CLINTON CREEK MINE SITE
FISHERIES AND BENTHIC INVERTEBRATE ASSESSMENT MONITORING, 2007

Prepared for

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April, 2008

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EXECUTIVE SUMMARY

Field investigations conducted in tributaries to Hudgeon Lake and Hudgeon Lake, near the Clinton Creek mine site, were conducted during the summer of 2007. The investigations were designed to determine the level of fish utilization and the extent of benthic invertebrate colonization.

The tributaries offer limited amounts of shallow water habitats suitable for seasonal fish utilization and provide well oxygenated water suitable for fish. No fish were recorded in any of the tributaries or in any of the lake environments and it is believed the limiting factor to fish utilization in the creek habitats is lack of over winter habitats. Hudgeon Lake is known to be anoxic below 5 meters depth and has an environment that cannot support fish.

The gabion basket constructed channel downstream of the lake was a barrier to fish passage at observed flow levels although it may be passable at higher flows as a single Arctic grayling was recorded by DFO in 2005.

Healthy benthic populations were recorded in Easter Creek and at the lake outlet. Smaller populations were found at all other sites.

1.0 INTRODUCTION

The following field program was conducted at the abandoned Clinton Creek asbestos mine during July and August of 2007. The investigation was designed to assess the impacts of the rock filled gabion basket structures constructed at the outlet of Hudgeon Lake on fish and benthic invertebrate utilization upstream. The investigations were conducted under the authority of fish collection license 07-19 issued by the Department of Fisheries and Oceans.

2.0 STUDY AREA AND BACKGROUND

The study was conducted on environments surrounding Hudgeon Lake and included investigating Hudgeon Lake, four tributaries to the lake, the outlet flow from the lake above and below the constructed gabion baskets and in Wolverine Creek, a tributary to Clinton Creek downstream of the Gabion structures. The tributaries to Hudgeon Lake investigated were Easter Creek, Bear Creek, Upper Clinton Creek, a tributary to Upper Clinton Creek, and an unnamed tributary near Easter Creek (Figure 1).

Hudgeon Lake was created when tailings from the abandoned Clinton Creek asbestos mine slumped into the creek channel in 1974 and blocked the outflow of Clinton Creek.
Fish have not been recorded in Hudgeon Lake since the construction of the gabion baskets in 2002 when Arctic grayling were observed at the outlet of the lake.
Hudgeon Lake is a meromictic lake, meaning that it does not mix to depth and only the top few meters of the lake mix. The lower reaches of the lake have high salinity and virtually no oxygen (Per. Com., Werner Liebau INAC, 2007).

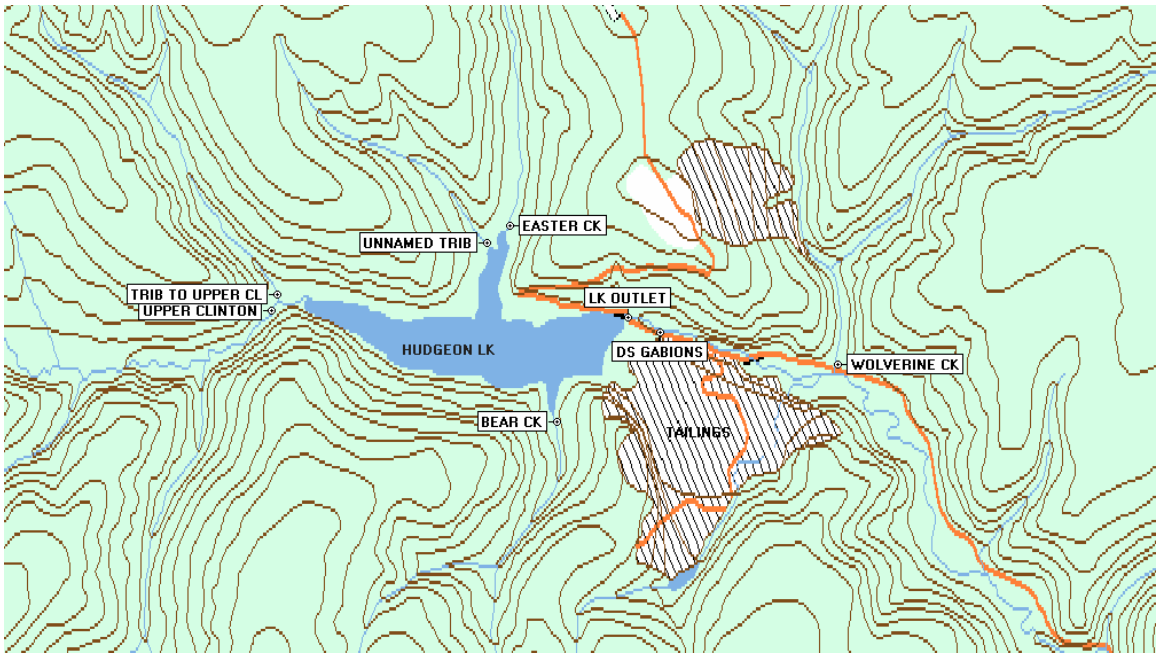

Figure 1: Map of the study area (1:50,000) showing sample locations in relation to the abandoned mine site and Hudgeon Lake.

3.0 Methodology

The field component of this project consisted of fish habitat assessments, fish utilization assessment and a benthic invertebrate survey of potential habitats associated with Hudgeon Lake and Clinton Creek near the gabion structures. The assessments included two separate visits to the site, the first between July 9 and 14 and the second between August 9 and 14, 2007. A total of 9 different sample sites were assessed including the lake.

Hudgeon Lake was accessed with a 4x4 truck and a zodiac boat was used to access the tributaries across the lake and for setting of gillnets.

The intent of the fisheries component of the project was to document the extent of fish utilization and fish habitats. A standardized evaluation criterion to document extent of fish habitat and fish utilization was used. The benthic collection techniques used conform to the standardized practice for the Yukon.

Sample sites were established on all tributaries to Hudgeon Lake that extended for at least 200 meters upstream of the lake. Habitat assessments included biophysical observations (stream dimensions. flow rates, riparian vegetation, substrate, bank stability, water pH, conductivity and temperature). Stream dimensions were measured with either a hip chain or a laser range finder or both, velocities were calculated using a floating object technique. Water pH, conductivity and temperature were measured using hand held Hanna instruments. Dissolved oxygen was measured using a DO test kit. Site locations were recoded and plotted using a hand held GPS. A photographic record of sample sites and work activities including any anomalies was maintained. All information was recorded onto general description forms and later transferred to a suitable computer format.

Evaluations for fish utilization within the creek environments consisted of several techniques to ensure capture of all species present. The primary collection technique used in the tributaries was electro-fishing with a Smith-root type 2 battery powered back pack electro fisher. Secondary techniques included, minnow traps set at all sampling locations with a variety of baits including chinook salmon roe (Yukon River origin), bread and fish food pellets. Beach seining was attempted along the lake shore however was very difficult due to submerged woody vegetation.

Angling with light spinning gear was attempted at several locations on Hudgeon Lake and in the outlet area and in the pools between the gabion structures. The tributaries had few angling or seining opportunities although Upper Clinton Creek provided excellent seining opportunities.

Hudgeon Lake was sampled using small mesh gillnets, angling and minnow traps. Initial sets were of short duration (1 hour or less), the duration of net sets was extended as the project proceeded and several overnight sets were made. Gillnets were set in a variety of habitats, including in shallow areas near creek outlets and in deeper areas of the lake off of points.

Benthic collections were made using substrate baskets installed during the July assessment and were retrieved during the August assessment. A triplicate set of baskets was installed at each creek site and the samples from each set of three baskets were combined when retrieved. Care was taken to ensure all samplers were placed in gravel to cobble strewn areas at each site, to maximize colonization. At each site the baskets were placed in the location with deepest and highest velocity flows.

The August sampling included a repeat of all sampling procedures conducted during the July sampling and a re-assessment of physical habitats including site stability. Benthic baskets were retrieved and the invertebrates were collected and stored in labeled nalgene bottles with 10% formalin.

Benthic samples were shipped to Dr. Charles Low, an entomologist in Victoria, British Columbia, at the completion of sampling for sorting, enumeration and identification to the species level. A report summarizing the results of the benthic sampling was prepared by Bonnie Burns.

4.0 RESULTS

No fish were found in any of the habitats upstream of the Gabion structure during this project during either of the sampling periods. The only fish recorded were found just below the Gabion structure and consisted of juvenile Arctic grayling, slimy sculpin (all ages) and juvenile chinook salmon.

Benthic invertebrates were collected from five sites within the study area; a tributary to Upper Clinton Creek, Upper Clinton Creek, Bear Creek, Easter Creek and Clinton Creek. Four phyla were found in this study area: Arthropoda, Mollusca, Annelida, and Platyhelminthes. A total of 2,737 individuals, representing 66 different taxonomic groups, were identified within these phyla. These data are presented in Appendix 2.

Abundance and diversity for each community is tabulated and graphed in Figure 2. To further characterize the taxonomic wealth of each community, the diversity was related to the population size using the formula: (Diversity –1) divided by the natural log of the population. Populations were low at the sites. A contributing factor producing low numbers was a significant decrease in flow during the colonization period, resulting in portions of some of the baskets being exposed. This reduced the area available for colonization.

The composition and dominant taxa were determined for each site (Figures 3 to 7). The most abundant species found in the study area was *Diamesa sp*. (of the Order Diptera) forming 18.6% of the total number of individuals collected. This was closely followed by *Podmosta sp.* (of the Order Plecoptera) at 13.6%.

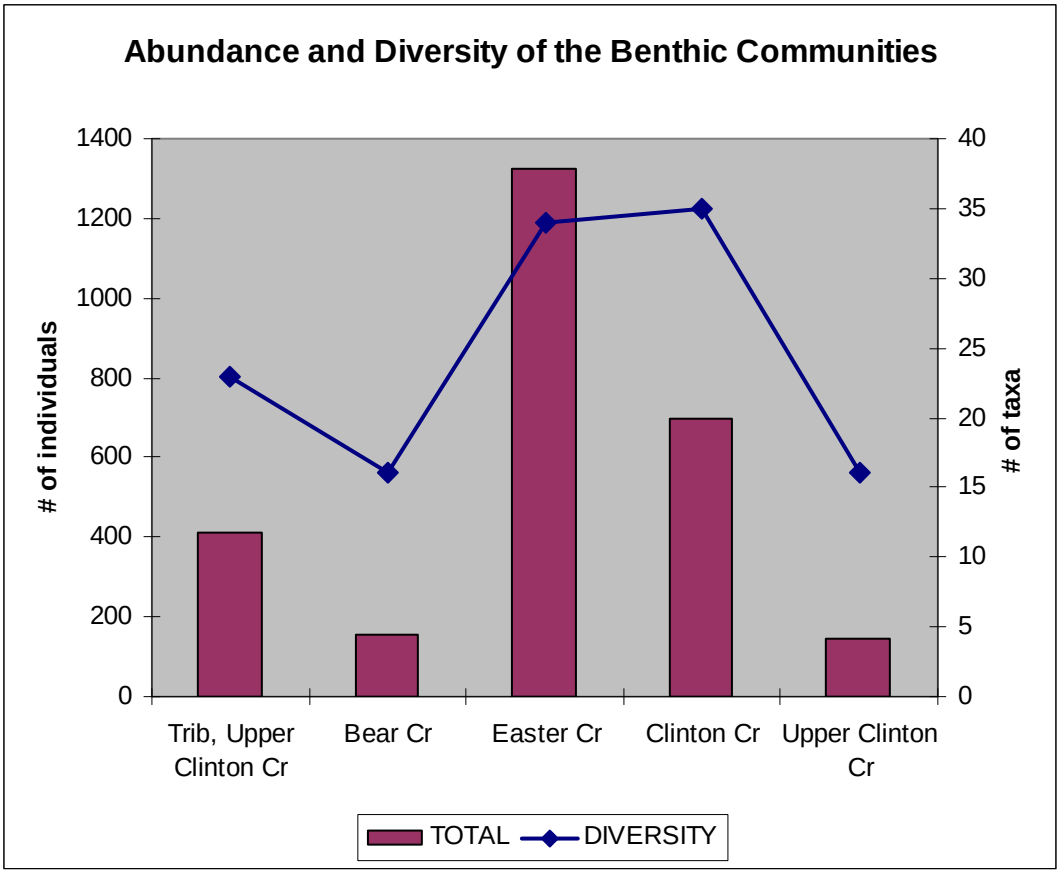

Figure 2: Abundance and diversity of benthic invertebrates from the Clinton Creek Mine Site, 2007.

Table 1: Taxonomic distribution of the benthic communities from the Clinton Creek Mine site area, 2007.

LOCATION	DOMINANT (> 25%)	SUBDOMINANT (10% to 24.9%)	COMMON (1.0% to 9.9%)	RARE (0.1% to 0.9%)
Tributary to Upper Clinton Cr	Plecoptera	Diptera Ephemeroptera	Other Trichoptera	Ostracoda
Bear Creek	Plecoptera	Ostracoda	Other Diptera	Ephemeroptera
Easter Creek	Diptera	Plecoptera	Other Ephemeroptera	Ostracoda Trichoptera
Clinton Creek	Diptera	Gastropoda	Other	Trichoptera Ostracoda Plecoptera
Upper Clinton Creek	Plecoptera Diptera		Trichoptera Ephemeroptera Other	

4.1 Hudgeon Lake

Sampling in Hudgeon Lake consisted of extensive gillnetting during both the July and August investigations, a total of 17 nets were set in July and a total of 16 nets were set in August. Soak times and depths of sets were varied during both periods from 1 hour on the first sets to as long as 28 during subsequent sets and from shore to a maximum depth of 12 meters. A total of four different nets (1", 1.5", 2" and 2.5") were set and reset at all times during the investigation for a total of approximately 300 hours of set time for each sample period. Minnow traps were set near creak outlets and the lake outlet. Seining was difficult within the lake as most of the shoreline has submerged woody vegetation. Seines were pulled at two sites, near the boat launch and at another road access point near the north east corner of the lake. No fish were captured in Hudgeon Lake with any of the techniques. The lake does not offer the potential to provide over wintering habitat for fish and only provides limited summer fish habitat in the near surface waters that oxygenate during the open water season.

4.2 Upper Clinton Creek

Upper Clinton Creek was investigated for a distance of 550 meters upstream of the lake. This creek flows into Hudgeon Lake as a flat bottomed creek with an average dry width of 5 meters, an average wet width of 8 and 4 meters, an average depth of 0.6 and 0.35 meters and an average velocity of 0.5 and <0.5 m/sec. The creek has homogeneous small gravel substrates with small cobbles occurring occasionally away from the lake. Significant channel modifications have occurred in the lower 500 meters of this creek in the past couple of years. A large woody debri pile 550- meters from the lake caused a diversion of splitting the creeks water into a new channel that extends for a distance of

200 meters before rejoining the main channel. The old and partially dewatered channel was at first mistaken for the tributary to Upper Clinton Creek.

Fishing effort consisted of visual assessments, 14 minnow traps during both July and August, electro-fishing 852 seconds in July and 620 seconds in August. Seining was conducted in July as habitats were well suited to this technique, a total of 9 successful seines were pulled. No fish were recorded.

The benthic community at upper Clinton Creek had the lowest population in the study area with 148 individuals collected. Diversity was also low with 16 different taxa identified. One of the baskets was dislodged during high flows at some point following installation. It is assumed that organisms would have been displaced and lost from the sampler during this occurrence. Plecoptera (58%), and Diptera (34%), dominated the community. There were no subdominant groups.

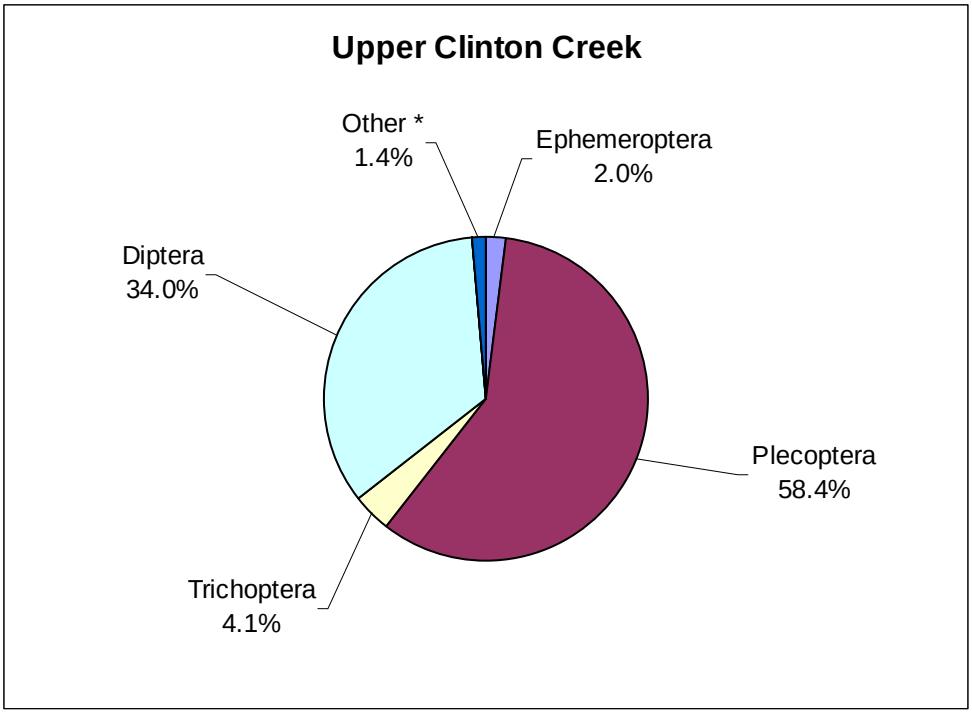

Figure 3: Composition of the benthic community from upper Clinton Creek for 2007.

4.3 Tributary to Upper Clinton Creek

This small unnamed tributary flows into a side channel of Upper Clinton Creek approximately 100 meters upstream of Hudgeon Lake. The creek is narrow and slightly meandering with an average dry width of 1.1 meters, wet width of 1.5 and 1.1 meters, an average depth of 0.4 and 0.15 meters and an average velocity of 0.3 and 0.25 m/sec. The substrates consist of fine gravel with sand and silt and no larges, flow structure is largely dictated by woody debri.

Fishing effort consisted of visual assessments, 5 minnow trap sets during July and August and electro-fishing for 168 70 seconds during July and August. No fish were recorded.

The benthic population contained a total of 411 individuals representing 23 different taxonomic groups. At the time of retrieval, 30% of the baskets were exposed providing less area for colonization. This coupled with the fact that this tributary is a very small stream, contributed to low numbers captured. Plecoptera (stoneflies) and Diptera (true flies) dominated the community, and Ephemeroptera (mayflies) were subdominant.

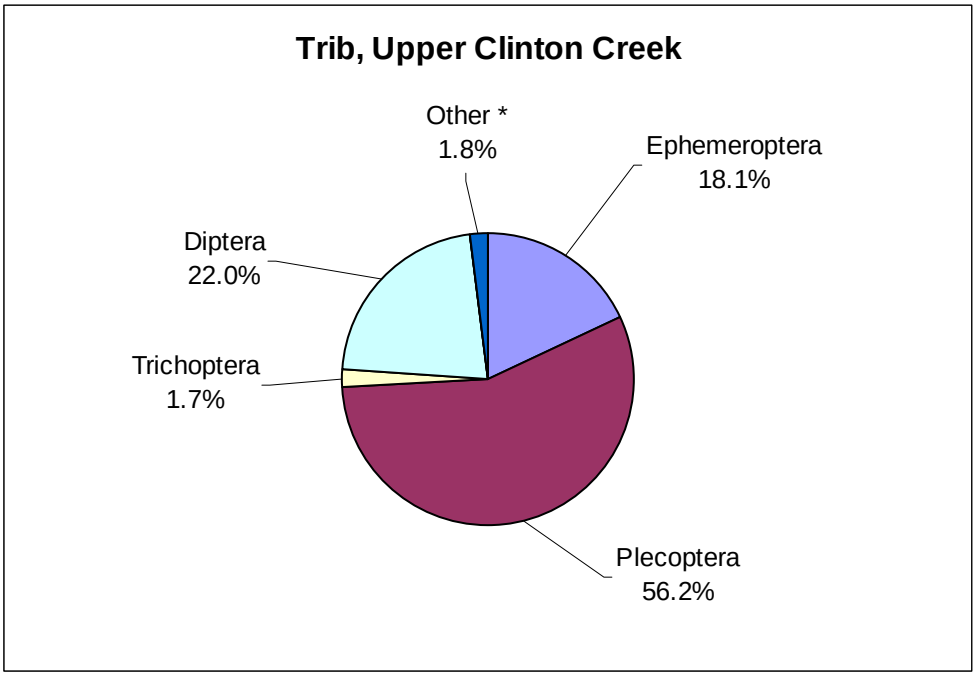

Figure 4: Composition of the benthic community from the tributary to upper Clinton Creek for 2007.

4.4 Bear Creek

Bear Creek flows into Hudgeon Lake as a narrow, deep channeled rill with an average width of 0.8 meters and was bank full during both periods of investigation, had an average depth of >1 and 0.45 meters and an during July and August respectively. The creek had a small flow in July and no flow during the August sampling period. The creek channel is entrenched and well defined with silty substrates and occasional fine gravel patches. Banks rise more than a meter above flow and some recent beaver activity was noted near the lake outlet.

Fishing effort consisted of visual assessments, 9 minnow trap sets during July and electro-fishing for 186 seconds in July and 100 seconds in August. No fish were recorded.

The benthic population was very low at Bear Creek where 157 individuals were collected. The upper portions of the samplers were exposed at the time of retrieval. In addition, there was very little flow and virtually no velocity in August when the baskets were retrieved, accounting for the small population. Diversity was also low with 16 different taxa identified. Plecoptera (stoneflies) dominated this site forming 71% of the community. All of the stoneflies were identified as Podmosta sp. who are shredders of

leaf litter. There was a great deal of organics and leaf litter on the substrate throughout the sample site. Ostracoda (seed shrimps) were subdominant.

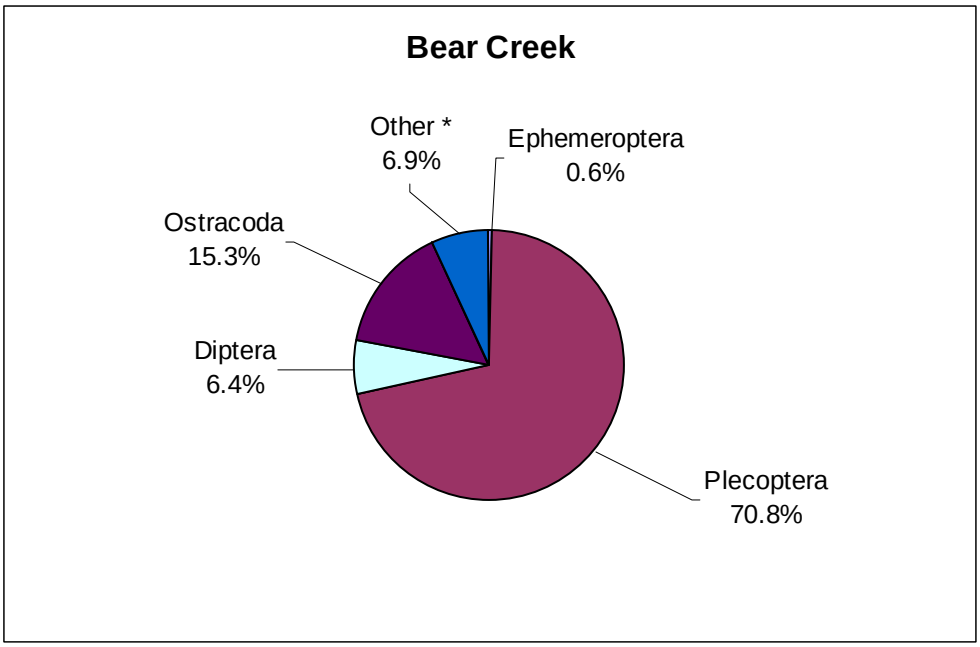

Figure 5: Composition of the benthic community from Bear Creek for 2007.

4.5 Easter Creek

Easter Creek flows into Hudgeon Lake as a flat bottomed creek in an open flood plain with an average dry width of 3 meters, an average wet width of 2.0 and 1.1 meters, an average depth of 0.35 and 0.2 meters and an average velocity of .07 m/sec during July and August respectively. Substrates become coarser moving away from the lake, with significant depositions of loose organic silts and fines at the lake edge followed by a 20 meter area of homogeneous sand and small gravel substrates before small cobbles become more common continuing away from the lake. The channel is loosely defined and is a product of historic beaver activities.

Fishing effort consisted of visual assessment, 9 minnow trap sets during both July and August and 400 and 740 seconds of electro-fishing time. No fish were recorded.

The highest benthic population was found here with a total of 1,345 individuals collected. The population was fairly diverse with 34 different taxonomic groups identified. Dipterans dominated Easter Creek forming 84% of the community. Plecoptera was the subdominant group.

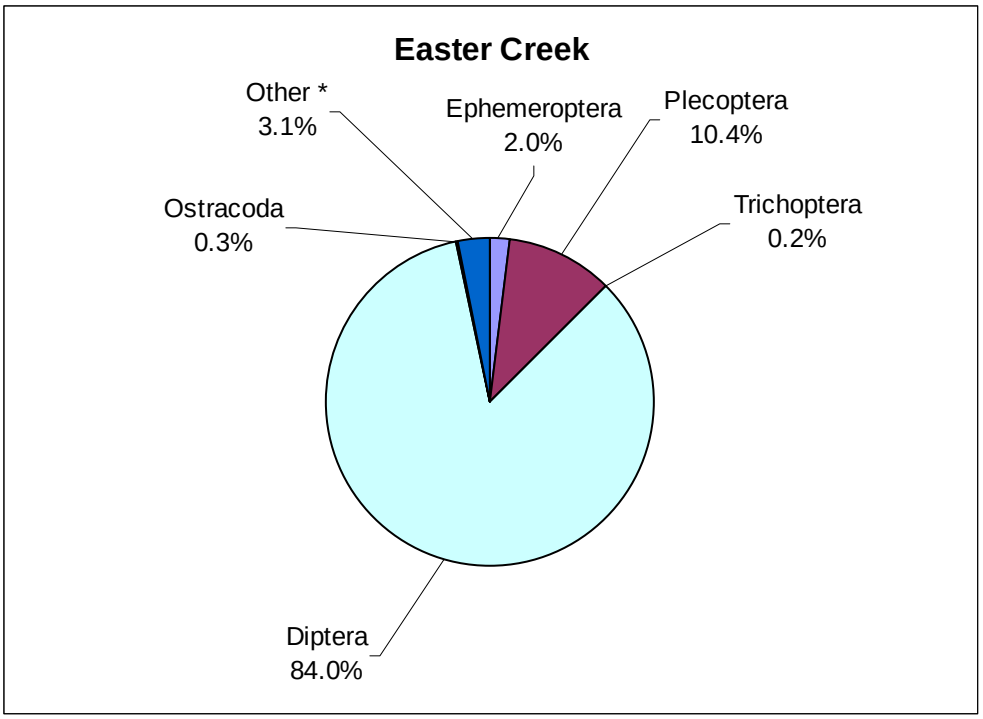

Figure 6: Composition of the benthic community from Easter Creek for 2007.

4.6 Unnamed tributary to Hudgeon Lake

This small unnamed tributary that flows into Hudgeon Lake just north of Easter Creek flowed as a small stepped rill with an average width of 0.5 meters, an average depth of 0.15 meters and an average velocity of 0.5 m/sec. Substrates were entirely organic in origin and flows were directed by woody debri, a gravel outwash area at the lake shore being the exception. This creek was assessed as having no potential for fish utilization more than 5 meters from the lake and only 78 seconds of electro fishing time was applied. No fish were recorded.

4.7 Clinton Creek at outlet of Hudgeon Lake

Clinton Creek flows from Hudgeon Lake through a 30 meter long constructed channel into the gabion structure channel as a flat bottomed creek that had an average width of 7 and 11 meters, an average depth of 0.8 and 0.4 meters, and an average velocity of 0.5 and <0.5 m/sec. during July and August respectively.

Fishing effort consisted of 9 minnow traps set and electro-fishing for over 500 seconds upstream and downstream of the first gabion weir during both July and August sampling periods, visual assessments were also conducted. No fish were recorded in the upper reaches of the gabion structure or in the lake outlet area.

The benthic community at this site on Clinton Creek had the greatest diversity, 35 different taxa, with a population of 696. It also had the highest taxonomic richness index of 5.2 (see Figure XX). The community was dominated by the order Diptera (74%), and Gastropoda (snails) were the subdominant group. Clinton Creek at the outlet of Hudgeon Lake does not represent a typical environment. The baskets rested on top of the gabion wire net structure, rather than on the substrates of a streambed. The water level had

decreased significantly and the baskets were partially submerged and draped in filamentous algae when they were retrieved in August (see photo in Appendix 1).

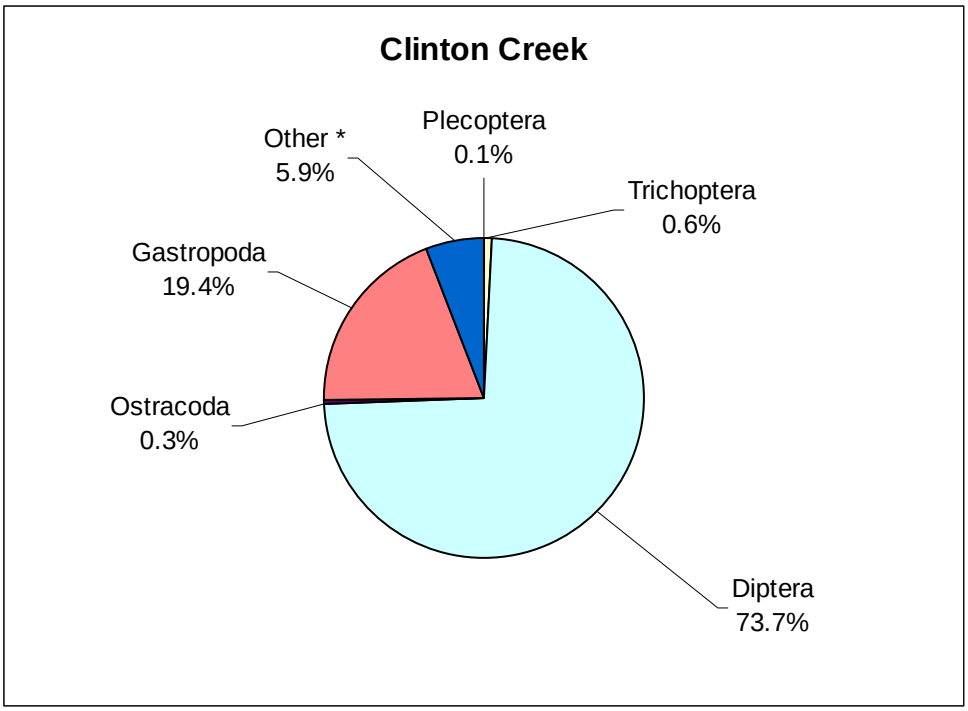

Figure 7: Composition of the benthic community from Clinton Creek immediately downstream of Hudgeon Lake for 2007.

4.8 Clinton Creek downstream of gabion structures

Downstream of the gabion structures Clinton Creek flows in an entrenched channel bordered by a crumbling cliff on the left (east) bank and steep embankment of tailings on the right bank. Flows are turbulent and the substrates consist of loosely consolidated washed cobbles and small boulders

Fishing effort was conducted during the August sampling period only and was restricted to the lowest reaches of the gabion structure and into the native channel for a distance of 15 meters. Effort consisted of 255 seconds of electro-fishing and visual assessment. A total of 5 juvenile chinook salmon (jcs) and 2 sub adult Arctic grayling were recorded. A program of study that involved moving jcs into the upper reaches of Clinton Creek was conducted during the summer of 2007. It is not unlikely that the jcs recorded at this site were from the transplanted fish.

4.8 Wolverine Creek

Wolverine Creek flows into Clinton Creek approximately 1.5 kms downstream of Hudgeon Lake and enters the creek immediately after crossing the mine access road through a culvert. A 180 meter long reach upstream of the culvert was investigated. The creek has an average width of 12 meters dry and 3 meters wet, an average depth of 0.2 meters and an average velocity of 0.75 m/sec. The culvert outlet is perched, has a drop of over 1.5 meters and does not provide opportunities for fish passage.

Fishing effort consisted of 9 minnow traps and 429 seconds of electro-fishing and visual assessment, no fish were recorded. Benthic invertebrates were not collected at this site.

5.0 DISCUSSION

Of the tributaries to Hudgeon Lake both upper Clinton Creek and Easter Creek have potential to provide seasonal (summer) fish utilization. Benthic invertebrate populations in Easter Creek were suitable for supporting fish populations however no fish were found in these creeks during prime season and this is likely a function of limited access during low flow over the gabion structure and a lack of over winter habitats. The anoxic conditions of Hudgeon Lake preclude the potential for the lake to provide over wintering habitat for fish and the creeks are not large enough to provide winter habitat.

Hudgeon Lake sits at an elevation high enough at which fish populations typically diminish and it would not be unusual for the area to have very little fish utilization during winter and a re-colonization of migrant fish for the spring and summer periods. This is a typical life history scenario for Arctic grayling and to a lesser degree slimy sculpin.

During both periods of investigation in 2007, water flow levels at the outlet of Hudgeon Lake were minimal and the gabion structures posed a barrier to fish passage. The possibility for fish passage during greater flows than observed is likely as DFO recorded a single Arctic grayling above the structure in 2005. Significant modifications to the existing structure would be required to allow for fish passage during all flow levels, Modifications such as increasing the number of steps in the constructed channel to reduce the rise of the individual steps may increase the extent of fish passage during moderate flow periods.

APPENDIX 1
GENERAL HABITAT DESCRIPTIONS

Clinton Creek General Descriptions

Upper Clinton Creek

Lat / Long: 64° 27.198 N/ 140° 46.771
Elevation: 1,384'
Date Sampled: July 12 and August 11, 2007

CHANNEL CHARACTERISTICS:

Surveyed Length:	500 m	Gradient:	est. 3%
Average Channel Width:	8 m (July)		
Average Wetted Width:	5 m (July)		
Average Riffle/ Pool Depths:	r= 0.4 m, (July)		p= >0.8 m (July)
Average Depth:	July 0.6 m		Aug. 0.25 m
Average Velocity	July).5 m/sec		Aug <0.5 m/sec
% Pool, Riffle, Run / Glide:	20% pool	40% riffle,	30% run/glide, 10% rapid
Side Channels:	numerous and often as far apart as 150 m		
Debris:	much large and small woody debris 500 m from lake, much small woody debris in lower reach		
Cover	Turbidity, cut banks, submerged willow		
Crown Closure:	40 %		
Riparian Vegetation:	Willow spruced complex		

BED MATERIAL: Substrates were loosely consolidated and shifting, a high degree of organic silts occurred in still areas.

Fines: 40% sand
Gravels: 50%
Larges: 10% small cobbles

STREAM BANKS: Banks were predominantly low and unconsolidated with some confinement near the valley edges above 250 meters from the lake.

STREAM FLOW CHARACTERISTICS:

Upper Clinton Creek flows across an open flood plain for at least 700 meters before entering Hudgeon Lake. The lower 150 meters spreads out across an alluvial apron with at least 2 main channels and several small channels that charge during high flows. Above 150 meters from the lake the channel has several small braids in a shifting channel. A significant channel change occurred during 2006 when a pile of woody debri 550 meters from the lake caused the channel to split into two equal sized braids. Approximately 50% of the flow remained in the original channel and the remainder flowed into a new channel cut through the organic peat in a narrow ((1.2m) and deep (>0.7 m) channel

WATER QUALITY:

Date	pH	Temp (C)	Cond (uS/cm)	DO (mg/l)	Visual color
July 12	8.1	8.9	480		clear with med. Tannin stain
Aug. 11	8.25	8.9	740	10.0	clear

FISH SPECIES PRESENT

None

Photo : The open flood plain of Upper Clinton Creek as it enters Hudgeon Lake. The main channel enters the lake on the extreme right of the photo.

Photo : Upper Clinton Creek 300 meters from Hudgeon Lake in the partially abandoned channel with approximately 50% of its original flow.

Unnamed Tributary to Upper Clinton Creek

Lat / Long: 64° 27.123 N/ 140° 46.774
Elevation: 1,376 feet
Date Sampled: July 12 and August 11, 2007

CHANNEL CHARACTERISTICS:

Surveyed Length:	75 m	Gradient:	<2%
Average Channel Width:	1.6 m		
Average Wetted Width:	July, 1.5 m,		August 1.1 m
Average Riffle/ Pool Depths:	riffle July 0.3 Aug. 0.1 m		pools July 0.9 m Aug 0.35 m
Average Depth:	July 0.3 m,		Aug. 0.15 m
Average Velocity	July 0.3m/sec		Aug 0.25 m/sec
% Pool, Riffle, Run / Glide:	10% pool	10% riffle	80% run/glide
Side Channels:	none		
Debris:	all organic and small		
Cover	instream very limited		
Crown Closure:	increases from o to 100% away from flood plain		
Riparian Vegetation:	alder with occ. willow		

BED MATERIAL: Substrates consist of fine gravel and sand with extensive siltation

STREAM BANKS: Banks are non-confining in open flood plain and become entrenched away from the confluence with Upper Clinton Creek.

STREAM FLOW CHARACTERISTICS: This creek flows as a small rill.

WATER QUALITY:

Date	pH	Temp (C)	Cond (uS/cm)	DO (mg/l)	Visual color
July 12	8.2	5.3	310		clear with light tannin stain
August 11	8.33	4.8	480	16.4	clear

FISH SPECIES PRESENT
None

Photo : Benthic baskets in unnamed tributary to Upper Clinton Creek.

Easter Creek

Lat / Long: 64° 27.458 N / 140° 44.865 E
Elevation: 1,538'
Dates Sampled: July 10, 11 and August 10, 11, 2007

CHANNEL CHARACTERISTICS:

Surveyed Length:	250 m	Gradient:	2%
Average Channel Width:	3.0 m		
Average Wetted Width:	July 10, 2.0m		Aug 10, 1.1m
Average Riffle/ Pool Depths:	July 10, 0.25, 0.6 m		Aug 10, 0.1, 0.5m
Average Depth:	July 10, 0.35m		Aug 10, 0.2m
Average Velocity	July >0.5 m/sec		Aug. 0.7 m/sec
% Pool, Riffle, Run / Glide:	% pool	% riffle	% run/glide
Side Channels:	above 160m from lake in July, 0 in Aug.		
Debris:	Organic silts and debris		
Cover	cut banks and limited woody debris		
Crown Closure:	open at lake increase to 30% moving upstream		
Riparian Vegetation:	alder, dead mature spruce, willow		

BED MATERIAL: Bed materials increase in coarseness moving upstream from the lake. The outlet area consists of fine unconsolidated organic muck, grading into sand then gravel and occasional cobbles within 75 meters form the lake. Substrate composition 60 meters from lake is as follows:

Fines: 10% sand with organic silt
Gravels: 30%
Cobbles: 60%
Bedrock: none

STREAM BANKS: Banks are partially confining on right bank and open on left, mostly abrupt rising 0.5 meters with 10% undercut.

STREAM FLOW CHARACTERISTICS: Channel is mostly slanted with a deep side opposing a shallow side. Few areas of deposition occur other than instream gravel bars and at the outlet area. A large beaver flood plain (abandoned) starts approximately 220 meters upstream of the lake and dominates the creek valley for a distance of several hundred meters.

WATER QUALITY:

Date	pH	Temp (C)	Cond (uS/cm)	DO (mg/l)	Visual color
July 11, 07	8.17	9.0	600		clear, light tannin stain
Aug 11, 07	8.2	8.4	740	10.0	clear, light tannin stain

FISH SPECIES PRESENT
None.

Photo : Easter Creek looking downstream towards benthic basket site. Upstream of this site has seen historic and extensive beaver flooding.

Photo : Easter Creek as it enters Hudgeon Lake has an extensive deposition of fine organic silts.

Bear Creek

Lat / Long: 64° 26.784 N/ 140° 44.459 W
Elevation: 1,531 feet
Date Sampled: July 10 and August 12, 2007

CHANNEL CHARACTERISTICS:

Surveyed Length:	220 m	Gradient:	approx. 3%
Average Channel Width:	0.8 m		
Average Wetted Width:	July 0.8m		Aug 0.8 m
Average Riffle/ Pool Depths:	July R= 0.2 m, P=>1m		Aug. R=0.01, P=0.7
Average Depth:	July >1m,		Aug 0.45 m
Average Velocity	July >0 m/sec		Aug 0 m/sec
% Pool, Riffle, Run / Glide:	10% pool	20% riffle	70% run/glide
Side Channels:	none		
Debris:	Collapsing mud banks with exposed roots and small organic debris		
Cover	Deep confined channel, flotsam and stick piles		
Crown Closure:	40% for first 30 m increase to 100% within 60 m		
Riparian Vegetation:	spruce alder near lake giving way to dense willow		

BED MATERIAL: Substrates consist mainly of mud with only occasional patches of cleaned small gravel and fine organic silts.

STREAM BANKS: Banks are consistently abrupt with >30% actively collapsing

STREAM FLOW CHARACTERISTICS: The channel is deeply entrenched and narrow in a semi open flood plain with occasional confinement by valley walls. Within 80 meters of Hudgeon Lake the channel narrows to an average width of 0.4 meters and glides become less common and flows as an even sequence of pool / riffle / run

WATER QUALITY:

Date	pH	Temp (C)	Cond (uS/cm)	DO (mg/l)	Visual color
July 11	7.98	21.3	420		clear with deep burgundy tannin stain
Aug 12	7.83	4.9	420	9.4	clear , light tannin stain

FISH SPECIES PRESENT
None

Photo : Benthic baskets in fine clean gravel area of Bear Creek.

Photo: A small beaver enhanced mud lip holds a small pool 20 meters upstream of Hudgeon Lake on Bear Creek.

Unnamed Tributary to Hudgeon Lake

Lat / Long: 64° 27.404 N / 140° 45.009
Elevation: 1,480'
Date Sampled: July 11, 2007

CHANNEL CHARACTERISTICS:

Surveyed Length:	80 m	Gradient:	3%
Average Channel Width:	0.8 m		
Average Wetted Width:	0.5 m		
Average Riffle/ Pool Depths:	only pool 0.3 m		
Average Depth:	0.15 m		
Average Velocity	0.5 m/sec		
% Pool, Riffle, Run / Glide:	10% pool	80% riffle	10% run/glide
Side Channels:	none		
Debris:	sticks		
Cover	occasional stick jam		
Crown Closure:	60%		
Riparian Vegetation:	willow, spruce, equisetum and grass		

BED MATERIAL: Substrates were entirely organic in origin and consisted of organic debri and silts. A small gravel outwash apron at the shore edge of the lake was the only granular material.

STREAM BANKS: gentle but mostly confined with banks sloping an even 35% away from channel.

STREAM FLOW CHARACTERISTICS: confined in a ravine with very little meandering, mostly straight channel flowing a s a small rill with occasional stick jams creating small pools

WATER QUALITY:

Date	pH	Temp (C)	Cond (uS/cm)	DO (mg/l)	Visual color
July 11, 07	7.84	8.2	120		clear, light tannin stain

FISH SPECIES PRESENT
This creek does not provide fish habitat other than very small habitats within 5 meters of the lake and certainly could not provide over winter refuge for fish. No fish were recorded.

Photo : The small unnamed tributary to Hudgeon Lake as it enters the lake during July.

Clinton Creek at outlet of Hudgeon Lake

Lat / Long: 64° 27.136 N / 140° 43.794 W
Elevation: 1,450'
Date Sampled: July 10 and August 11, 2007

CHANNEL CHARACTERISTICS:

Surveyed Length:	400 m	
Average Channel Width:	>30 m	
Average Wetted Width:	July 11 m	Aug. 7 m
Average Riffle/ Pool Depths:	July P=0.8m ,R= 0.3	Aug. P=0.4m R= 0.15
Average Depth:	July 0.65 m	Aug. 0.35 m
Average Velocity	July 0.5 m/sec	Aug <0.5 m/sec
Cover	Water depth, interstitial spaces of gabion fill	
Debris		
Crown Closure:	0%	
Riparian Vegetation:	none	

BED MATERIAL: The bed materials of this reach consist entirely of rectangular wire gabion baskets filled with local rock. The baskets are loosely packed and the fill material is friable leaving many open spaces that allow water flow seepage.

STREAM BANKS: The banks in this reach are an even, constructed slope of gabion baskets that extend an even 10 meters from the high water mark.

STREAM FLOW CHARACTERISTICS: This area of Clinton Creek consists of the gabion basket constructed channel built after the tailings slumped. The reach evaluated has had recent construction activities and does not have any established vegetation. All flow patterns have been engineered and the materials within the gabion baskets are unstable and deteriorating.

WATER QUALITY:

Date	pH	Temp (C)	Cond (uS/cm)	DO (mg/l)	Visual color
July 10	8.13	17.9	450		clear with heavy tannin stain
Aug 11	8.34	16.4	500	8.9	clear, light tannin stain

FISH SPECIES PRESENT
No fish were recorded near the lake outlet nor were any fish found in the constructed channel during either sampling period. Juvenile chinook salmon and Arctic grayling were found at the downstream end of the constructed channel, adjacent to the native channel during the August sampling period.

Photo : Hudgeon Lake outlet looking downstream towards the first constructed rapid.

Photo : The upper most constructed rapid during July. The benthic baskets were placed immediately in front of the technician on the wide bench.

Photo: The benthic baskets at time of collection during low flow in August.

Wolverine Creek

Lat / Long: 64° 27.002 N / 140° 42.160 E
Elevation: 1,287”
Date Sampled: July 13, 2007

CHANNEL CHARACTERISTICS:

Surveyed Length:	180 m	Gradient:		
Average Channel Width:	12.0 m			
Average Wetted Width:	3.0 m			
Average Riffle/ Pool Depths:	R= 0.15, P= 0.06			
Average Depth:	0.2 m			
% Pool, Riffle, Run / Glide:	10% pool	70% riffle	15% run/glide	5% rapid
Average Velocity	0.75 m/sec			
Side Channels:	1 only with some instream gravel bars			
Debris:	Some stick piles			
Cover	Stick jams and pools in upper part of reach, angular bed materials			
Crown Closure:	5% becoming more common upstream of sample reach			
Riparian Vegetation:	willow			

BED MATERIAL: Unconsolidated and shifting, with asbestos fiber

Fines: 30% sand, 20% pea gravel
Gravels: 20%
Larges: 0%
Bedrock: none

STREAM BANKS: open flood plain, substrates well washed by high volume floods, extensive deposition of old tailings with asbestos piles common along gravel flood plain. Banks are shallow, unstable and non-confining.

STREAM FLOW CHARACTERISTICS: Significant deposition of old tailings as the channel constricts at the culvert. Flow crosses open flood plain with gravel deposition in stream creating gentle meanders with occasional pools behind debri piles

WATER QUALITY:

Date	pH	Temp (C)	Cond (uS/cm)	DO (mg/l)	Visual color
July 13, 07	8.4	9.7	670		clear with light tea tannin stain

FISH SPECIES PRESENT
None

Photo: Wolverine Creek flows under the access road through an old culvert. The culvert is perched a distance of 2.5 meters above Clinton Creek and cascades directly from the outflow into Clinton Creek.

Photo : Wolverine Creek upstream of the culvert in the studied area.

APPENDIX 2:
Benthic Invertebrate Data
All Sites

Clinton Cr Study	Trib, Upper Clinton	Bear Cr	Easter Cr	Clinton Cr	Upper Clinton	Totals	%
Fines split to:			1/4				
PHYLUM ARTHROPODA							
Class Insecta							
Order Ephemeroptera							
Family Ameletidae							
Ameletus sp			2			2	0.07
Family Baetidae							
Baetis sp	53	1	10			64	2.3
Family Heptageniidae							
Cinygmula sp	21		15		3	39	1.4
Order Plecoptera							
Family Capniidae							
Capnia sp	51		130		1	182	6.6
Family Leuctride							
Leuctra sp			1			1	0.04
Family Nemouridae							
Podmosta sp	174	111	2		86	373	13.6
Zapada sp	5		4	1		10	0.4
Family Perlodidae							
Skwala paralella			1			1	0.04
Sweltsa Grp	1					1	0.04
Order Trichoptera							
Trichoptera Unid J	1					1	0.04
Family Brachycentridae							
Brachycentrus sp				4		4	0.15
Family Limneptiildae							
Dicosmoecus	6		1		6	13	0.5
Limnephilus sp			1			1	0.04
Order Diptera							
Diptera Unid A				22		22	0.8
Family Chironomidae							
Chironomidae J (unident)	6		1	22	4	33	1.2
Chironomidae P	8		12	50	1	71	2.6
SubFamily Orthocladinae							
Brillia sp					2	2	0.07
Cardiocladius sp			1			1	0.04
Corynoneura sp			21			21	0.8
Cricotopus sp	19	2	289	55	4	369	13.5
Thienemanniella sp					1	1	0.04
Sub Family Diamesinae							
Diamesa sp	39	1	461	7	2	510	18.6
Eukiefferiella sp	2	1	7	59	29	98	3.6
Euryhapsis sp	9		11	1		21	0.8
Sub Family Chironominae							
Rheotanytarsus sp	1			18		19	0.7

Sub Family Tanypodinae							
Thienemannimyia			4	67		71	2.6
Family Empididae							
Empididae P				2		2	0.07
Weidemannia sp				18		18	0.7
Family Muscidae							
Muscidae P				1		1	0.04
Limnophora sp				22		22	0.8
Family Psychodidae							
Pericoma sp			5			5	0.18
cf Phoridae L				1		1	0.04
Family Simulidae							
Cnephia L			4	9		13	0.5
Prosimulium L		1	196			197	7.2
Prosimulium P			42	1		43	1.6
Simulium sp L	1		46	140		187	6.8
Simulium sp P			3	16	1	20	0.7
Family Syrphidae L				1		1	0.04
Family Tipulidae							
Dicronata sp	5	5	10		3	23	0.8
Tipula sp					3	3	0.11
Order Coleoptera							
Coleoptera Unid L (terr)		1				1	0.04
Dytiscidae A				1		1	0.04
Hydaticus sp L				2		2	0.07
Haliplidae A	1					1	0.04
Staphylinidae A (terr)				2		2	0.07
Staphylinidae L (terr)				19		19	0.7
Order Homoptera							
Aphididae (terr)		1				1	0.04
Cicadellidae (terr)	2				1	3	0.11
Order Hymenoptera A (terr)		1				1	0.04
Order Araneae (terr)		2		2		4	0.15
Order Hydracarina							
Lebertia				1		1	0.04
Sperchon			4	1		5	0.18
Oribatei	1					1	0.04
Class Crustacea							
Order Amphipoda							
Hyalella azteca				5		5	0.18
Order Cladocera							
Daphnia sp			4			4	0.15
Sub Class Copepoda							
Sub Order Cyclopoida			4			4	0.15
Sub Class Ostracoda							
Candona sp	1	24	4	2		31	1.1

PHYLUM MOLLUSCA							
Class Gastropoda							
Gyraulus parvus				125		125	4.6
Fossaria sp				8		8	0.29
Physella gyrina				2		2	0.07
PHYLUM ANNILIDA							
Class Oligochaeta							
Enchytraeidae J	1	1	21	8		31	1.1
Family Lumbricidae							
Kincaidiana hexatheca		1	1			2	0.07
Family Naididae							
Nais sp		1	1			2	0.07
Family Tubificidae J		3	6		1	10	0.37
Class Hirudinea							
Helobdella stagnalis				1		1	0.04
PHYLUM PLATYHELMINTHES							
Polycelis coronata	3					3	0.11
ABUNDANCE / SITE	411	157	1325	696	148	2737	100
TAXONOMIC RICHNESS / SITE	23	16	34	35	16	66	

APPENDIX 2 BENTHIC INVERTEBRATE DATA COLLECTED FROM THE CLINTON CREEK STUDY AREA, 2007

Clinton Cr Study	Trib, Upper Clinton	Bear Cr	Easter Cr	Clinton Cr	Upper Clinton	Totals	%
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A = adult L = larvae P = pupae Unid = unidentified terr = terristrial

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Cicadellidae (terr)	2				1	3	0.11
Order Hymenoptera A (terr)		1				1	0.04
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Order Hydracarina							
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Sperchon			4	1		5	0.18
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