

**Date: March 28, 2008**

**To: Foth Infrastructure & Environment, LLC**

**From: R. Douglas Workman, Ph.D., Advanced Ecological Management, LLC**

**Memo: Eagle Project, Investigations of the Main Branch of the Salmon Trout River, tributaries in the East Branch of the Salmon Trout River, the Yellow Dog River, and Cedar Creek.**

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## **INTRODUCTION**

Advanced Ecological Management, LLC (AEM) conducted a fall fish survey at ten previously established stream sample stations on October 29, 30, and 31, 2007 for Kennecott Eagle Minerals Company. Fish communities were evaluated within the Salmon Trout River and its tributaries, the Yellow Dog River, and Cedar Creek.

## **Study Area**

The Salmon Trout River and its tributaries are characterized by a variety of habitat types in the vicinity of the sites that were investigated for this study. Physical habitat characteristics include slow-flowing segments with silt substrates that have been influenced by beaver activity, and high-gradient segments flowing through forested and hilly terrain. The headwaters of the Salmon Trout River begin in the Yellow Dog Plains and flow north through the Huron Mountains, and eventually into Lake Superior at Salmon Trout Bay, which is located northwest of Big Bay (Figure 1-1). The Yellow Dog River flows to the east along the southern boundary of the Yellow Dog Plains, and Cedar Creek flows to the north and is not located within the same watershed as the proposed mining project. Cedar Creek serves as a reference stream for the Eagle Project.

## **METHODS**

Aquatic community sampling was conducted by AEM from October 29, 2007 through October 31, 2007. A total of ten stations were sampled, including five stations in the Main Branch of the Salmon Trout River, three stations in tributaries to the East Branch of the Salmon Trout River, one station in the Yellow Dog River, and one station in Cedar Creek (Figure 1-2).

Stations were blocked at the upstream and downstream extents using seines that measured 4 feet by 50 feet, with a 0.19-inch mesh size. A backpack electro-fishing unit was used in narrow (approximately  $\leq 10$  feet) or difficult-to-access stations (e.g., areas with abundant woody debris). A barge-mounted electro-fishing unit was used to sample stations that were deeper (approximately 2 to 3 feet), wider (approximately  $> 10$  feet), and where woody debris was sparse enough to permit the passage of the barge unit. When adequate habitat conditions permitted, a multi-pass removal technique was used to evaluate fish abundance throughout each station (Van Deventer and Platts, 1983). The duration of electroshocking was recorded for each pass and stunned fish were placed in a live well for identification and enumeration. Following each pass and subsequent fish identification, the enumerated fish were released approximately 100 feet upstream of the station to avoid re-collection in subsequent passes.

One representative of each species that was not identifiable in the field was placed in a voucher jar containing 10% formalin for later identification. Each voucher jar was labeled according to the sample location and date. Fish were identified to species using various taxonomic references (Eddy and Underhill, 1978; Becker, 1983; Page and Burr, 1991; Pflieger, 1997; Coon, 2001; Bailey et al., 2003). The Michigan County Element List (MNFI, 2007) was also reviewed to determine if any threatened, endangered, or special concern fish species occurred within the Salmon Trout River and its tributaries, the Yellow Dog River, or Cedar Creek.

Wetted stream width was measured at the lower, middle, and upper extent of each sample station. Depth was measured in the center, and at 20% and 80% of each stream width cross section. Stream discharge (gallons per minute - gpm) was measured with a Marsh-McBirney flow meter. Water temperature, pH, dissolved oxygen, and conductivity were measured using a Yellow Springs Instrument Model YSI 556 water quality meter. Photographs were taken at each station to illustrate the conditions during the sampling period.

## **RESULTS**

A total of 480 fish and six species were observed among all ten stations during October, 2007 (Table 1). Fish were collected from all stations, with over 70% of total fish captured in Station 6. No MNFI listed threatened or endangered fish species were

identified in the stations investigated in the Salmon Trout River and its tributaries, Yellow Dog River, and Cedar Creek in Marquette County, Michigan (MNFI, 2007).

## Salmon Trout River

### Main Branch: Stations 1, 2, 3, 6 and 7

#### Station 1

Station 1 is located in a narrow valley with relatively steep slopes rising more than 100 feet to the Yellow Dog Plains. Station 1 was sampled with a backpack electro-fishing unit and has a length of 120 feet. Brook trout (*Salvelinus fontinalis*) ranged in length from 3.4 to 5.9 inches (average,  $\bar{x}$  = 4.3 inches; sample size,  $n$  = 3; standard deviation,  $s$  = 1.4 inches) and weighed between 0.2 and 1.4 ounces ( $\bar{x}$  = 0.7 ounces,  $n$  = 3,  $s$  = 0.7).

The average width of Station 1 was 8.0 feet ( $n$  = 3;  $s$  = 1.3) and the average depth was 0.6 feet ( $n$  = 9;  $s$  = 0.1; Table 2). Streambanks were vegetated with herbaceous and woody vegetation in fall dormancy (Photograph C-1). The streambed is characterized by a relatively steep gradient and the substrate was comprised of a variety of particles including sand, gravel, cobble, and boulders. Woody debris was frequently observed throughout the station (Photograph C-2). Stream flow was measured at the downstream extent of Station 1 and discharge was estimated at 1,601 gallons per minute (gpm; Table 3).

#### Stations 2 and 3

Station 2 is located immediately upstream of Triple A Road northwest (downstream) of the ore body and is 100 feet in length. Station 3 is located immediately downstream of Station 2 and Triple A Road and is 200 feet in length (Figure 1-2). Sampling of both stations was conducted using a backpack electro-fishing unit. Eight brook trout, two blacknose dace (*Rhinichthys obtusus*), and two pearl dace (*Margariscus margarita*) were captured in Station 2 (Table 1). Brook trout were between 2.5 inches and 5.6 inches in length ( $\bar{x}$  = 3.8 inches;  $n$  = 8;  $s$  = 1.0) and weighed between 0.1 and 1.0 ounces ( $\bar{x}$  = 0.4 ounces;  $n$  = 8;  $s$  = 0.3). Pearl dace were between 3.4 and 3.7 inches in length ( $\bar{x}$  = 3.5 inches;  $n$  = 2;  $s$  = 0.2) and weighed between 0.24 and 0.31 ounces ( $\bar{x}$  = 0.27 ounces;  $n$  = 2;  $s$  = 0.05).

Four brook trout and one pearl dace were captured in Station 3 (Table 1). Brook trout lengths ranged from 3.8 inches to 7.1 inches ( $\bar{x}$  = 5.2 inches;  $n$  = 4;  $s$  = 1.4) and weighed between 0.3 ounces and 2.2 ounces ( $\bar{x}$  = 1.1 ounces;  $n$  = 4;  $s$  = 0.8).

The average width of Station 2 was 7.3 feet ( $n$  = 3;  $s$  = 1.3) and the average depth was 1.0 feet ( $n$  = 9;  $s$  = 0.3; Table 2). The average width of Station 3 was 8.2 feet ( $n$  = 3;  $s$  = 2.3) and the average depth was 0.5 feet ( $n$  = 9;  $s$  = 0.3; Table 2). The streambanks of Stations 2 and 3 were vegetated with speckled alder (*Alnus rugosa*) and bluejoint grass (*Calamagrostis canadensis*; Photographs C-3, C-4, C-5, and C-6). Substrate was predominately sand with large cobbles and boulders in the vicinity of the Triple A Road crossing. Stream flow was measured approximately 20 feet upstream of Triple A Road crossing was 954 gpm (Table 3).

### Station 6

Station 6 is located in the vicinity of the ore body (Figure 1-2). Station 6 is 300 feet in length and was sampled with a barge mounted electro-fishing unit. Fish species collected included blacknose dace, brook stickleback (*Culaea inconstans*), brook trout, finescale dace (*Phoxinus neogaeus*), and northern redbelly dace (*Phoxinus eos*; Table 1). Brook trout were between 3.3 and 6.3 inches in length ( $\bar{x}$  = 4.2 inches;  $n$  = 21;  $s$  = 0.8) and weighed between 0.3 and 1.2 ounces ( $\bar{x}$  = 0.5 ounces;  $n$  = 21;  $s$  = 0.3).

The average width of Station 6 was 19.6 feet ( $n$  = 3;  $s$  = 2.2) and the average depth was 1.4 feet ( $n$  = 9;  $s$  = 0.5; Table 2). Streambanks were characterized by tussock sedge (*Carex stricta*), iris (*Iris* sp.), rush (*Juncus* sp.), and speckled alder (Photographs C-7 and C-8). Much of the aquatic vegetation was growing on organic matter that appeared to function as a floating mat of vegetation. The substrate of Station 6 was predominantly comprised of organic matter and fine sediments, such as silt and clay. Beaver dams were observed downstream of Station 6 and large woody debris was abundant throughout the stream channel.

### Station 7

Station 7 is located near the headwaters of the Salmon Trout River and is influenced by beaver dams throughout the vicinity. Station 7 is 100 feet in length and was sampled

with a backpack electro-fishing unit. Fish species present were blacknose dace, brook stickleback, and pearl dace (Table 1).

The average width of Station 7 was 4.4 feet ( $n = 3$ ;  $s = 0.9$ ) and the average depth was 1.8 feet ( $n = 9$ ;  $s = 0.3$ ). Streambanks were vegetated with speckled alder, tussock sedge, rush, and iris (Photographs C-9 and C-10). The substrate was comprised of predominately organic matter and silt, and woody debris was abundant throughout this station. Stream flow was not measured in Station 7 because of channel braiding due to beaver activity.

### **East Branch of the Salmon Trout River: Stations 8, 9, and 10**

#### **Station 8**

Station 8 is 135 feet in length and is located approximately 50 ft south of Northwestern Road (Figure 1-2). Fish were sampled with a backpack electro-fishing unit. Fish species collected included three brook stickleback and two brook trout (Table 1). Brook trout were 6.3 and 8.3 inches in length and weighed 1.4 and 5.8 ounces respectively.

The average width of Station 8 was 6.9 feet ( $n = 3$ ;  $s = 1.5$ ) and the average depth was 0.9 feet ( $n = 9$ ;  $s = 0.4$ ; Table 2). Streambanks were predominately vegetated with speckled alder and tussock sedge (Photographs C-11 and C-12). Substrate was predominantly comprised of sand and silt throughout Station 8.

#### **Station 9**

Station 9 is approximately 85 feet in length and is located immediately west of Northwestern Road (Figure 1-2). The station was sampled with a backpack electro-fishing unit and brook trout were the only fish species collected (Table 1). Brook trout were between 2.4 and 8.2 inches in length ( $\bar{x} = 4.9$  inches;  $n = 24$ ;  $s = 2.0$ ) and weighed between 0.1 and 3.3 ounces ( $\bar{x} = 1.2$  ounces;  $n = 24$ ;  $s = 1.2$ ).

The average width of Station 9 was 8.5 feet ( $n = 3$ ;  $s = 0.8$ ) and the average depth was 1.1 feet ( $n = 9$ ;  $s = 0.5$ ). Speckled alder covered much of the stream channel and contributed to in-stream cover, while the understory was predominately tussock sedge (Photographs C-13 and C-14). The substrate was predominantly comprised of sand and

silt. Stream flow was measured at the downstream extent of Station 9 and discharge was estimated at 5,260 gpm.

**Station 10**

Station 10 is approximately 100 feet in length and is located immediately south of Northwestern Road (Figure 1-2). The station was sampled with a backpack electro-fishing unit and brook trout were the only fish species collected (Table 1). Brook trout were between 3.6 and 7.8 inches in length ( $\bar{x}$  = 4.9 inches;  $n$  = 6;  $s$  = 1.8) and weighed between 0.3 and 3.0 ounces ( $\bar{x}$  = 1.1 ounces;  $n$  = 6;  $s$  = 1.1).

The average width of Station 10 was 6.2 feet ( $n$  = 3;  $s$  = 1.1) and the average depth was 0.6 feet ( $n$  = 9;  $s$  = 0.2). Streambanks were vegetated with large deciduous trees, speckled alder, and other herbaceous vegetation (Photograph C-15). Large woody debris and undercut banks provided in-stream cover throughout this station (Photograph C-16). The substrate was predominantly comprised of sand and silt, although cobble and large boulders were also present. Stream flow was measured at the downstream extent of Station 10 and discharge was estimated at 470 gpm.

**Yellow Dog River: Station 5**

The Yellow Dog River flows east along the southern boundary of the Yellow Dog Plains (Figure 1-2). In previous sampling efforts Station 5 was 300 feet in length, but due to high water, sampling length was limited to 268 feet. The station was sampled with a barge electro-fishing unit and fish species collected included blacknose dace and brook trout (Table 1). The brook trout captured was 5.9 inches in length and weighed 1.3 ounces.

The average width of Station 5 was 26.3 feet ( $n$  = 3;  $s$  = 6.6) and the average depth was 1.9 feet ( $n$  = 9;  $s$  = 0.8). Streambanks were vegetated with a dense covering of speckled alder, contributing to in-stream cover (Photographs C-17 and C-18). The substrate was predominantly comprised of sand and silt, and woody debris was abundant throughout Station 5. Stream flow was measured at the downstream extent of Station 5 and discharge was estimated at 17,079 gpm.

**Cedar Creek: Station 4**

Cedar Creek is located northwest of the primary research area (Figure 1-2). Station 4 is 300 feet in length and flows in a northerly direction. The station was sampled with a barge electro-fishing unit and fish species collected included brook trout and brook stickleback (Table 1). Brook trout were between 2.1 and 10.4 inches in length ( $\bar{x}$  = 4.0 inches;  $n$  = 43;  $s$  = 1.9) and weighed between 0.1 and 6.9 ounces ( $\bar{x}$  = 6.1 ounces;  $n$  = 43;  $s$  = 1.1).

The downstream extent of Station 4 was located approximately 117 feet upstream of Northwestern Road (Figure 1-2). Station 4 had an average width of 15.6 feet ( $n$  = 3;  $s$  = 0.5) and an average depth of 1.9 feet ( $n$  = 9;  $s$  = 0.5). The riparian vegetation throughout much of the station was predominantly speckled alder and tussock sedge (Photograph C-19). A beaver dam was located near the upstream extent of the station (Photograph C-20). Stream flow was measured at the downstream extent of Station 4 and discharge was estimated at 5,158 gpm.

**Water Quality**

In the Salmon Trout River, water temperatures ranged from 7.6°C in Station 1 to 8.7°C in Station 7 during late October 2007 (Table 3). Water temperatures recorded in Cedar Creek and the Yellow Dog River were cooler ranging from 5.9°C in Station 4 to 6.0°C in Station 5. The pH ranged from 3.5 in Station 5 to 8.2 in Station 10 (Table 3). The average pH among the stations located in the Main Branch of the Salmon Trout River was 6.2 ( $n$  = 5;  $s$  = 1.5). The average pH among the stations located in the East Branch of the Salmon Trout River was 7.8 ( $n$  = 3;  $s$  = 0.5).

Conductivity measurements in the Main Branch of the Salmon Trout River were relatively low ( $\bar{x}$  = 49.8 microSiemens per cm ( $\mu\text{S}/\text{cm}$ );  $n$  = 5;  $s$  = 9.63  $\mu\text{S}/\text{cm}$ ), while measurements in the East Branch of the Salmon Trout River were higher, averaging 104.3  $\mu\text{S}/\text{cm}$  ( $n$  = 3;  $s$  = 2.52  $\mu\text{S}/\text{cm}$ ; Table 3). Station 4 of Cedar Creek had a conductivity of 112  $\mu\text{S}/\text{cm}$  and Station 5 of the Yellow Dog River had a conductivity of 40  $\mu\text{S}/\text{cm}$ .

Dissolved oxygen levels observed during October 2007 were generally consistent with flowing stream conditions. The Salmon Trout River had an average dissolved oxygen level of 8.6 mg/l ( $n$  = 8;  $s$  = 1.88 mg/l). Station 7 had the lowest dissolved oxygen level

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in the Salmon Trout River measuring 4.8 mg/l (Table 3). Station 5 in the Yellow Dog River had the lowest dissolved oxygen level measuring 3.6 mg/l (Table 3). Dissolved oxygen in Station 4 of Cedar Creek was the highest of all sample stations measuring 11.0 mg/l (Table 3).



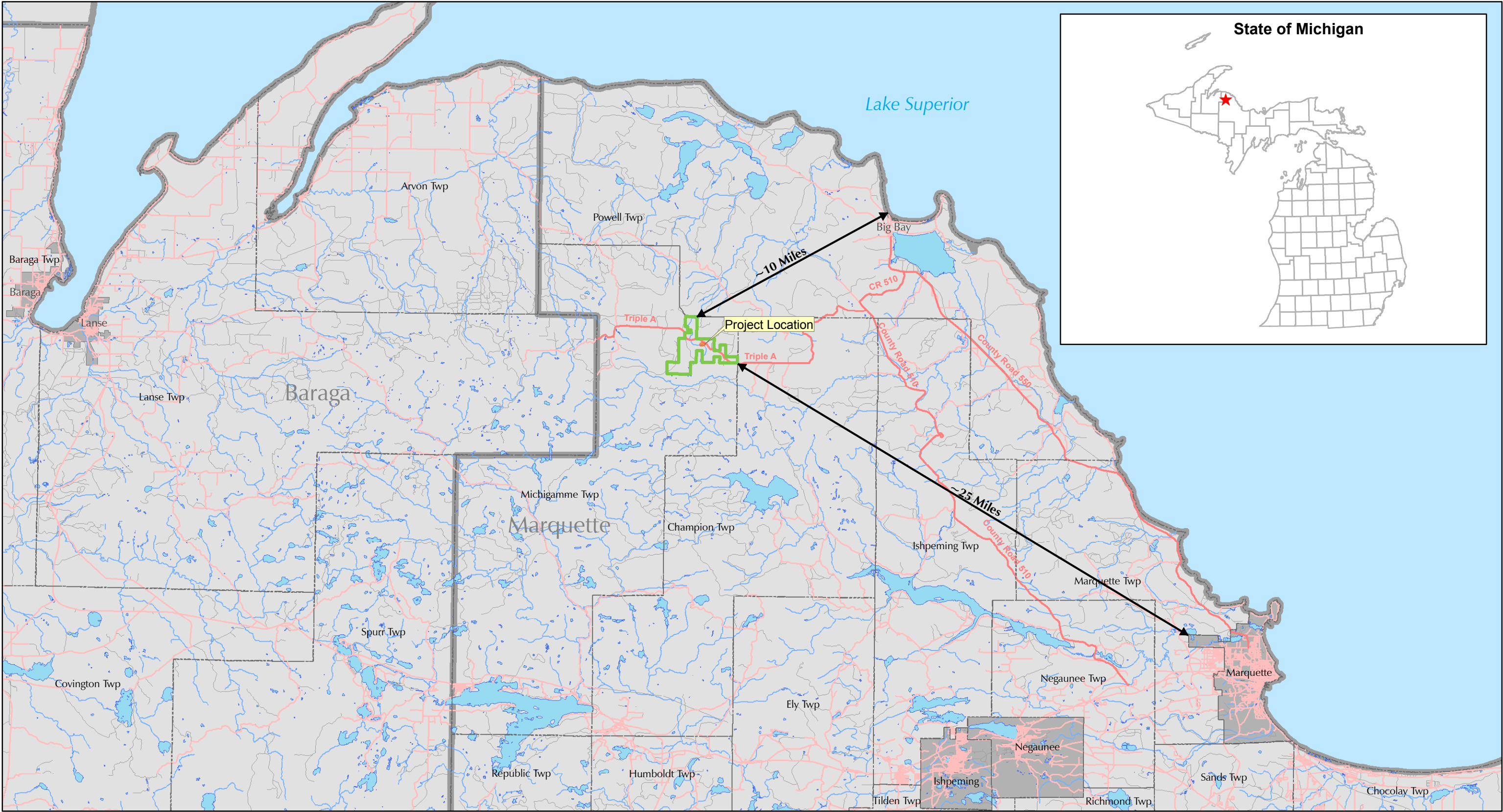
**REFERENCES**

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**ADVANCED ECOLOGICAL MANAGEMENT**

**REPORT FIGURES**



NOTES

- 1. Surface property boundary as of November 18, 2004 supplied by Kennecott via Golder & Associates Inc., August, 2005.
- 2. Horizontal datum based on NAD 83/94.  
Horizontal coordinates based on UTM Zone 16.
- 3. All base information downloaded from Michigan Center of Geographic Information (<http://www.michigan.gov/cgi>).
- 4. Site Location - Project Site within Sections 11 & 12, T50N, R29W, Town of Michigamme, Marquette County, Michigan.

LEGEND

- Counties
- Minor Civil Divisions
- Kennecott Surface Ownership
- Lakes and Rivers
- Highways
- Major Roads
- Minor Roads



Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
CHECKED BY:		AKM	DATE: MAR. '08
APPROVED BY:		SVD1	DATE: MAR. '08
APPROVED BY:			DATE:



FIGURE 1-1  
PROJECT LOCATION

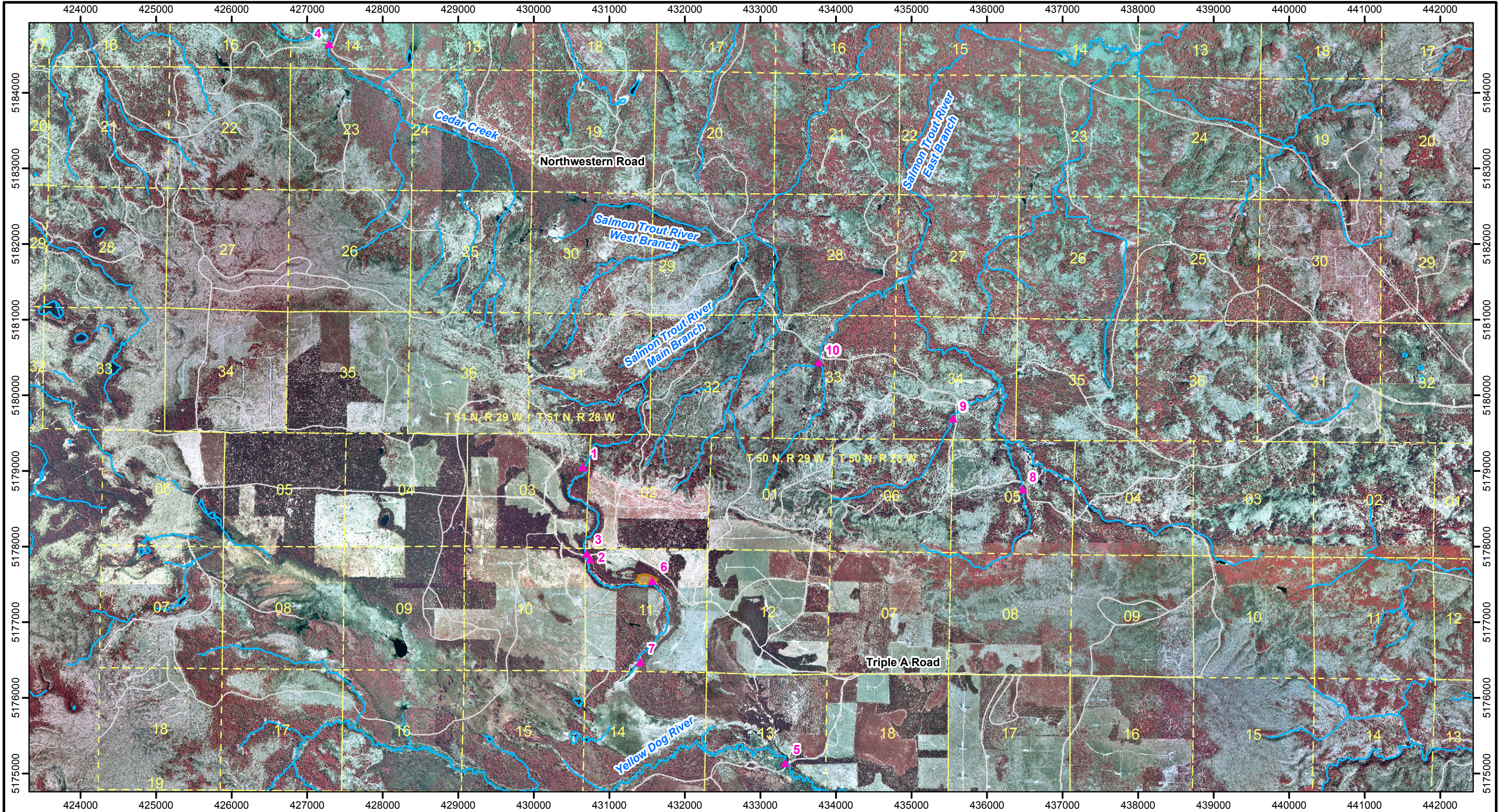
Scale: 0 2 4 Miles

Date: MARCH 2008

Prepared by: DAT

Scope: 04W018





**NOTES**

- 1. Surface Property Boundary, Ore Body, and Orthophotography supplied by Kennecott via Golder Associates Inc., August, 2005.
- 2. Horizontal datum based on NAD 83/94. Horizontal coordinates based on UTM Zone 16.
- 3. Site Location - Project Site within Sections 11 & 12, T50N, R29W, Town of Michigamme, Marquette County, Michigan.

**LEGEND**

- 6 ▲ Aquatic Sampling Location and Number
- River
- Orange Box Ore Body



**Foth Infrastructure & Environment, LLC**

REVISED	DATE	BY	DESCRIPTION
CHECKED BY:		AKM	DATE: MAR. '08
APPROVED BY:		SVD1	DATE: MAR. '08
APPROVED BY:			DATE:



**FIGURE 1-2**  
**KENNECOTT EAGLE PROJECT**  
**2007 AQUATIC SAMPLING LOCATIONS**

Scale: 0 600 1,200 Meters	Date: MARCH 2008
Prepared by: DAT	Scope: 04W018



## REPORT TABLES

**Table 1. Fish community compositions among sampling stations in the Salmon Trout River and its tributaries, the Yellow Dog River, and Cedar Creek, Marquette County, MI, 2007.**

Common name	Station										Species total
	1	2	3	4	5	6	7	8	9	10	
Blacknose dace ( <i>Rhinichthys obtusus</i> )		2			3	6	17				28
Brook stickelback ( <i>Culaea inconstans</i> )				5		317	1	3			326
Brook trout ( <i>Salvelinus fontinalis</i> )	3	8	4	43	1	21		2	24	6	112
Finescale dace ( <i>Phoxinus neogaeus</i> )						2					2
Northern redbelly dace ( <i>Phoxinus eos</i> )						8					8
Pearl dace ( <i>Margariscus margarita</i> )		2	1				1				4
<b>Station total</b>	3	12	5	48	4	354	19	5	24	6	480

**Table 2. Physical stream dimensions among sampling stations in the Salmon Trout River and its tributaries, the Yellow Dog River, and Cedar Creek, Marquette County, MI, 2007.**

Station	Station length (ft)	Average width (ft)	Average depth (ft)
1	120	8.0	0.6
2	100	7.3	1.0
3	200	8.2	0.5
4	300	15.6	1.9
5*	268	26.3	1.9
6	300	19.6	1.4
7	100	4.4	1.8
8	135	6.9	0.9
9	85	8.5	1.1
10	100	6.2	0.6

Salmon Trout River Main Branch: Stations 1, 2, 3, 6, 7

Salmon Trout River East Branch: Stations 8, 9, 10

Cedar Creek: Station 4

Yellow Dog River: Station 5

\*Note: Station 5 sampling length was shorter than previous efforts due to sampling limitations from high water.

**Table 3. Water quality measurements among sampling stations in the Salmon Trout River and its tributaries, the Yellow Dog River, and Cedar Creek, Marquette County, MI, 2007.**

Station	Date	Time	Temp (°C)	pH	Conductivity μS/cm	DO (mg/l)	%DO	Discharge (gpm)
1	10/31/07	13:12	7.6	8.0	62	7.85	65.2	1,601
2	10/31/07	10:32	7.8	6.2	51	9.82	82.6	954
3	10/31/07	10:58	7.8	6.1	51	9.23	77.5	954
4	10/30/07	9:40	5.9	7.1	112	10.97	87.8	5,158
5	10/29/07	17:46	6.0	3.5	40	3.55	94.0	17,079
6	10/29/07	14:55	7.7	4.0	50	9.73	82.2	*
7	10/31/07	15:44	8.7	6.8	35	4.80	6.8	*
8	10/30/07	17:10	7.9	7.2	104	10.71	90.2	*
9	10/30/07	17:25	8.2	8.0	107	9.18	78.4	5,260
10	10/30/07	13:14	8.2	8.2	102	7.28	61.1	470

Salmon Trout River Main Branch: Stations 1, 2, 3, 6, 7

Salmon Trout River East Brach: Stations 8, 9, 10

Cedar Creek: Station 4

Yellow Dog River: Station 5

REPORT PHOTOGRAPHS



**Photograph C-1. Station 1 - Downstream extent. View south.**



**Photograph C-2. Station 1 – Upstream extent. View north.**





Photograph C-3. Station 2 – Downstream extent. View south.



Photograph C-4. Station 2 – Upstream extent. View north.



Photograph C-5. Station 3 – Upstream extent. View north.



Photograph C-6. Station 3 – Downstream extent. View south.





**Photograph C-7. Station 6 – Upstream extent. View west.**



**Photograph C-8. Station 6 – Downstream extent. View southeast.**





Photograph C-9. Station 7 – Downstream extent. View south.



Photograph C-10. Station 7 – Upstream extent. View north.





Photograph C-11. Station 8 – Downstream extent. View south.



Photograph C-12. Station 8 – Upstream extent. View north.





Photograph C-13. Station 9 – Downstream extent. View southwest.



Photograph C-14. Station 9 – Upstream extent. View northeast.





Photograph C-15. Station 10 – Downstream extent. View south.



Photograph C-16. Station 10 – Upstream extent. View north.





Photograph C-17. Station 5 – Downstream extent. View west.



Photograph C-18. Station 5 – Upstream extent. View east.





Photograph C-19. Station 4 – Downstream extent. View southeast.



Photograph C-20. Station 4 – Upstream extent. View northwest.