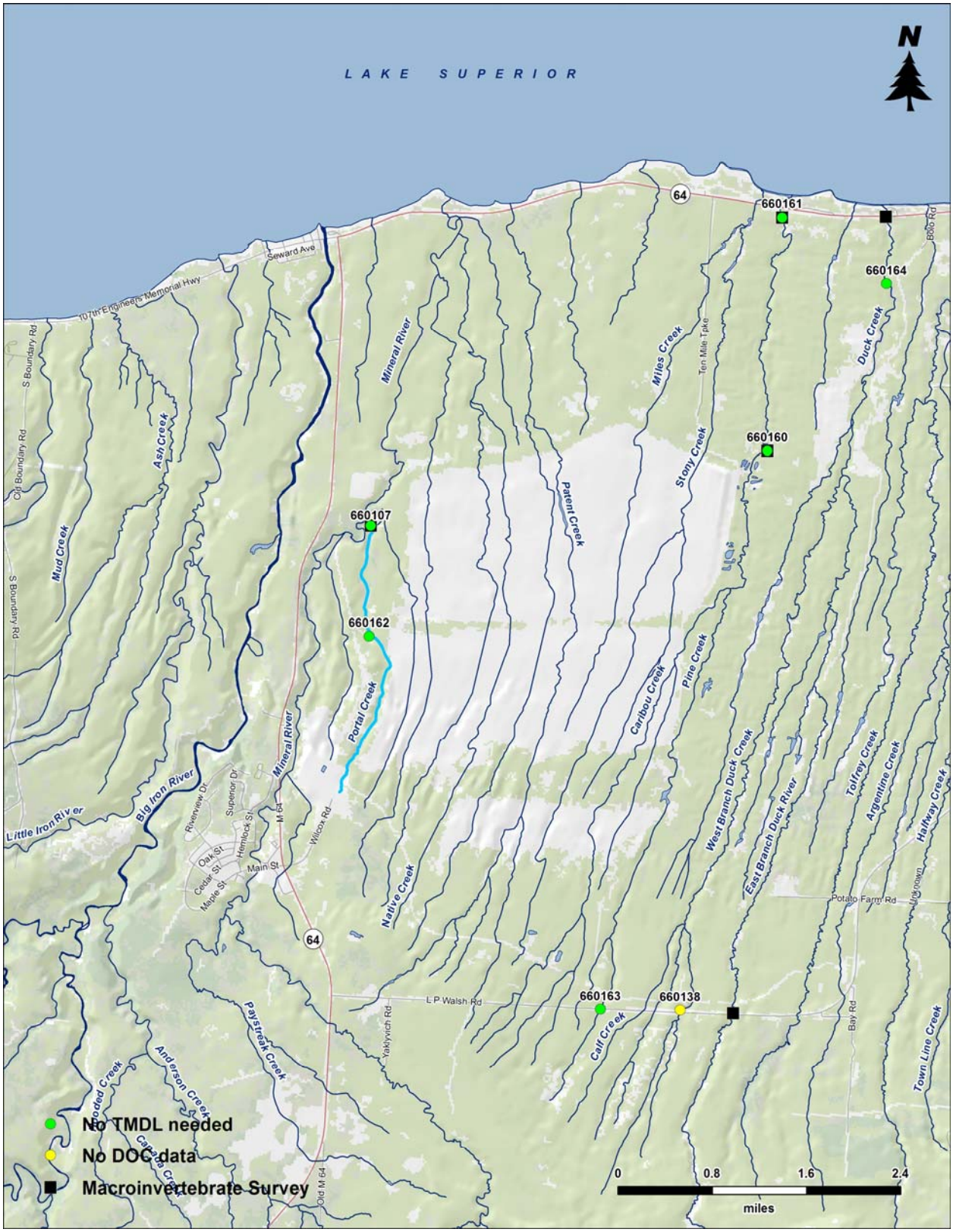

Figure 7. Portal Creek watershed sampling stations for collection of water quality and macroinvertebrate community data to develop site-specific aquatic life values for total copper. Ontonagon County, Michigan.

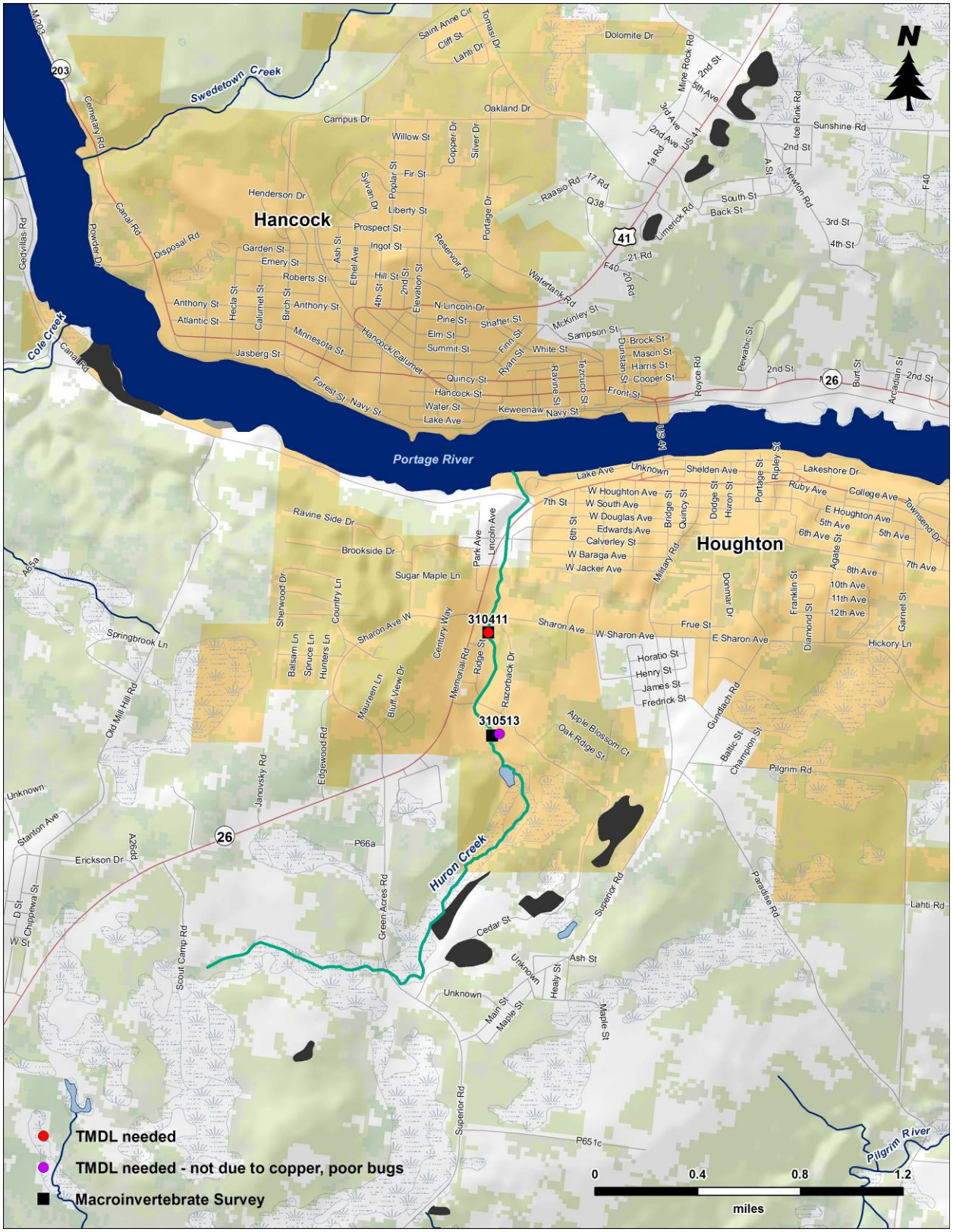

Figure 8. Huron Creek watershed sampling stations for collection of water quality and macroinvertebrate community data to develop site-specific aquatic life values for total copper. Houghton County, Michigan.

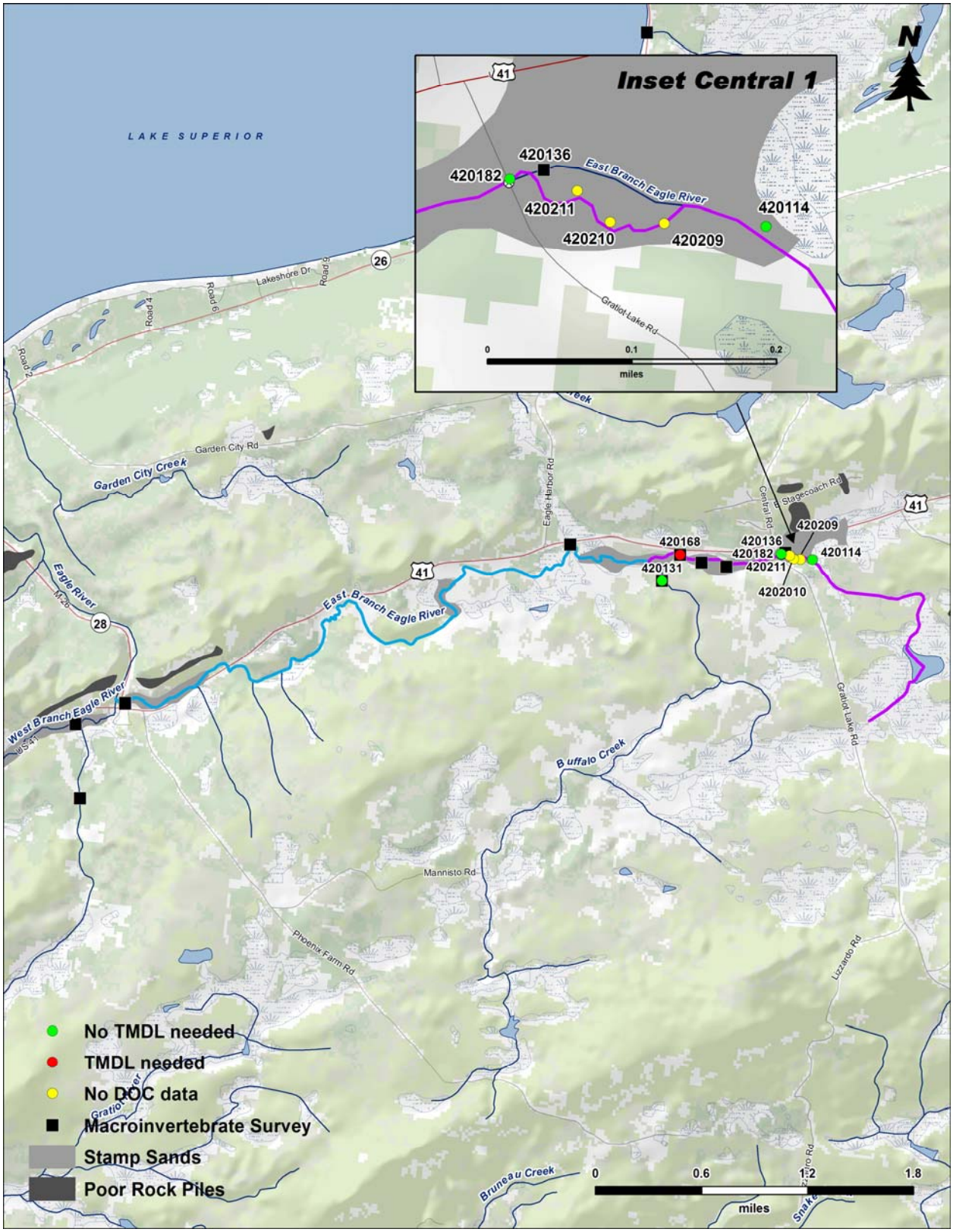

Figure 9. East Branch Eagle River watershed sampling stations for collection of water quality and macroinvertebrate community data to develop site-specific aquatic life values for total copper. Keweenaw County, Michigan.

Appendix 1. Macroinvertebrate community data collected by the MDEQ in copper-impacted streams in the Keweenaw Peninsula area Michigan (1991-2011).

AUID	Storet #	Water Body Name	Station Location	Date Sampled	P-51 Rating and Score	Report #
040201030303-11	310345	Slaughterhouse Creek	Philipsville	6/27/2001	Excellent (+6)	MI/DEQ/SWQ-02/005
040201030303-11	310345	Slaughterhouse Creek	Philipsville	7/29/1991	Good	MI/DEQ/SWQ-92/040
040201030303-08	310466	Slaughterhouse Creek	below QA Falls	6/16/2006	Excellent (+7)	MI/DEQ/WB-07/080
040201030303-08	310466	Slaughterhouse Creek	below QA Falls	7/29/1991	Good	MI/DEQ/SWQ-92/040
040201030303-09	310409	Mud Creek	Copper City	6/20/2006	Acceptable (+2)	MI/DEQ/WB-07/080
040201030303-08	310354	Kearsarge Creek	upstream of confluence of Slaughterhouse Creek	6/16/2006	Acceptable (+1)	MI/DEQ/WB-07/080
040201030303-08	310354	Kearsarge Creek	upstream of confluence of Slaughterhouse Creek	6/16/2011	Acceptable (+2)	MI/DEQ/WRD-12/018
040201030303-08	310354	Kearsarge Creek	upstream of confluence of Slaughterhouse Creek	7/29/1991	Poor	MI/DEQ/SWQ-92/040
040201030303-08	310392	Kearsarge Creek	downstream remediation site	6/6/2000	Acceptable (+2)	MI/DEQ/SWQ-02/005
040201030303-12	310467	Scales Creek	upstream Slaughterhouse Creek	6/13/2007	Excellent (+7)	MI/DEQ/WRD-12/027
040201030303-08	310353	Scales Creek	upstream Valley Road crossing	7/30/1991	Fair	MI/DEQ/SWQ-92/040
040201030303-08	310338	Scales Creek	50 yds downstream Valley Road	6/16/2006	Acceptable (+4)	MI/DEQ/WB-07/080
040201030303-08	310338	Scales Creek	50 yds downstream Valley Road	6/22/2001	Acceptable (0)	MI/DEQ/SWQ-02/005
040201030303-04	310412	Trap Rock River	Wood Bush Road	7/30/1991	Good	MI/DEQ/SWQ-92/040
040201030303-05	310341	Trap Rock River	Valley Road crossing (W)	7/30/1991	Good	MI/DEQ/SWQ-92/040
040201030303-05	310382	Trap Rock River	Angman Road	6/26/2001	Acceptable (+4)	MI/DEQ/SWQ-02/005
040201030303-05	310415	Trap Rock River	Rimfetti Road	6/15/2011	Excellent (+6)	MI/DEQ/WRD-12/018
040201030405-06	420133	Owl Creek	Lake Superior (W)	6/17/2006	Acceptable (+1)	MI/DEQ/WB-07/080
040201030405-06	420137	Owl Creek	stamp sands	6/14/2006	Acceptable (-2)	MI/DEQ/WB-07/080
040201030405-06	420143	Owl Creek	upstream Stamp sands	6/17/2006	Acceptable (+4)	MI/DEQ/WB-07/080
040201030405-06	420164	Owl Creek	Copper Falls (Loop Road)	6/14/2011	Acceptable (0)	MI/DEQ/WRD-12/018
040201030107-03	660126	Sleepy Creek	below Red Creek	7/10/2006	Acceptable (+4)	MI/DEQ/WB-07/080
040201030107-01	660113	East Sleeping River	Snowmobile Trail	6/25/2001	Acceptable (+2)	MI/DEQ/WD-02/122
040201010107-02	660107	Portal Creek	CC1 (mouth confluence with Mineral River)	6/21/2008	Acceptable (-3)	MI/DEQ/WRD-11/023

Appendix 1. Macroinvertebrate community data collected by the MDEQ in copper-impacted streams in the Keweenaw Peninsula area Michigan (1991-2011).

AUID	Storet #	Water Body Name	Station Location	Date Sampled	P-51 Rating and Score	Report #
040201010108-NA	660160	Pine Creek	NE #2 Tailing Basin	6/21/2008	Acceptable (2)	MI/DEQ/WRD-11/023
040201010108-NA	660161	Pine Creek	Upstream M-64 (Lower)	6/22/2008	Acceptable (1)	MI/DEQ/WRD-11/023
040201010109-NA	660168	Duck Creek	M-64	6/25/2008	Acceptable (-1)	MI/DEQ/WRD-11/023
040201010109-NA	660171	Duck Creek	LP Walsh Rd.	6/24/2008	Acceptable (0)	MI/DEQ/WRD-11/023
040201030307-10	310410	Huron Creek	Ming Garden	6/17/2011	Poor (-5)	MI/DEQ/WRD-12/018
040201030307-10	310410	Huron Creek	Ming Garden	6/21/2008	Acceptable (-4)	MI/DEQ/WB-09/037
040201030307-10	310410	Huron Creek	Ming Garden	6/14/2007	Acceptable (-4)	MI/DEQ/WB-09/037
040201030307-10	310411	Huron Creek	Sharon Road	6/17/2011	Acceptable (-4)	MI/DEQ/WRD-12/018
040201030307-10	310411	Huron Creek	Sharon Road	6/21/2008	Poor (-7)	MI/DEQ/WB-09/037
040201030307-10	310411	Huron Creek	Sharon Road	6/14/2007	Poor (-5)	MI/DEQ/WB-09/037
040201030404-01	420136	Eagle River, East Branch	upstream Gratiot Lake Road (Reach B)	6/16/2006	Acceptable (0)	MI/DEQ/WB-07/080
040201030404-01	420136	Eagle River, East Branch	upstream Gratiot Lake Road (Reach B)	6/13/2011	Acceptable (-2)	MI/DEQ/WRD-12/018
040201030404-02	420131	Buffalo Creek	Snowmobile trail	6/14/2006	Excellent (+7)	MI/DEQ/WB-07/080
040201030404-02	420131	Buffalo Creek	Upstream of snowmobile bridge	6/13/2011	Excellent (6)	MI/DEQ/WRD-12/018
040201030404-01	420169	Eagle River, East Branch	Site D	6/12/2007	Acceptable (0)	MI/DNRE/WB-10/015 & MI/DEQ/WRD-12/027
040201030404-01	420170	Eagle River, East Branch	Site E	6/12/2007	Acceptable (+1)	MI/DNRE/WB-10/015 & MI/DEQ/WRD-12/027
040201030404-01	420168	Eagle River, East Branch	South off U.S. 41 (Site F)	6/12/2007	Acceptable (+2)	MI/DNRE/WB-10/015 & MI/DEQ/WRD-12/027
040201030404-01	420168	Eagle River, East Branch	South off U.S. 41 (Site F)	6/13/2011	Acceptable (0)	MI/DEQ/WRD-12/018
040201030404-01	420207	Eagle River, East Branch	downstream end on Central Mine 3	6/16/2011	Acceptable (1)	MI/DEQ/WRD-12/018
040201030404-01	420087	Eagle River, East Branch	Phoenix Church	6/13/2006	Acceptable (+1)	MI/DEQ/WB-07/080
040201030404-01	420087	Eagle River, East Branch	Phoenix Church	7/12/1996	Acceptable	MI/DEQ/SWQ-97/024
040201030404-03	420173	Brodie Creek (Trib to W.Br. Eagle)	ORV Crossing	6/22/2008	Excellent (+7)	MI/DEQ/WRD-11/023

Appendix 1. Macroinvertebrate community data collected by the MDEQ in copper-impacted streams in the Keweenaw Peninsula area Michigan (1991-2011).

AUID	Storet #	Water Body Name	Station Location	Date Sampled	P-51 Rating and Score	Report #
040201030404-01	420088	Eagle River, West Branch	Phoenix	6/14/2006	Acceptable (0)	MI/DEQ/WB-07/080
040201030404-01	420088	Eagle River, West Branch	Phoenix	7/12/1996	Poor	MI/DEQ/SWQ-97/024
040201030404-01	420128	Eagle River, West Branch	upstream Cliffs Mine	6/22/2008	Excellent (+6)	MI/DEQ/WRD-11/023
040201030401-01	420132	Hills Creek	Dextron & Bumbletown	6/20/2006	Excellent (+5)	MI/DEQ/WB-07/080
040201030401-05	420138	Hills Creek	upper stamps sands	6/19/2006	Excellent (+5)	MI/DEQ/WB-07/080
040201030401-05	420139	Hills Creek	lower stamp sands	6/20/2006	Acceptable (+1)	MI/DEQ/WB-07/080

Appendix 2. Water Quality Data collected in Houghton, Keweenaw, and Ontonagon Counties, Michigan (June-September 2011).

AUID #	Storet #	Water Body Name	Sampling Location	Latitude	Longitude	County	Date	Hardness (mg/L)	DOC (mg/L)	TOC (mg/L)	Copper (µg/L)	Notes
040201030303-03	310463	Slaughterhouse Creek	Calumet Lake Outlet	47.25950	-88.43680	Houghton	6/21/2011	94.8	9.7	11	23.4	
040201030303-03	310463	Slaughterhouse Creek	Calumet Lake Outlet	47.25950	-88.43680	Houghton	7/22/2011	118	13.7	15.4	19	
040201030303-03	310463	Slaughterhouse Creek	Calumet Lake Outlet	47.25950	-88.43680	Houghton	8/16/2011	108	15.5	17.2	4.8	
040201030303-03	310463	Slaughterhouse Creek	Calumet Lake Outlet	47.25950	-88.43680	Houghton	9/19/2011	106	11.8	48.3	76.9	Double checked TOC
040201030303-11	310464	Slaugtherhouse Creek	upstream of Fulton Creek	47.28230	-88.39450	Houghton	6/21/2011	65.5	7.1	8.2	14.3	
040201030303-11	310464	Slaugtherhouse Creek	upstream of Fulton Creek	47.28230	-88.39450	Houghton	7/22/2011	74.2	6.2	6.9	17.8	
040201030303-11	310464	Slaugtherhouse Creek	upstream of Fulton Creek	47.28230	-88.39450	Houghton	8/16/2011	31.5	3.8	4.1	22	
040201030303-11	310464	Slaugtherhouse Creek	upstream of Fulton Creek	47.28230	-88.39450	Houghton	9/19/2011	26.4	3.3	3.4	27.1	
040201030303-08	310466	Slaughterhouse Creek	below Queen Ann Falls	47.27470	-88.39070	Houghton	6/21/2011	64.2	7.5	8.8	12.1	
040201030303-08	310466	Slaughterhouse Creek	below Queen Ann Falls	47.27470	-88.39070	Houghton	7/22/2011	91.6	6.9	7.3	9.8	
040201030303-08	310466	Slaughterhouse Creek	below Queen Ann Falls	47.27470	-88.39070	Houghton	8/16/2011	60.3	5.5	5.9	9.9	
040201030303-08	310466	Slaughterhouse Creek	below Queen Ann Falls	47.27470	-88.39070	Houghton	9/19/2011	52.7	5.2	5.6	9.2	
040201030303-08	310354	Kearsarge Creek	u/s Slaughterhouse Creek	47.27500	-88.39100	Houghton	6/21/2011	66.3	5	6.2	64.4	
040201030303-08	310354	Kearsarge Creek	u/s Slaughterhouse Creek	47.27500	-88.39100	Houghton	7/22/2011	91.8	4.4	4.7	45	
040201030303-08	310354	Kearsarge Creek	u/s Slaughterhouse Creek	47.27500	-88.39100	Houghton	8/16/2011	94.5	3.8	4.2	24	
040201030303-08	310354	Kearsarge Creek	u/s Slaughterhouse Creek	47.27500	-88.39100	Houghton	9/19/2011	88.6	4.2	4.6	40.5	
040201030303-12	310467	Scales Creek	u/s Slaughterhouse Creek	47.27170	-88.39050	Houghton	6/21/2011	51.4	12	14	<1.1	
040201030303-12	310467	Scales Creek	u/s Slaughterhouse Creek	47.27170	-88.39050	Houghton	7/22/2011	95	7.4	8	4	
040201030303-12	310467	Scales Creek	u/s Slaughterhouse Creek	47.27170	-88.39050	Houghton	8/16/2011	100	3.8	4.1	3.4	
040201030303-12	310467	Scales Creek	u/s Slaughterhouse Creek	47.27170	-88.39050	Houghton	9/19/2011	86.4	3.3	3.6	2.3	
040201030303-08	310338	Scales Creek	u/s Valley Road crossing	47.26720	-88.36980	Houghton	6/21/2011	56.4	9.2	9.1	21.7	
040201030303-08	310338	Scales Creek	u/s Valley Road crossing	47.26720	-88.36980	Houghton	7/22/2011	79.7	6.3	5.9	20.3	
040201030303-08	310338	Scales Creek	u/s Valley Road crossing	47.26720	-88.36980	Houghton	8/16/2011	70.1	4.2	4.7	15.6	
040201030303-08	310338	Scales Creek	u/s Valley Road crossing	47.26720	-88.36980	Houghton	9/19/2011	67.6	4	4.3	15.3	

Appendix 2. Water Quality Data collected in Houghton, Keweenaw, and Ontonagon Counties, Michigan (June-September 2011).

AUID #	Storet #	Water Body Name	Sampling Location	Latitude	Longitude	County	Date	Hardness (mg/L)	DOC (mg/L)	TOC (mg/L)	Copper (µg/L)	Notes
040201030303-05	310341	Trap Rock River	Valley Road crossing (W)	47.24990	-88.37120	Houghton	6/21/2011	48	10	11	16	
040201030303-05	310341	Trap Rock River	Valley Road crossing (W)	47.24990	-88.37120	Houghton	7/22/2011	74.6	6.2	6.7	14.4	
040201030303-05	310341	Trap Rock River	Valley Road crossing (W)	47.24990	-88.37120	Houghton	7/22/2011	76.3	6.1	6.9	14.2	duplicate
040201030303-05	310341	Trap Rock River	Valley Road crossing (W)	47.24990	-88.37120	Houghton	8/16/2011	67.9	3.9	4.4	11.4	
040201030303-05	310341	Trap Rock River	Valley Road crossing (W)	47.24990	-88.37120	Houghton	9/19/2011	64.6	3.1	3.4	9.4	
040201030303-05	310382	Trap Rock River	Angman Road	47.23000	-88.38276	Houghton	6/21/2011	49	9.7	10	16.5	
040201030303-05	310382	Trap Rock River	Angman Road	47.23000	-88.38276	Houghton	7/22/2011	46.6	5.1	5.3	12.6	
040201030303-05	310382	Trap Rock River	Angman Road	47.23000	-88.38276	Houghton	8/16/2011	73	3.4	3.7	9.9	
040201030303-05	310382	Trap Rock River	Angman Road	47.23000	-88.38276	Houghton	9/19/2011	67.3	2.8	3	7.9	
040201030303-05	310382	Trap Rock River	Angman Road	47.23000	-88.38276	Houghton	9/19/2011	68	2.9	3.2	8.1	duplicate
040201030303-05	310415	Trap Rock River	Rimfetti	47.20708	-88.39062	Houghton	6/21/2011	47.1	10	11	21.2	
040201030303-05	310415	Trap Rock River	Rimfetti	47.20708	-88.39062	Houghton	7/22/2011	76.7	5	5.2	15.3	
040201030303-05	310415	Trap Rock River	Rimfetti	47.20708	-88.39062	Houghton	8/16/2011	65.9	3.4	3.7	11.8	
040201030303-05	310415	Trap Rock River	Rimfetti	47.20708	-88.39062	Houghton	9/19/2011	67.7	2.9	3.2	11.5	
040201030405-06	420164	Owl Creek	Copper Falls-(W)	47.42980	-88.19600	Keweenaw	6/20/2011	71.8	4.2	4.4	28.2	
040201030405-06	420164	Owl Creek	Copper Falls-(W)	47.42980	-88.19600	Keweenaw	7/20/2011	61.6	4.4	4.1	19.2	
040201030405-06	420164	Owl Creek	Copper Falls-(W)	47.42980	-88.19600	Keweenaw	8/15/2011	88.2	4	3.7	12.7	
040201030405-06	420164	Owl Creek	Copper Falls-(W)	47.42980	-88.19600	Keweenaw	8/15/2011	92.5	4	3.7	12.8	duplicate
040201030405-06	420164	Owl Creek	Copper Falls-(W)	47.42980	-88.19600	Keweenaw	9/14/2011	65.9	4.6	4.2	21.4	
040201030405-06	420143	Owl Creek	u/s Stamp sands	47.43780	-88.19670	Keweenaw	6/20/2011	49.6	9.9	11	106	
040201030405-06	420143	Owl Creek	u/s Stamp sands	47.43780	-88.19670	Keweenaw	6/20/2011	49.6	11	11	105	duplicate
040201030405-06	420143	Owl Creek	u/s Stamp sands	47.43780	-88.19670	Keweenaw	7/20/2011	49.6	11	11	135	
040201030405-06	420143	Owl Creek	u/s Stamp sands	47.43780	-88.19670	Keweenaw	8/15/2011	73.9	8.6	8.5	76.4	
040201030405-06	420143	Owl Creek	u/s Stamp sands	47.43780	-88.19670	Keweenaw	9/14/2011	51.6	8.4	7.7	73.3	
040201030405-06	420137	Owl Creek	stamp sands	47.43870	-88.19940	Keweenaw	6/20/2011	58.4	9.4	10	115	
040201030405-06	420137	Owl Creek	stamp sands	47.43870	-88.19940	Keweenaw	7/20/2011	59.8	10	10	140	
040201030405-06	420137	Owl Creek	stamp sands	47.43870	-88.19940	Keweenaw	8/15/2011	90.7	7.4	7.4	92.9	
040201030405-06	420137	Owl Creek	stamp sands	47.43870	-88.19940	Keweenaw	9/14/2011	71.2	6.8	6.5	80	
040201030405-06	420137	Owl Creek	stamp sands	47.43870	-88.19940	Keweenaw	9/14/2011	92.3	7	6.5	80.8	duplicate
040201030107-02	310407	East Sleeping River	above Red Creek	46.86710	-88.93000	Houghton	6/22/2011	61.3	6.5	7.2	2.6	
040201030107-02	310407	East Sleeping River	above Red Creek	46.86710	-88.93000	Houghton	7/29/2011	71.3	3.8	4.2	0.87	

Appendix 2. Water Quality Data collected in Houghton, Keweenaw, and Ontonagon Counties, Michigan (June-September 2011).

AUID #	Storet #	Water Body Name	Sampling Location	Latitude	Longitude	County	Date	Hardness (mg/L)	DOC (mg/L)	TOC (mg/L)	Copper (µg/L)	Notes
040201030107-02	310407	East Sleeping River	above Red Creek	46.86710	-88.93000	Houghton	8/16/2011	68.8	3.5	3.9	8.9	
040201030107-02	310407	East Sleeping River	above Red Creek	46.86710	-88.93000	Houghton	9/19/2011	65.2	3.3	3.7	0.98	
040201030107-03	660126	Sleepy Creek	below Red Creek	46.88050	-88.94360	Ontonagon	6/22/2011	56.2	11	11	175	
040201030107-03	660126	Sleepy Creek	below Red Creek	46.88050	-88.94360	Ontonagon	7/29/2011	83.7	3.6	3.5	11.4	
040201030107-03	660126	Sleepy Creek	below Red Creek	46.88050	-88.94360	Ontonagon	8/16/2011	87.6	3.2	3.5	8.6	
040201030107-03	660126	Sleepy Creek	below Red Creek	46.88050	-88.94360	Ontonagon	9/19/2011	68.9	3.7	4.2	47	
040201030107-01	660113	East Sleeping River	Snowmobile Trail	46.96000	-89.06530	Ontonagon	6/22/2011	77.1	8.4	8.9	15.2	
040201030107-01	660113	East Sleeping River	Snowmobile Trail	46.96000	-89.06530	Ontonagon	7/29/2011	88.8	6.5	6.8	13.6	
040201030107-01	660113	East Sleeping River	Snowmobile Trail	46.96000	-89.06530	Ontonagon	8/17/2011	95.4	5.6	5.3	10.6	
040201030107-01	660113	East Sleeping River	Snowmobile Trail	46.96000	-89.06530	Ontonagon	8/17/2011	95.9	5.6	5.4	10.3	duplicate
040201030107-01	660113	East Sleeping River	Snowmobile Trail	46.96000	-89.06530	Ontonagon	9/27/2011	85.9	6.2	6.1	11.9	
040201030307-10	310513	Huron Creek	Upstream of Razorback Road	47.10660	-88.58650	Houghton	6/21/2011	75.1	10	11	9.5	
040201030307-10	310513	Huron Creek	Upstream of Razorback Road	47.10660	-88.58650	Houghton	7/20/2011	96.3	12	12	14.7	
040201030307-10	310513	Huron Creek	Upstream of Razorback Road	47.10660	-88.58650	Houghton	8/15/2011	167	9.2	9.4	7.6	
040201030307-10	310513	Huron Creek	Upstream of Razorback Road	47.10660	-88.58650	Houghton	9/14/2011	189	7.5	7.8	17.3	
040201030307-10	310411	Huron Creek	Sharon Road	47.11230	-88.58770	Houghton	6/21/2011	81.5	9.4	9.9	26.6	
040201030307-10	310411	Huron Creek	Sharon Road	47.11230	-88.58770	Houghton	7/20/2011	89.3	7.9	7.5	35.9	
040201030307-10	310411	Huron Creek	Sharon Road	47.11230	-88.58770	Houghton	8/15/2011	311	4.9	5.2	69.3	
040201030307-10	310411	Huron Creek	Sharon Road	47.11230	-88.58770	Houghton	9/14/2011	243	5.7	5.4	33.6	
040201010107-02	660162	Portal Creek	Upper road crossing near tailings basin	46.78146	-89.55910	Ontonagon	6/22/2011	120	13	14	55.1	
040201010107-02	660162	Portal Creek	Upper road crossing near tailings basin	46.78146	-89.55910	Ontonagon	7/29/2011	241	14.6	16.1	6.3	
040201010107-02	660162	Portal Creek	Upper road crossing near tailings basin	46.78146	-89.55910	Ontonagon	8/17/2011	208	15	15.2	29.6	
040201010107-02	660162	Portal Creek	Upper road crossing near tailings basin	46.78146	-89.55910	Ontonagon	9/27/2011	250	13.1	13.9	19.1	
040201010107-02	660107	Portal Creek	CC1 (confluence with Mineral River)	46.7951	-89.5597	Ontonagon	6/22/2011	124	12	13	33.4	
040201010107-02	660107	Portal Creek	CC1 (confluence with Mineral River)	46.7951	-89.5597	Ontonagon	6/22/2011	117	12	13	35.3	duplicate
040201010107-02	660107	Portal Creek	CC1 (confluence with Mineral River)	46.7951	-89.5597	Ontonagon	7/29/2011	166	15.4	16.7	19.7	

Appendix 2. Water Quality Data collected in Houghton, Keweenaw, and Ontonagon Counties, Michigan (June-September 2011).

AUID #	Storet #	Water Body Name	Sampling Location	Latitude	Longitude	County	Date	Hardness (mg/L)	DOC (mg/L)	TOC (mg/L)	Copper (µg/L)	Notes
040201010107-02	660107	Portal Creek	CC1 (confluence with Mineral River)	46.7951	-89.5597	Ontonagon	8/17/2011	418	11.7	191	11.7	Hardness and TOC double checked by lab. Considered an outlier
040201010107-02	660107	Portal Creek	CC1 (confluence with Mineral River)	46.7951	-89.5597	Ontonagon	9/27/2011	137	9.6	15.8	32.6	double checked TOC
040201010108-NA	660163	Pine Creek	LP Walsh Road	46.73678	-89.51472	Ontonagon	6/22/2011	43.7	11	12	10.4	
040201010108-NA	660163	Pine Creek	LP Walsh Road	46.73678	-89.51472	Ontonagon	7/29/2011	156	10.5	10.9	2.9	
040201010108-NA	660163	Pine Creek	LP Walsh Road	46.73678	-89.51472	Ontonagon	8/17/2011	217	10.1	12	1.4	
040201010108-NA	660163	Pine Creek	LP Walsh Road	46.73678	-89.51472	Ontonagon	9/27/2011	117	9.4	9.5	9.1	
040201010109-NA	660164	Duck Creek	Logging Road Crossing	46.82770	-89.46940	Ontonagon	6/22/2011	41.8	11	12	7.5	
040201010109-NA	660164	Duck Creek	Logging Road Crossing	46.82770	-89.46940	Ontonagon	7/29/2011	59.1	8.7	8.9	3.3	
040201010109-NA	660164	Duck Creek	Logging Road Crossing	46.82770	-89.46940	Ontonagon	8/17/2011	60.4	8.4	8.5	3.1	
040201010109-NA	660164	Duck Creek	Logging Road Crossing	46.82770	-89.46940	Ontonagon	9/27/2011	30.5	12.9	13	4	
040201030404-01	420114	Eagle River, East Branch	u/s of Central #1 (SS6)	47.40270	-88.19480	Keweenaw	6/20/2011	36.9	18	19	7.2	
040201030404-01	420114	Eagle River, East Branch	u/s of Central #1 (SS6)	47.40270	-88.19480	Keweenaw	7/20/2011	45.7	20.6	25.2	2.8*	2.8 is an estimate because the result is < QL but > DL
040201030404-01	420114	Eagle River, East Branch	u/s of Central #1 (SS6)	47.40270	-88.19480	Keweenaw	8/15/2011	56.2	16	16.6	1.2	
040201030404-01	420114	Eagle River, East Branch	u/s of Central #1 (SS6)	47.40270	-88.19480	Keweenaw	9/14/2011	57.3	13.1	13.8	1.1	
040201030404-01	420182	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.19861	Keweenaw	6/20/2011	56.9	13	14	12.1	
040201030404-01	420182	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.19861	Keweenaw	7/20/2011	75.6	15	16	16.7	
040201030404-01	420182	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.19861	Keweenaw	7/20/2011	65.5	16	16	17.8	duplicate
040201030404-01	420182	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.19861	Keweenaw	8/15/2011	100	10.8	11.4	22.2	
040201030404-01	420182	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.19861	Keweenaw	9/14/2011	96.6	10.1	9.2	18.9	
040201030404-01	420168	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.40280	-88.21080	Keweenaw	6/20/2011	56.5	13	14	60.5	

Appendix 2. Water Quality Data collected in Houghton, Keweenaw, and Ontonagon Counties, Michigan (June-September 2011).

AUID #	Storet #	Water Body Name	Sampling Location	Latitude	Longitude	County	Date	Hardness (mg/L)	DOC (mg/L)	TOC (mg/L)	Copper (µg/L)	Notes
040201030404-01	420168	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.40280	-88.21080	Keweenaw	7/20/2011	77.5	13	13	101	
040201030404-01	420168	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.40280	-88.21080	Keweenaw	8/15/2011	105	8.5	8.8	70.2	
040201030404-01	420168	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.40280	-88.21080	Keweenaw	8/15/2011	109	8.9	9.2	87.1	extra sample
040201030404-01	420168	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.40280	-88.21080	Keweenaw	9/14/2011	101	8.7	8.9	79.9	
040201030404-02	420131	Buffalo Cr.	Snowmobile Trail	47.40060	-88.21290	Keweenaw	6/20/2011	37	12	12	1.9*	1.9 is an estimate because the result is < QL but > DL
040201030404-02	420131	Buffalo Cr.	Snowmobile Trail	47.40060	-88.21290	Keweenaw	7/20/2011	49.5	12	12	<1.1	
040201030404-02	420131	Buffalo Cr.	Snowmobile Trail	47.40060	-88.21290	Keweenaw	8/15/2011	70.3	7.4	7.6	1.1	
040201030404-02	420131	Buffalo Cr.	Snowmobile Trail	47.40060	-88.21290	Keweenaw	9/14/2011	50.4	6.7	6.8	1	
Field Blank							7/29/2011	<.2	<1	<1	0.56	field blank
Field Blank							8/16/2011	<.2	<1	1	1.8	field blank
Field Blank							6/22/2011	<.2	<1	<1	<1.1	field blank
Field Blank							9/27/2011	<.7	<1.0	<1.0	<0.22	field blank

Appendix 3. All water chemistry data collected prior to 2011 in relation to investigations of water bodies impacted by copper in the U.P. of Michigan. Highlighted cells are those that were used in development of site-specific WQS using a WER.

STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	7/30/1991	81		31	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	4/3/2007	40	6.1	23	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	5/17/2007	73	8.8	21	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	5/30/2007	63	7.5	23	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	6/13/2007	79	5.8	22	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	6/14/2007	76	5	20	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	7/12/2007	76	4.2	22	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	9/14/2007	83	4.3	21	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	9/27/2007	82	7	20	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	9/27/2007	82	6.9	20	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	10/17/2007	63	10	29	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	10/22/2007	57	10	34	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	6/11/2008	71	6.5	25	
310338	040201030303-08	Scales Creek	50 yds d/s Valley Road	47.26645	-88.3697	Houghton	6/30/2010	85	6.7	19	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	7/30/1991	71		16.1	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	5/17/2007		8.8		Hardness & Copper = "NA"
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	5/30/2007	56	8.3	16	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	7/12/2007	71	3.6	14	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	9/14/2007	67	5.5	10	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	9/27/2007	65	8	14	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	10/17/2007	46	12	19	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	10/22/2007	38	12	21	
310341	040201030303-05	Trap Rock River	Valley Rd. crossing (W)	47.2499	-88.3712	Houghton	10/26/2007	42	9.1	17	
310345	040201030303-11	Slaughterhouse Creek	Philipsville	47.2806	-88.4137	Houghton	7/29/1991	107		4.4	
310345	040201030303-11	Slaughterhouse Creek	Philipsville	47.2806	-88.4137	Houghton	6/22/2001	108		3.3	
310345	040201030303-11	Slaughterhouse Creek	Philipsville	47.2806	-88.4137	Houghton	6/13/2007	125	9.3	3.5	
310345	040201030303-11	Slaughterhouse Creek	Philipsville	47.2806	-88.4137	Houghton	6/14/2007	130	9.4	3.4	
310345	040201030303-11	Slaughterhouse Creek	Philipsville	47.2806	-88.4137	Houghton	6/11/2008	95	8.8	5.2	
310345	040201030303-11	Slaughterhouse Creek	Philipsville	47.2806	-88.4137	Houghton	6/11/2008	96	8.7	5.1	
310353	040201030303-08	Scales Creek	u/s Valley Road crossing	47.2672	-88.3698	Houghton	7/29/1991	81	5.8	25	
310353	040201030303-08	Scales Creek	u/s Valley Road crossing	47.2672	-88.3698	Houghton	6/22/2001	71		27	
310353	040201030303-08	Scales Creek	u/s Valley Road crossing	47.2672	-88.3698	Houghton	6/16/2006	69	5.8	23	

Appendix 3. All water chemistry data collected prior to 2011 in relation to investigations of water bodies impacted by copper in the U.P. of Michigan. Highlighted cells are those that were used in development of site-specific WQS using a WER.

STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
310354	040201030303-08	Kearsarge Creek	Slaughterhouse Cr.	47.275	-88.391	Houghton	7/29/1991	88		125	
310354	040201030303-08	Kearsarge Creek	Slaughterhouse Cr.	47.275	-88.391	Houghton	6/16/2006	81	4.7	47	
310354	040201030303-08	Kearsarge Creek	Slaughterhouse Cr.	47.275	-88.391	Houghton	6/13/2007	90	3.8	44	
310354	040201030303-08	Kearsarge Creek	Slaughterhouse Cr.	47.275	-88.391	Houghton	6/11/2008	68	4.1	51	
310354	040201030303-08	Kearsarge Creek	Slaughterhouse Cr.	47.275	-88.391	Houghton	6/9/2009	63	4.5	56	
310354	040201030303-08	Kearsarge Creek	Slaughterhouse Cr.	47.275	-88.391	Houghton	7/15/2009	81	5.6	54	
310382	040201030303-05	Trap Rock River	Angman Rd.	47.23	-88.3828	Houghton	7/13/2008	67	4.9	13	
310382	040201030303-05	Trap Rock River	Angman Rd.	47.23	-88.3828	Houghton	9/8/2008	76	5.9	16	
310382	040201030303-05	Trap Rock River	Angman Rd.	47.23	-88.3828	Houghton	6/7/2009	74	4.5	12	
310382	040201030303-05	Trap Rock River	Angman Rd.	47.23	-88.3828	Houghton	8/12/2009	84	3.3	11	
310392	040201030303-08	Kearsarge Creek	d/s remediation site	47.27508	-88.3928	Houghton	6/6/2000	86		34	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	7/10/2006	74	4	1.3	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	5/17/2007	60	8.2	1.8	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	5/31/2007	66	5.6	1.3	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	7/12/2007	72	3.9	1	Copper: K 1.0
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	9/14/2007	69	4.1	1.3	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	9/28/2007	55	16	2.9	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	10/17/2007	43	22	5.3	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	10/22/2007	35	22	6.1	
310407	040201030107-02	Sleepy Creek	Sleepy Dam Rd.	46.8671	-88.93	Houghton	10/25/2007	38	18	3.9	
310409	040201030303-09	Mud Creek	Copper City	47.2839	-88.393	Houghton	6/19/2006	77	13	5.2	
310409	040201030303-09	Mud Creek	Copper City	47.2839	-88.393	Houghton	6/13/2007	84	11	3.7	
310409	040201030303-09	Mud Creek	Copper City	47.2839	-88.393	Houghton	6/11/2008	68	16	16	
310409	040201030303-09	Mud Creek	Copper City	47.2839	-88.393	Houghton	6/7/2009	77	12	6.5	
310410	040201030307-10	Huron Creek	Ming Garden	47.1065	-88.5871	Houghton	6/18/2006	107	11	35	
310410	040201030307-10	Huron Creek	Ming Garden	47.1065	-88.5871	Houghton	6/14/2007	149	7.9	36	
310410	040201030307-10	Huron Creek	Ming Garden	47.1065	-88.5871	Houghton	6/21/2008	134	8.2	42	
310411	040201030307-10	Huron Creek	Sharon Road	47.1123	-88.5877	Houghton	6/21/2001	186		39	
310411	040201030307-10	Huron Creek	Sharon Road	47.1123	-88.5877	Houghton	6/18/2006	175	9	49	
310411	040201030307-10	Huron Creek	Sharon Road	47.1123	-88.5877	Houghton	6/14/2007	209	6.1	46	
310411	040201030307-10	Huron Creek	Sharon Road	47.1123	-88.5877	Houghton	6/21/2008	189	6.2	51	
310412	040201030303-04	Trap Rock River	Wood Bush Rd.	47.2718	-88.361	Houghton	7/30/1991	61		1.9	
310412	040201030303-04	Trap Rock River	Wood Bush Rd.	47.2718	-88.361	Houghton	8/2/2005	63	6.97	4	
310412	040201030303-04	Trap Rock River	Wood Bush Rd.	47.2718	-88.361	Houghton	6/13/2007	67	6.4	2.5	
310412	040201030303-04	Trap Rock River	Wood Bush Rd.	47.2718	-88.361	Houghton	6/11/2008	51	7.8	2.7	

Appendix 3. All water chemistry data collected prior to 2011 in relation to investigations of water bodies impacted by copper in the U.P. of Michigan. Highlighted cells are those that were used in development of site-specific WQS using a WER.

STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
310412	040201030303-04	Trap Rock River	Wood Bush Rd.	47.2718	-88.361	Houghton	6/7/2009	61	6.7	2	
310415	040201030303-05	Trap Rock River	Rimfetti	47.20708	-88.3906	Houghton	7/13/2008	74	4.8	16	
310415	040201030303-05	Trap Rock River	Rimfetti	47.20708	-88.3906	Houghton	9/8/2008	77	2.8	11	
310415	040201030303-05	Trap Rock River	Rimfetti	47.20708	-88.3906	Houghton	6/7/2009	71	4.4	15	
310415	040201030303-05	Trap Rock River	Rimfetti	47.20708	-88.3906	Houghton	8/12/2009	81	3.2	11	
310456	040201030303-01	Fulton Creek	along snowmobile trail (W)	47.2848	-88.3944	Houghton	6/19/2006	37	8.5	11	
310456	040201030303-01	Fulton Creek	along snowmobile trail (W)	47.2848	-88.3944	Houghton	6/7/2009	30	6.1	13	
310458	040201030107-NA	Sleepy Creek tributary	M-26 bridge	46.8577	-88.918	Houghton	7/10/2006	62	3.8	1	Copper: K 1.0
310463	040201030303-03	Slaughterhouse Creek	Calumet Lk. Outlet	47.2595	-88.4368	Houghton	7/30/1991	91		50	
310463	040201030303-03	Slaughterhouse Creek	Calumet Lk. Outlet	47.2595	-88.4368	Houghton	6/11/2008	48	17	67	
310463	040201030303-03	Slaughterhouse Creek	Calumet Lk. Outlet	47.2595	-88.4368	Houghton	6/7/2009	115	10	35	
310463	040201030303-03	Slaughterhouse Creek	Calumet Lk. Outlet	47.2595	-88.4368	Houghton	7/15/2009	118	17	46	
310463	040201030303-03	Slaughterhouse Creek	Calumet Lk. Outlet	47.2595	-88.4368	Houghton	8/12/2009	129	13	15	
310464	040201030303-11	Slaughterhouse Creek	u/s of Fulton Creek	47.2823	-88.3945	Houghton	6/13/2007	62	5.4	18	
310464	040201030303-11	Slaughterhouse Creek	u/s of Fulton Creek	47.2823	-88.3945	Houghton	6/14/2007	64	5.2	17	
310464	040201030303-11	Slaughterhouse Creek	u/s of Fulton Creek	47.2823	-88.3945	Houghton	6/11/2008	73	6.4	17	
310464	040201030303-11	Slaughterhouse Creek	u/s of Fulton Creek	47.2823	-88.3945	Houghton	6/7/2009	71	6	15	
310465	040201030303-01	Fulton Creek	u/s of Slaughterhouse (W)	47.2832	-88.3943	Houghton	6/13/2007	83	5.2	7.2	
310465	040201030303-01	Fulton Creek	u/s of Slaughterhouse (W)	47.2832	-88.3943	Houghton	6/14/2007	96	4.8	7.8	
310465	040201030303-01	Fulton Creek	u/s of Slaughterhouse (W)	47.2832	-88.3943	Houghton	6/11/2008	71	5.3	9.2	
310465	040201030303-01	Fulton Creek	u/s of Slaughterhouse (W)	47.2832	-88.3943	Houghton	6/7/2009	96	4.4	6.1	
310466	040201030303-08	Slaughterhouse Creek	below Queen Ann Falls	47.2747	-88.3907	Houghton	7/29/1991	86		25	
310466	040201030303-08	Slaughterhouse Creek	below Queen Ann Falls	47.2747	-88.3907	Houghton	6/16/2006	66	6.5	12	
310466	040201030303-08	Slaughterhouse Creek	below Queen Ann Falls	47.2747	-88.3907	Houghton	6/13/2007	74	5.7	9.9	
310466	040201030303-08	Slaughterhouse Creek	below Queen Ann Falls	47.2747	-88.3907	Houghton	6/11/2008	72	7.9	13	
310466	040201030303-08	Slaughterhouse Creek	below Queen Ann Falls	47.2747	-88.3907	Houghton	6/9/2009	77	7.3	11	

Appendix 3. All water chemistry data collected prior to 2011 in relation to investigations of water bodies impacted by copper in the U.P. of Michigan. Highlighted cells are those that were used in development of site-specific WQS using a WER.

STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
310467	040201030303-12	Scales Creek	u/s Slaughterhouse Cr.	47.2717	-88.3905	Houghton	6/13/2007	66	9.9	6.1	
310467	040201030303-12	Scales Creek	u/s Slaughterhouse Cr.	47.2717	-88.3905	Houghton	6/11/2008	49	9.5	7.7	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	7/12/1996	43	9.7	60	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	6/23/2001	52		47	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	10/23/2003	69		59	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	6/13/2006	50	10	62	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	4/3/2007	20	11	48	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	5/17/2007	43	10	56	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	5/30/2007	41	12	61	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	7/12/2007	81	7.2	44	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	9/14/2007	96	5.2	24	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	9/27/2007	57	12	63	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	10/17/2007	38	15	76	
420087	040201030404-01	Eagle River, East Branch	Phoenix Church	47.3893	-88.2773	Keweenaw	10/22/2007	33	15	77	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	7/12/1996	62	7.8	97	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	10/23/2003	78		60	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	6/13/2006	68	8.1	56	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	4/3/2007	37	9.5	54	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	5/17/2007	61	9.4	47	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	5/30/2007	63	7.8	54	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	7/12/2007	82	5.5	41	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	9/14/2007	96	6.8	47	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	9/27/2007	86	9.4	73	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	10/17/2007	60	11	69	
420088	040201030404-01	Eagle River, West Branch	Phoenix (SS 2)	47.3875	-88.2832	Keweenaw	10/22/2007	45	13	84	
420105	N/A	Kingston mine Discharge (W)		47.2903	-88.3906	Keweenaw	6/21/2001	18		64	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420105	N/A	Kingston mine Discharge (W)		47.2903	-88.3906	Keweenaw	6/16/2006	20	3	51	
420105	N/A	Kingston mine Discharge (W)		47.2903	-88.3906	Keweenaw	6/7/2009	21	2.3	43	
420109	040201030401-05	Hills Creek	ORV Bridge (W)	47.3135	-88.4259	Keweenaw	10/23/2003	65		3.8	
420109	040201030401-05	Hills Creek	ORV Bridge (W)	47.3135	-88.4259	Keweenaw	6/19/2006	59	7.9	3.8	
420109	040201030401-05	Hills Creek	ORV Bridge (W)	47.3135	-88.4259	Keweenaw	10/26/2007	46	8.8	5.2	
420110	040201030401-05	Hills Creek	base of hill at stream ford	47.3269	-88.4596	Keweenaw	10/23/2003	119		37	
420111	040201030401-01	Hills Creek tributary		47.3036	-88.4242	Keweenaw	10/23/2003	41		2.7	
420112	040201030401-01	Hills Creek tributary	Gratiot Lake Crossing	47.3096	-88.4203	Keweenaw	10/23/2003	64		5.7	
420113	040201030404-01	Eagle River, East Branch	northeast of Church at US-41	47.3924	-88.2656	Keweenaw	10/23/2003	67		60	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/23/2003	31		4.1	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	6/14/2006	29	19	3	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	4/3/2007	17	15	2.2	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	5/17/2007	28	18	4.3	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	5/30/2007	43	15	8.5	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	7/12/2007	47	17	1.7	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	7/12/2007	45	17	1.7	Duplicate
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	7/30/2007	58	14	1.3	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	9/14/2007	59	8.7	2.1	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	9/27/2007	42	16	5.1	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/17/2007	33	27	4.8	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/22/2007	25	26	3.8	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	11/14/2007	28	23	3.6	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	6/10/2008	44	14	6.4	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	6/1/2010	53	22	2.4	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	6/30/2010	50	20	2.5	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	8/25/2010	56	16	2	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	8/25/2010	58	16	2.2	Duplicate
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	9/1/2010	62	14	2.6	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	9/1/2010	60	14	4.7	Duplicate
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	9/2/2010	36	17	3.1	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	9/8/2010	43	16	4.9	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	9/15/2010	32	18	3.3	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/1/2010	33	22	3.8	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/8/2010	34	22	3.2	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/12/2010	36	21	3.4	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/22/2010	36	19	2.5	
420114	040201030404-01	Eagle River, East Branch	u/s Stamp Sands (W), (SS6)	47.4027	-88.1948	Keweenaw	10/29/2010	27	25	3.2	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	10/23/2003	78		60	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	6/7/2009	74	5.5	31	
420127	040201030404-01	Eagle River, West	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	6/7/2009	75	5.6	29	Duplicate

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
		Branch									
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	7/15/2009	85	6.1	34	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	8/10/2009	83	4.4	26	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	8/12/2009	86	4.5	34	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	9/1/2009	65	13	68	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	5/17/2010	68	6.8	40	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	5/24/2010	83	6.9	57	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	5/24/2010	86	6.9	53	Duplicate
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	6/1/2010	97	7	58	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	6/11/2010	85	7.6	75	
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	6/11/2010	83	7.5	75	Duplicate
420127	040201030404-01	Eagle River, West Branch	d/s Cliffs Mine	47.3753	-88.3085	Keweenaw	6/16/2010	83	8.1	46	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	10/23/2003	73		1.3	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	6/22/2008	70	4	3.3	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	6/7/2009	64	5.4	3.4	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	7/15/2009	71	6.4	2.8	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	7/15/2009	75	6.4	2.9	Duplicate
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	8/10/2009	79	2.3	1	Copper: ND (< 1.0)
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	8/12/2009	75	2.2	1.1	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	9/1/2009	66	7.5	4.3	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	5/17/2010	67	5	2.3	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	5/17/2010	66	4.4	2.5	Duplicate
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	5/24/2010	71	3.1	3.1	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	6/1/2010	74	1.9	1	Copper: ND (< 1.0)
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	6/1/2010	71	1.9	1	Copper: ND (< 1.0),

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	6/11/2010	68	4.8	3.6	Duplicate
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	6/16/2010	73	4.8	2.9	
420128	040201030404-01	Eagle River, West Branch	u/s Cliffs Mine	47.3668	-88.3219	Keweenaw	6/16/2010	73	4.8	2.8	Duplicate
420130	040201030404-01	Eagle River, East Branch	d/s St. Claire Mine	47.3888	-88.2763	Keweenaw	10/23/2003	69		59	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	6/14/2006	37	11	1.3	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	4/3/2007	16	10	1.8	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	5/17/2007	30	14	1.9	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	5/30/2007	30	13	1.8	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	6/15/2007	42	11	1.8	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	7/12/2007	56	7.5	1.1	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	7/29/2007	57	5.7	1.7	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	8/3/2007	62	5.4	1.3	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	8/3/2007	60	5.2	1.2	Duplicate
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	9/14/2007	68	5.4	1	Copper: K 1.0
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	9/27/2007	40	14	2.4	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/17/2007	27	14	2.6	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/22/2007	22	14	2.5	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	11/10/2007	26	10	1.8	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	11/15/2007	24	11	1.9	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	11/15/2007	24	11	2.1	Duplicate
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	12/10/2007	27	8.3	3.6	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	4/21/2008	18	7.6	2.4	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	7/1/2008	42	10	2	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	7/12/2008	44	11	1.4	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	7/14/2008	45	11	1.5	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	6/1/2010	53	8.4	1.6	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	6/30/2010	46	11	1.6	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	8/25/2010	66	8.4	1.2	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	9/1/2010	63	6.3	1	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	9/8/2010	43	13	1.9	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	9/15/2010	39	14	2.3	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	9/23/2010	45	13	1.4	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	9/23/2010	45	13	1.3	Duplicate

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/1/2010	34	15	2.1	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/8/2010	41	3	1.6	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/12/2010	48	12	2.2	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/12/2010	48	12	2.7	Duplicate
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/17/2010	34	16	2.3	
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/22/2010	49	10	1	Copper: ND (< 1)
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/22/2010	48	10	1	Copper: ND (< 1)
420131	040201030404-02	Buffalo Creek	Snowmobile trail	47.4006	-88.2129	Keweenaw	10/29/2010	31	16	2.3	
420132	040201030401-01	Hills Creek	Dextron & Bumbletown	47.2935	-88.4363	Keweenaw	6/20/2006	61	12	2.4	
420133	040201030405-06	Owl Creek	Lake Superior (W)	47.4456	-88.2166	Keweenaw	10/23/2003	86		2	
420133	040201030405-06	Owl Creek	Lake Superior (W)	47.4456	-88.2166	Keweenaw	6/17/2006	76	11	9.6	
420133	040201030405-06	Owl Creek	Lake Superior (W)	47.4456	-88.2166	Keweenaw	6/11/2007	67	8.4	13	
420133	040201030405-06	Owl Creek	Lake Superior (W)	47.4456	-88.2166	Keweenaw	8/3/2007	80	7.7	2	
420133	040201030405-06	Owl Creek	Lake Superior (W)	47.4456	-88.2166	Keweenaw	10/26/2007	52	11	28	
420134	040201030401-01	Hills Creek	Bumbletown/Sec. 1 (W)	47.2808	-88.4469	Keweenaw	6/19/2006	58	15	3.1	
420136	040201030404-01	Eagle River, East Branch	u/s Gratiot Lk. Rd; reach B	47.4032	-88.1981	Keweenaw	6/13/2006	47	14	13	
420137	040201030405-06	Owl Creek	stamp sands	47.4387	-88.1994	Keweenaw	6/14/2006	49	9.3	110	
420137	040201030405-06	Owl Creek	stamp sands	47.4387	-88.1994	Keweenaw	6/11/2007	47	10	130	
420137	040201030405-06	Owl Creek	stamp sands	47.4387	-88.1994	Keweenaw	8/3/2007	99	6.4	99	
420138	040201030401-05	Hills Creek	upper stamps sands	47.3158	-88.4288	Keweenaw	6/19/2006	69	6.8	13	
420138	040201030401-05	Hills Creek	upper stamps sands	47.3158	-88.4288	Keweenaw	6/11/2007	73	5.1	12	
420138	040201030401-05	Hills Creek	upper stamps sands	47.3158	-88.4288	Keweenaw	8/3/2007	84	2.4	12	
420138	040201030401-05	Hills Creek	upper stamps sands	47.3158	-88.4288	Keweenaw	10/26/2007	51	8.4	9.1	
420139	040201030401-05	Hills Creek	lower stamp sands	47.3288	-88.4647	Keweenaw	6/20/2006	97	4.7	37	
420139	040201030401-05	Hills Creek	lower stamp sands	47.3288	-88.4647	Keweenaw	6/12/2007	110	3.1	35	
420139	040201030401-05	Hills Creek	lower stamp sands	47.3288	-88.4647	Keweenaw	8/3/2007	121	1.9	27	
420139	040201030401-05	Hills Creek	lower stamp sands	47.3288	-88.4647	Keweenaw	10/26/2007	71	6.8	42	
420143	040201030405-06	Owl Creek	u/s Stamp sands	47.4378	-88.1967	Keweenaw	10/23/2003	52		72	
420143	040201030405-06	Owl Creek	u/s Stamp sands	47.4378	-88.1967	Keweenaw	6/17/2006	41	10	98	
420143	040201030405-06	Owl Creek	u/s Stamp sands	47.4378	-88.1967	Keweenaw	6/15/2007	45	10	120	
420143	040201030405-06	Owl Creek	u/s Stamp sands	47.4378	-88.1967	Keweenaw	10/26/2007	39	15	190	
420164	040201030405-06	Owl Creek	Copper Falls-(W)	47.4298	-88.196	Keweenaw	6/16/2006	52	5.2	21	
420164	040201030405-06	Owl Creek	Copper Falls-(W)	47.4298	-88.196	Keweenaw	6/11/2007	59	3.4	17	
420164	040201030405-06	Owl Creek	Copper Falls-(W)	47.4298	-88.196	Keweenaw	8/3/2007	90	4	15	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420164	040201030405-06	Owl Creek	Copper Falls-(W)	47.4298	-88.196	Keweenaw	10/26/2007	44	5.9	28	
420164	040201030405-06	Owl Creek	Copper Falls-(W)	47.4298	-88.196	Keweenaw	10/26/2007	44	5.8	28	Duplicate
420165	040201030401-05	Hills Creek	Lk. Superior (W)	47.3316	-88.4668	Keweenaw	6/20/2006	95	6	33	
420165	040201030401-05	Hills Creek	Lk. Superior (W)	47.3316	-88.4668	Keweenaw	6/12/2007	107	3.5	36	
420165	040201030401-05	Hills Creek	Lk. Superior (W)	47.3316	-88.4668	Keweenaw	8/3/2007	117	2.2	68	
420165	040201030401-05	Hills Creek	Lk. Superior (W)	47.3316	-88.4668	Keweenaw	10/26/2007	70	7.5	36	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	4/3/2007	23	10	46	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	4/3/2007	22	11	45	Duplicate
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	5/17/2007	50	12	52	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	5/17/2007	50	12	53	Duplicate
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	5/30/2007	47	11	52	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	7/12/2007	75	6.8	35	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	7/12/2007	86	6.8	35	Duplicate
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	9/14/2007	94	6.4	26	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	9/14/2007	93	6.4	25	Duplicate
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	9/27/2007	62	11	58	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	10/17/2007	44	14	66	
420167	040201030404-01	Eagle River	M-26 (W) (SS 1)	47.3927	-88.2767	Keweenaw	10/22/2007	33	14	73	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	4/3/2007	24	14	110	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	5/17/2007	49	14	130	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	5/30/2007	48	14	160	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	6/16/2007	68	15	280	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/12/2007	97	12	270	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/29/2007	111	12	240	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/29/2007	110	12	240	Duplicate
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	8/3/2007	105	12	210	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	9/14/2007	109	9.2	210	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	9/27/2007	86	12	230	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/17/2007	43	20	190	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/22/2007	32	20	190	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	11/10/2007	47	13	110	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	11/15/2007	43	15	110	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	12/10/2007	46	13	140	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	12/10/2007	45	12	130	Duplicate
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	4/21/2008	26	9.2	550	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	4/21/2008	26	9.5	580	Duplicate
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/1/2008	73	12	180	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/1/2008	69	12	190	Duplicate
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/12/2008	75	12	150	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/12/2008	74	12	150	Duplicate
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	7/14/2008	77	12	290	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	6/7/2009	64	10	150	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	8/10/2009	68	10	170	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	8/12/2009	102	12	190	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	6/1/2010	82	12	160	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	6/30/2010	79	13	120	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	8/25/2010	110	9.1	130	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	9/1/2010	126	9.3	130	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	9/8/2010	70	12	110	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	9/15/2010	64	13	140	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	9/23/2010	75	13	130	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/1/2010	50	17	150	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/8/2010	61	16	120	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/8/2010	58	15	120	Duplicate
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/12/2010	60	15	120	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/22/2010	63	13	100	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/27/2010	47	19	140	
420168	040201030404-01	Eagle River, East Branch	Site F(ER-F) (SS 4)	47.4028	-88.2108	Keweenaw	10/29/2010	42	20	94	
420171	N/A	Unnamed Tributary to Cat Harbor		47.4512	-88.1995	Keweenaw	8/3/2007	76	9.9	1	Copper: K 1.0
420172	N/A	Owl Creek	Marsh d/s of Stamp Sand deposit	47.44298	-88.2005	Keweenaw	6/11/2007	76	12	110	
420172	N/A	Owl Creek	Marsh d/s of Stamp Sand deposit	47.44298	-88.2005	Keweenaw	10/26/2007	43	13	170	
420173	040201030404-03	Brodie Creek (Trib to W.Br. Eagle)	ORV Crossing east of Phoenix	47.3814	-88.2824	Keweenaw	6/22/2008	60	6.3	1.4	
420174	040201030404-01	Eagle River, East Branch	d/s end of Central Mine #3 deposit - Site G	47.40121	-88.2273	Keweenaw	6/7/2009	47	9.5	52	
420174	040201030404-01	Eagle River, East Branch	d/s end of Central Mine #3 deposit - Site G	47.40121	-88.2273	Keweenaw	8/10/2009	68	10	64	
420174	040201030404-01	Eagle River, East Branch	d/s end of Central Mine #3 deposit - Site G	47.40121	-88.2273	Keweenaw	8/10/2009	66	10	66	Duplicate
420174	040201030404-01	Eagle River, East Branch	d/s end of Central Mine #3 deposit - Site G	47.40121	-88.2273	Keweenaw	8/12/2009	75	9.6	67	
420174	040201030404-01	Eagle River, East Branch	d/s end of Central Mine #3 deposit - Site G	47.40121	-88.2273	Keweenaw	8/25/2010	79	8.6	70	
420176	040201030404-01	Eagle River, West Branch	within Cliff Mine stamp sand deposit, south of stamp mill foundation (Within 1)	47.3716	-88.3141	Keweenaw	8/10/2009	79	3.6	8.3	
420177	040201030404-01	Eagle River, West Branch	within Cliff Mine stamp sand deposit between stamp sands and wetland (Within 2)	47.3724	-88.3124	Keweenaw	8/10/2009	80	3.5	19	
420178	040201030405-08	Garden City Creek	Garden City Road	47.4139	-88.2921	Keweenaw	7/15/2009	77	8.5	12	
420178	040201030405-08	Garden City Creek	Garden City Road	47.4139	-88.2921	Keweenaw	8/10/2009	95	6.9	10	
420179	040201030404-05	Unnamed Tributary to the Eagle River	M-26	47.4004	-88.2889	Keweenaw	7/15/2009	51	9.7	3.8	
420179	040201030404-05	Unnamed Tributary to the Eagle River	M-26	47.4004	-88.2889	Keweenaw	8/10/2009	67	8.5	3	
420180	040201030403-01	Schlitz Creek	Section 24	47.4045	-88.3069	Keweenaw	7/15/2009	68	6.6	10	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420180	040201030403-01	Schlitz Creek	Section 24	47.4045	-88.3069	Keweenaw	8/10/2009	77	4.7	7.3	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	6/15/2007	61	15	240	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	7/29/2007	112	13	280	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	8/3/2007	115	13	300	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	11/10/2007	45	13	89	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	11/15/2007	40	15	83	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	12/10/2007	45	12	120	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	4/21/2008	26	9.2	180	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	7/1/2008	75	12	190	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	7/12/2008	73	12	140	
420181	040201030404-01	Eagle River, East Branch	at snowmobile trail bridge (ER-SMT)	47.40167	-88.2075	Keweenaw	7/14/2008	76	12	240	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	4/3/2007	23	15	30	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	5/17/2007	46	14	36	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	5/30/2007	49	15	46	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	6/15/2007	60	16	64	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	7/12/2007	92	14	87	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	7/29/2007	114	13	120	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	8/3/2007	112	13	250	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	9/14/2007	106	8.9	180	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	9/27/2007	79	12	76	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/17/2007	40	22	130	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/22/2007	33	23	51	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	11/10/2007	46	14	33	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	11/10/2007	42	14	32	Duplicate
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	11/15/2007	39	17	29	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	12/10/2007	42	16	37	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	4/21/2008	26	10	96	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	7/1/2008	68	13	64	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	7/12/2008	73	14	40	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	7/14/2008	80	13	56	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	7/14/2008	77	13	55	Duplicate
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/29/2009	37	21	11	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	6/1/2010	77	15	16	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	6/1/2010	79	15	16	Duplicate
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	6/30/2010	77	15	9.6	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	8/25/2010	101	10	35	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	9/1/2010	112	11	29	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	9/8/2010	68	13	18	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	9/8/2010	66	13	17	Duplicate
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	9/15/2010	60	14	13	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	9/23/2010	68	13	19	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/1/2010	47	19	13	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/8/2010	50	17	11	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/12/2010	52	17	15	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/22/2010	57	14	11	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/26/2010	60	15	32	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/27/2010	49	18	23	
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/27/2010	49	18	23	Duplicate
420182	040201030404-01	Eagle River, East Branch	Gratiot Lake Road (ER-C)	47.40306	-88.1986	Keweenaw	10/29/2010	35	21	12	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	6/15/2007	58	18	22	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	7/29/2007	98	14	4.5	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	7/29/2007	102	14	3.5	Duplicate
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	8/3/2007	99	15	6.7	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	11/10/2007	41	15	8.2	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	11/15/2007	36	18	5.5	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	12/10/2007	38	14	74	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	4/21/2008	23	11	4.4	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	7/1/2008	70	15	3.9	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	7/12/2008	73	14	11	
420183	040201030404-01	Eagle River, East Branch	u/s end of Central Mine #1 (ER-A)	47.40278	-88.1958	Keweenaw	7/14/2008	69	15	7.2	
420184	040201030404-01	Eagle River, East Branch	within the wetland at Central Mine # 1 (ER-WL-Stream)	47.403	-88.1969	Keweenaw	7/15/2008	60	16	15	
420184	040201030404-01	Eagle River, East Branch	within the wetland at Central Mine # 1 (ER-WL-Stream)	47.403	-88.1969	Keweenaw	7/16/2008	59	17	9.4	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420185	N/A	Eagle River, East Branch	Outlet of the poor rock pile at Central Exploration Mine CM-Explore-1 (ER-Central Exploration)	47.39897	-88.178	Keweenaw	7/30/2007	72	7.3	48	
420185	N/A	Eagle River, East Branch	Outlet of the poor rock pile at Central Exploration Mine CM-Explore-1 (ER-Central Exploration)	47.39897	-88.178	Keweenaw	11/10/2007	44	19	44	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	6/1/2010	62	9.1	77	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	6/30/2010	54	12	37	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	9/1/2010	87	8.2	70	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	9/8/2010	55	13	48	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	9/15/2010	50	14	55	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	9/23/2010	50	13	63	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	10/1/2010	42	16	51	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	10/8/2010	51	13	54	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	10/12/2010	54	12	61	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	10/22/2010	54	11	46	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	10/27/2010	40	17	42	
420207	040201030404-01	Eagle River, East Branch	d/s, Eagle River within CM-3 deposit, near US-41 (CM3-D/S)	47.4034	-88.2241	Keweenaw	10/29/2010	32	17	32	
420208	040201030404-01	Eagle River, West Branch	North American-1 (d/s of Cliffs-u/s)	47.36758	-88.3212	Keweenaw	6/1/2010	73	2.1	4.2	
420208	040201030404-01	Eagle River, West Branch	North American-1 (d/s of Cliffs-u/s)	47.36758	-88.3212	Keweenaw	6/30/2010	74	5.6	5	
420209	040201030404-01	Eagle River, East Branch	CM-1-1	47.4027	-88.1963	Keweenaw	10/26/2010	51	16	23	
420210	040201030404-01	Eagle River, East Branch	CM-1-2	47.40268	-88.1971	Keweenaw	10/26/2010	54	16	16	
420211	040201030404-01	Eagle River, East Branch	CM-1-3	47.40295	-88.1976	Keweenaw	10/26/2010	77	13	79	
420212	040201030404-01	Eagle River, East Branch	CM 1.5-STREAM	47.40208	-88.2013	Keweenaw	10/27/2010	49	18	53	
420213	040201030404-01	Eagle River, East Branch	CM 1.5-TRIM	47.40218	-88.2014	Keweenaw	10/27/2010	33	16	76	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	6/1/2010	84	12	96	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	6/30/2010	80	13	58	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	6/30/2010	79	13	58	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	8/25/2010	105	9.3	88	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	9/1/2010	129	9.3	110	

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STORET #	AUID	Water Body Name	Station Location	Latitude	Longitude	County	Date	Total Hardness (mg/L)	TOC (mg/L)	Total Copper (µg/L)	Data Notes
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	9/8/2010	71	12	79	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	9/15/2010	62	13	67	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	9/15/2010	60	13	71	Duplicate
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	9/23/2010	70	12	67	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	10/1/2010	52	18	67	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	10/8/2010	55	16	65	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	10/12/2010	59	15	72	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	10/22/2010	65	13	53	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	10/27/2010	51	17	81	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	10/29/2010	38	19	51	
420215	040201030404-01	Eagle River, East Branch	new ATV trail crossing within Central #2 (SMT or SMT-2)	47.40167	-88.2075	Keweenaw	10/29/2010	41	20	48	Duplicate
420216	040201030401-05	Hills Creek	Hills 1-u/s (HC-1)	47.31352	-88.4258	Keweenaw	7/2/2010	71	5.9	2.5	
420216	040201030401-05	Hills Creek	Hills 1-u/s (HC-1)	47.31352	-88.4258	Keweenaw	10/27/2010	61	7.8	3.1	
420217	040201030401-05	Hills Creek	Hills 2-u/s (HC-2)	47.32196	-88.4388	Keweenaw	7/2/2010	109	3	37	

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420218	040201030401-05	Hills Creek	Hills 3-u/s (HC-3)	47.32198	-88.4413	Keweenaw	7/2/2010	108	3	35	
420219	040201030401-05	Hills Creek	Hills 4-u/s (HC-4)	47.32431	-88.4445	Keweenaw	7/2/2010	109	3	34	
420220	040201030401-05	Hills Creek	Hills 4-u/s (HC-5)	47.32644	-88.4608	Keweenaw	7/2/2010	110	3	35	
420221	040201030401-05	Hills Creek	Hills 6-u/s (HC-6)	47.33176	-88.4644	Keweenaw	7/2/2010	108	3	41	
420222	040201030401-05	Hills Creek	Hills 1-d/s	47.31721	-88.4321	Keweenaw	10/29/2010	72	6.5	46	
420223	N/A	Hills Creek	Hills 1-mine outlet	47.31455	-88.4265	Keweenaw	10/29/2010	99	3.2	46	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	6/1/2010	86	11	140	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	6/30/2010	80	13	100	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	8/25/2010	110	9.2	120	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	9/1/2010	130	9	120	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	9/8/2010	74	12	130	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	9/15/2010	65	13	150	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	9/23/2010	74	13	130	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	10/1/2010	52	17	170	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	10/1/2010	53	17	170	Duplicate
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	10/8/2010	60	16	130	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	10/12/2010	60	15	140	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	10/22/2010	46	13	87	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	10/27/2010	50	18	140	
420224	040201030404-01	Eagle River, East Branch	d/s end of Central #2 deposit	47.40246	-88.2091	Keweenaw	10/29/2010	42	20	89	
660107	040201010107-02	Portal Creek	CC1 (mouth confluence with Mineral River)	46.79505	-89.5597	Ontonagon	6/21/2008	165	11	36	

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660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	6/25/2001	76		22	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	5/17/2007	75	10	26	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	5/31/2007	76	7.8	21	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	7/12/2007	86	5.4	11	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	9/14/2007	93	4.8	10	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	9/28/2007	59	16	31	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	10/17/2007	47	18	40	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	10/17/2007	47	18	39	Duplicate
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	10/22/2007	37	20	38	
660113	040201030107-01	East Sleeping River	Snowmobile Trail	46.96	-89.0653	Ontonagon	10/25/2007	44	14	54	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	7/10/2006	75	2	18	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	5/17/2007	69	7.3	33	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	5/31/2007	64	5	30	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	7/12/2007	78	3.2	13	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	9/14/2007	74	3.9	29	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	9/28/2007	62	12	51	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	10/17/2007	48	16	76	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	10/22/2007	39	16	70	
660126	040201030107-03	Sleepy Creek	below Red Creek	46.8805	-88.9436	Ontonagon	10/25/2007	44	14	54	
660138	040201010109-01	Duck Creek, West Branch	LP Walsh Road	46.7371	-89.5005	Ontonagon	5/23/2005	26		7.77	
660138	040201010109-01	Duck Creek, West Branch	LP Walsh Road	46.7371	-89.5005	Ontonagon	7/18/2005	44	16	6.85	
660138	040201010109-01	Duck Creek, West Branch	LP Walsh Road	46.7371	-89.5005	Ontonagon	11/8/2005	30	9.3	7.22	
660138	040201010109-01	Duck Creek, West Branch	LP Walsh Road	46.7371	-89.5005	Ontonagon	5/30/2006	26	12	11.6	
660138	040201010109-01	Duck Creek, West Branch	LP Walsh Road	46.7371	-89.5005	Ontonagon	7/18/2006	54	16	8.76	
660138	040201010109-01	Duck Creek, West Branch	LP Walsh Road	46.7371	-89.5005	Ontonagon	11/13/2006	50	10	6.56	
660160	040201010108-NA	Pine Creek	NE #2 Tailing Basin	46.8065	-89.4894	Ontonagon	6/20/2008	169	10	6.6	
660161	040201010108-NA	Pine Creek	Upstream M-64 (Lower)	46.83533	-89.4886	Ontonagon	6/20/2008	148	8.1	5.8	
660162	040201010107-02	Portal Creek	Upper road crossing near tailings basin	46.78146	-89.5591	Ontonagon	6/21/2008	165	14	54	
660163	040201010108-NA	Pine Creek	LP Walsh Road	46.73678	-89.5147	Ontonagon	6/20/2008	60	9.2	10	
660164	040201010109-NA	Duck Creek	Logging Road Crossing	46.8277	-89.4694	Ontonagon	6/20/2008	56	8	6.2	
660165	040201010109-NA	Halfway Creek	Townline Road Crossing	46.83009	-89.4597	Ontonagon	6/20/2008	71	7.2	4.2	