EDI ENVIRONMENTAL DYNAMICS INC.
Natural Resource Consultants

BENTHIC INVERTEBRATE COMMUNITIES AT THE MT. NANSEN MINE SITE, PONY CREEK

PREPARED FOR:

YUKON ENERGY MINES AND RESOURCES

ABANDONED MINES PROJECT OFFICE (TYPE II)

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1 INTRODUCTION

This report is a continuation of the benthic invertebrate work begun in the previous year on the mine site. The Yukon Government's Assessment and Abandoned Mines Branch is currently working towards reclamation of the Mt. Nansen gold and silver mine site. In 2007/08, EDI Environmental Dynamics Inc. (EDI) was retained by the Yukon Government, Abandoned Mines Branch, to investigate benthic invertebrate communities on the Mt. Nansen mine site (EDI 2008a). In that study, it was determined that data from Pony Creek would also be valuable in assessing mine reclamation as Pony Creek is free of impacts due to placer mining. This 2008/09 report contains information gathered from the sampling of Pony Creek, both upstream and downstream of the site where waste rock was historically piled in and adjacent to the creek. In addition, this report draws comparisons, where applicable, of results from Pony Creek with those from Dome and Victoria creeks (those sampled in 2007/08; EDI 2008a). It should be noted that sampling occurred after the waste rock was removed from the Pony Creek site (removed July 2008).

Benthic invertebrate communities can be a valuable ecological indicator in aquatic systems. As sedentary, bottom-dwelling and detritus-feeding aquatic organisms, benthic invertebrates sustain exposure to stream sediments and stream water throughout their life cycle. They are also an important food source for fish. Some species of invertebrates are known to be intolerant to the elevated concentrations of metals often associated with mining activity, while other, more tolerant species become more dominant in contaminated sites (Maret et al., 2003). Benthic invertebrates also demonstrate sensitivity to sediment exposure and increased stream sediment levels associated with placer mining (Madison, 1981; Shaw and Richardson, 2003; Weber, 1986). Monitoring of benthic invertebrates provides a time-integrated look at watercourse conditions rather than the snap-shot view provided by chemical and physical water sampling and analyses.

1.1 STUDY AREA

The Mt. Nansen mine is located approximately 60 kilometres west of Carmacks, Yukon. The site is accessed via a gravel-surface road connecting the mine site to Carmacks (Figure 1). The Mt. Nansen mine site lies within the watershed of Victoria Creek, a tributary stream to the Nisling River, which is a medium sized river in the Donjek/White Rivers drainage basin.

Two small streams drain the majority of the mine footprint. The primary drainage is Dome Creek which flows from above the mill site, past the tailings facilities into Victoria Creek. In addition, Pony Creek drains a small portion of the mine site north of the Brown-McDade Pit and eventually flows into Back Creek, which is a tributary to Victoria Creek. It should be noted that there is an active placer operation is present on Back Creek upstream of the mouth of Pony Creek. Dome Creek was sampled as part of the 2007 program, and sampling in 2008 focused on Pony Creek.

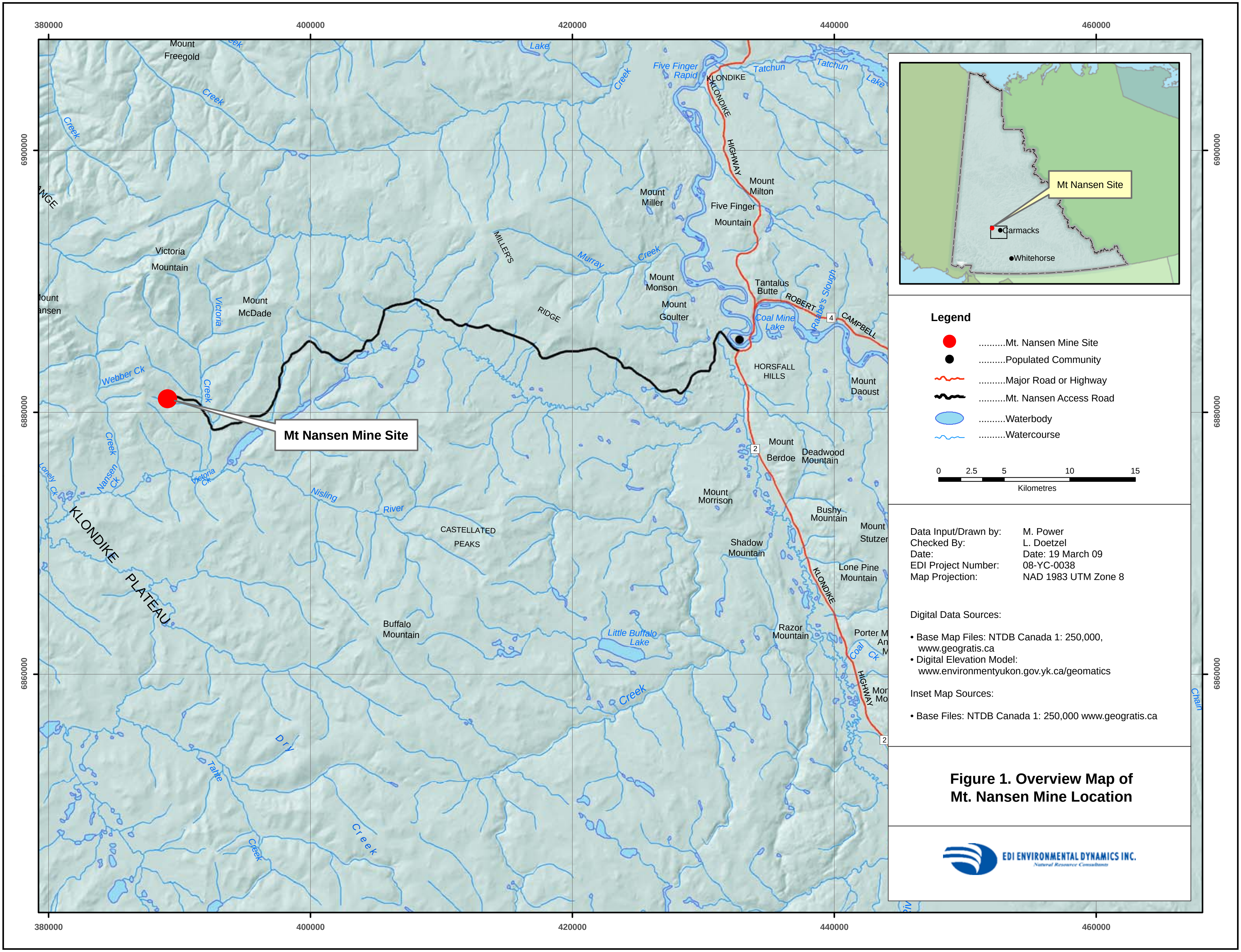

Figure 1. Overview Map of Mt. Nansen Mine Location

2 METHODS

2.1 SAMPLING LOCATIONS

Sampling locations were established at two sites on Pony Creek (Table 1; Figure 2). The first sampling location was located on Pony Creek upstream of the waste rock dump site. This site is upstream of all mining activities. A second sampling location on Pony Creek was located downstream of the waste rock pile location. It should be noted that the benthic invertebrate sampling occurred approximately six weeks following the removal of the waste rock pile.

Table 1: Benthic Invertebrate Sampling Locations.

Location	UTM Coordinates	Rationale for Sampling
Pony Creek, upstream of waste rock site	8 V 389166 6881723	Upstream of impacts from the mine site, including impacts from waste rock pile.
Pony Creek, downstream of waste rock site	8 V 388847 6881823	Directly impacted by waste rock stored on top of the creek during active mining and until Summer 2008.

2.2 FIELD SAMPLING METHODS

Benthic invertebrate sampling followed the field procedures outlined in the Canadian Aquatic Biomonitoring Network Invertebrate Biomonitoring Field and Laboratory Manual (Reynoldson et al., 2003). This method involved sampling a stream reach equal to six bank full widths of the stream at the sampling location, using a kick-net (363 micron). Samples were then placed in 70% ethanol for storage prior to identification. Additional data were collected at each sampling location to characterize the attributes of the sample stream, including stream velocities, water quality parameters, substrate dimensions, and vegetation conditions.

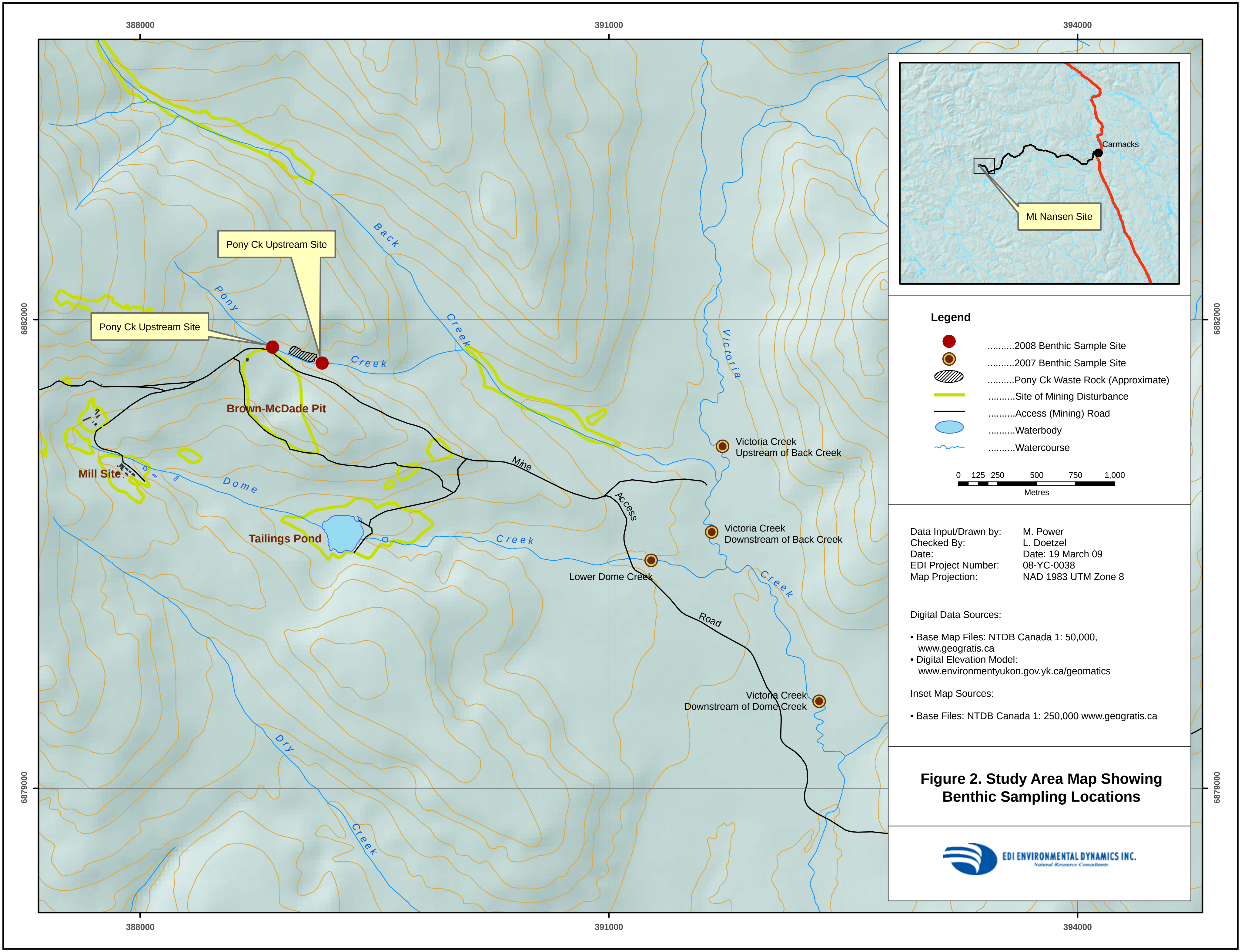

Figure 2. Study Area Map Showing Benthic Sampling Locations

2.3 SAMPLE IDENTIFICATION

Benthic invertebrates were identified to family for individuals within the four major orders (Diptera, Ephemeroptera, Trichoptera, and Plecoptera) and to order for all other individuals, following Clifford (1991). These families/orders were then further categorized into functional feeding groups, following Merritt and Cummins (1995).

2.4 DATA ANALYSIS

The benthic invertebrate community composition at the sampling sites was evaluated through the calculation of the relative abundance and diversity indices outlined in Table 2 and Table 3.

Table 2. Relative abundance indices and their associated descriptions.

Abundance Indices	Description
Abundance defined by Order	
% Ephemeroptera	The number of Ephemeroptera individuals divided by the total number of individuals in each sample (Karr and Chu 1999).
% Plecoptera	The number of Plecoptera individuals divided by the total number of individuals in each sample (Karr and Chu 1999).
% Trichoptera	The number of Trichoptera individuals divided by the total number of individuals in each sample (Karr and Chu 1999).
% Diptera	The number of Diptera individuals divided by the total number of individuals in each sample (Karr and Chu 1999).
Abundance Defined by Functional Feeding Groups	
% Predators	The number of predators divided by the total number of individuals in each sample (Karr and Chu 1999).
% Collector-gatherers	The number of collector-gatherers divided by the total number of individuals in each sample (Karr and Chu 1999).
% Collector-filterer	The number of Collector-filterers divided by the total number of individuals in each sample (Karr and Chu 1999).
% Scrapers	The number of scrapers divided by the total number of individuals in each sample (Karr and Chu 1999).
% Shredders	The number of shredders divided by the total number of individuals in each sample (Karr and Chu 1999).

Table 3. Diversity indices and their associated descriptions.

Diversity Indices	Description
Total Taxa Richness	The total number of distinct taxa counted at each site. Distinct taxa include individuals identified only to family/order (Resh and Jackson 1993, Karr and Chu 1999).
Ephemeroptera Taxa Richness	Number of distinct Ephemeroptera families counted at each site (Karr and Chu 1999).
Plecoptera Taxa Richness	Number of distinct Plecoptera families counted at each site (Karr and Chu 1999).
Trichoptera Taxa Richness	Number of distinct Trichoptera families counted at each site (Karr and Chu 1999).
Diptera Taxa Richness	Number of distinct Diptera families counted at each site (Karr and Chu 1999).

3 RESULTS

3.1 STREAM CHARACTERISTICS

Pony Creek is a narrow, shallow stream at most locations. At the upstream location the bank full width was 1.0 m. Just downstream of this site, the stream splits into two and travels for 15 to 20 m, where the two channels reconnect in a small pond upstream of the culvert at the road crossing. This culvert is hanging at the downstream end, and water flows out and down through the area once filled with waste rock. Depths in this area are very shallow; approximately 15 to 20 cm. The downstream sample location was approximately 20 m downstream of the waste rock location. Water velocity was much faster at the downstream location (0.31 m/s); this higher velocity is due to the higher grade associated with the site. In comparison, water velocity at the upstream location was only 0.09 m/s. The substrate also varied at the two locations; the upstream site was composed largely of fines, with some gravel, while at the downstream site the substrate was made of gravel with some cobble (the source of the gravel and cobble is likely the waste rock present upstream). Riparian vegetation at both sites was dominated by willow, shrubs and grasses, often present in abundant amounts. At both sites there was some instream vegetation, composed of grass species. There was no overhanging canopy in either area; however, due to the narrow nature of the stream, the riparian willows and shrubs provided significant coverage.

Water quality was similar at both sites. Water was clear and cold, with a temperature of 2.3°C at the upstream site and 2.5°C at the downstream site. The conductivity ranged from 302 µS/cm upstream to 345 µS/cm downstream and the pH was neutral with values of 7.05 and 7.06, respectively. Water was well oxygenated, with a dissolved oxygen concentration of 11.1 mg/L at both sites. Detailed stream attribute data for all sampling locations are provided in Appendix B.

3.2 ORDER LEVEL RELATIVE ABUNDANCE ANALYSIS

The relative abundances of the four major benthic invertebrate orders were very similar at both of the sampling locations on Pony Creek (Figure 3 and Figure 4).

- Diptera were the dominant order at both locations, comprising 63.9% of the total taxa at the upstream site, and 50% at the downstream site.
- Plecoptera were the next most abundant order, comprising 36.1 and 43.4% of the upstream and downstream sites, respectively.
- Ephemeroptera was absent from samples taken at both upstream and downstream locations.
- Trichoptera was absent from the upstream site, but comprised 6.6% of the samples from the downstream location.

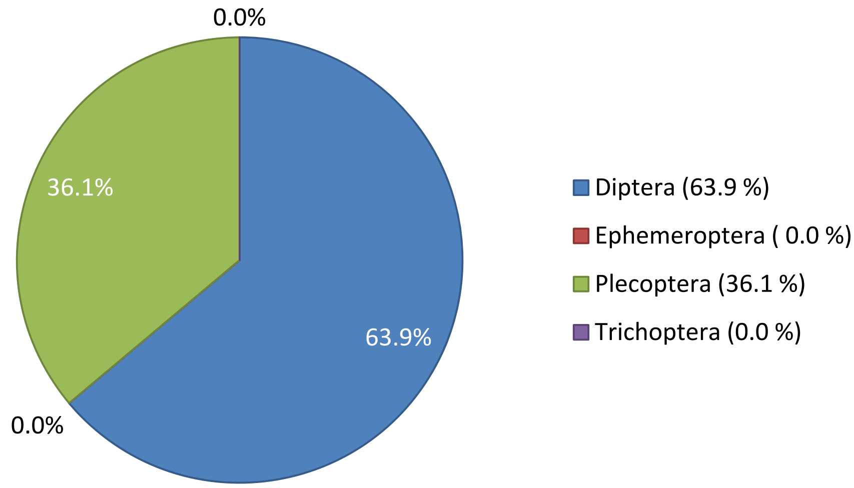

Figure 3. The relative abundance (%) of the four major benthic invertebrate orders at the Pony Creek upstream site.

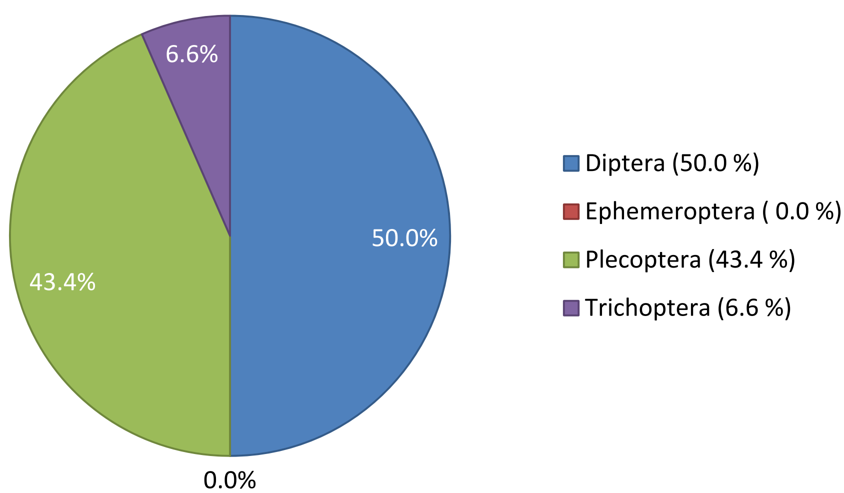

Figure 4. The relative abundance (%) of the four major benthic invertebrate orders at the Pony Creek downstream site.

3.3 FUNCTIONAL FEEDING GROUP ANALYSIS

Analysis of relative abundance of five functional feeding groups at the two sites on Pony Creek yielded the following results.

- Collector-gatherers were the most abundant feeding group at both sampling locations, and comprised a similar percentage of the community at each (40 – 38%).

- Shredders were the next most abundant functional feeding group at both sites, and comprised a similar percentage of the community at each (27 - 33%).
- Predators were less abundant than shredders at both the upstream and downstream sites, with predators comprising 18 and 12 % of the community at the two locations on Pony Creek, respectively.
- Collector-filterers and scrapers were the least abundant feeding groups. At the upstream site, collector-filterers were slightly more abundant than scrapers (8.0 and 6.6 %, respectively); while at the downstream site abundance was nearly equal with 8.2 % of abundance as collector-filterers, and 8.7 % comprised of scrapers.

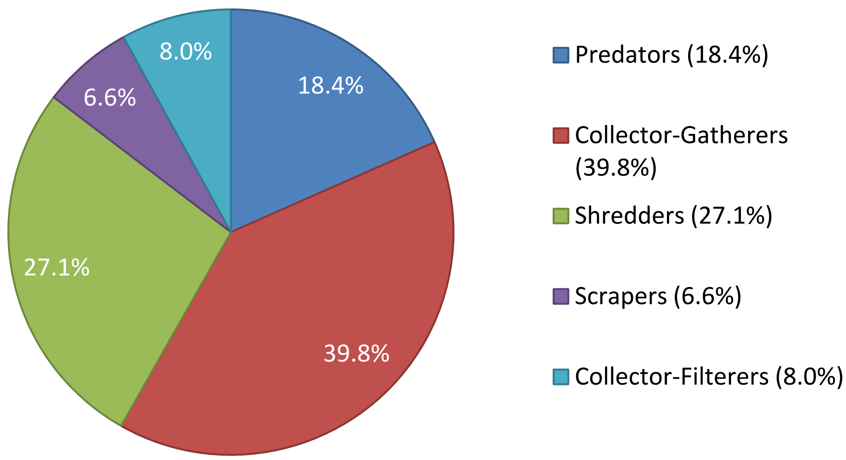

Figure 5. The relative abundance (%) of the five functional feeding groups at Pony Creek upstream site.

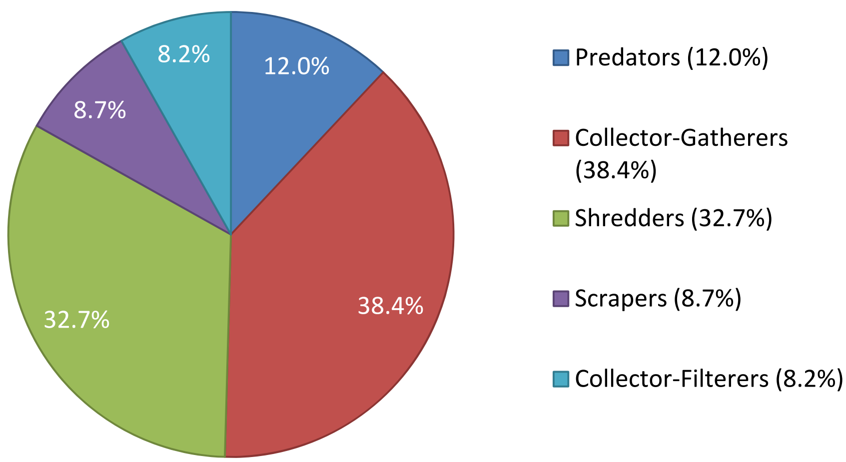

Figure 6. The relative abundance (%) of the five functional feeding groups at Pony Creek downstream site.

3.4 TAXA RICHNESS ANALYSIS

Taxa richness of benthic invertebrates identified to family/order was relatively low at both the upstream and downstream sampling locations; however, it was greater at the downstream location (Figure 7), where a total of nine taxa were identified.

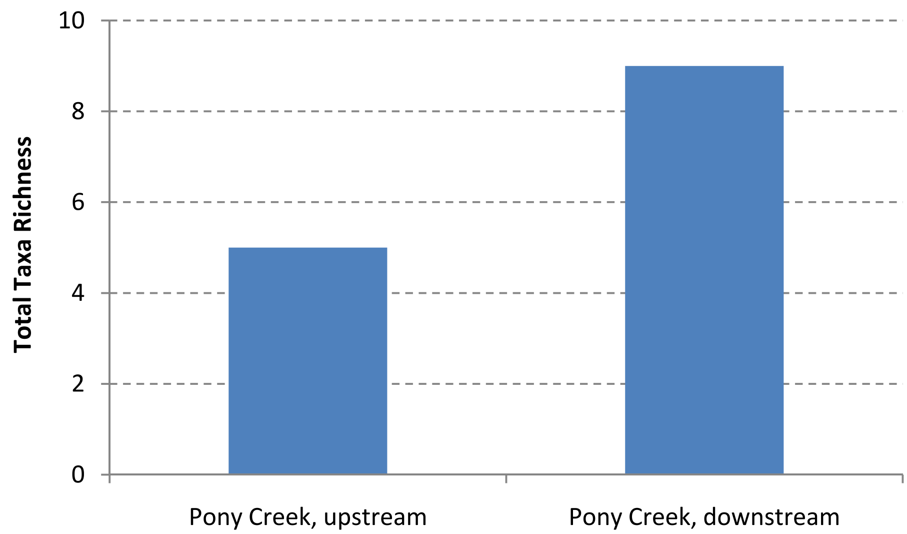

Figure 7. Taxa richness (total number of distinct taxa) at each sampling location. Distinct taxa include individuals identified to family/order.

Trends in richness of each of the four major orders of benthic invertebrates were as follows.

- There were more distinct Diptera families at the downstream (9) site than the upstream (5) (Figure 8).
- The number of distinct Plecoptera families found was the same in both Pony Creek sampling locations (1 taxon) (Figure 9).
- Ephemeroptera were absent from both sampling locations on Pony Creek.
- One Trichoptera taxon was present at the downstream location while there were none noted at the upstream site (Figure 11).

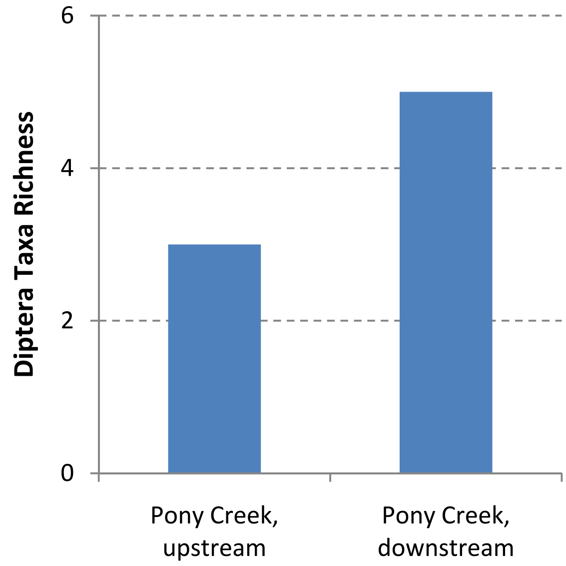

Figure 8. Diptera taxa richness at both sampling locations.

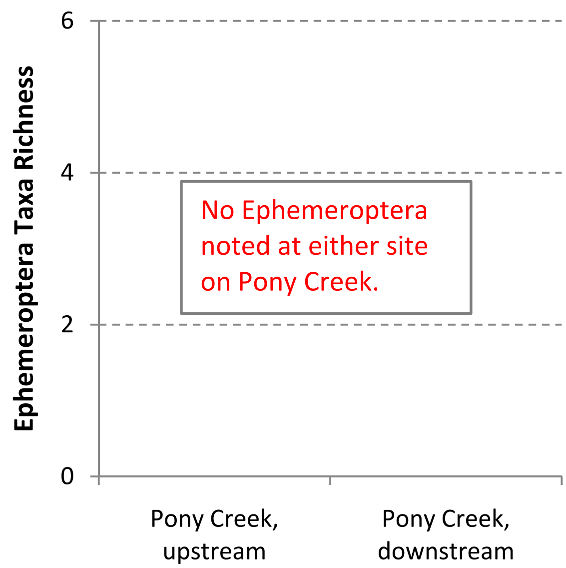

Figure 9. Ephemeroptera taxa richness at both sampling locations.

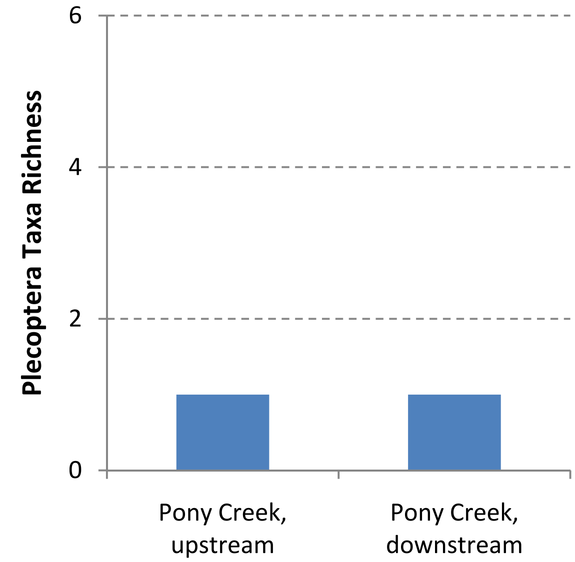

Figure 10. Plecoptera taxa richness at both sampling locations.

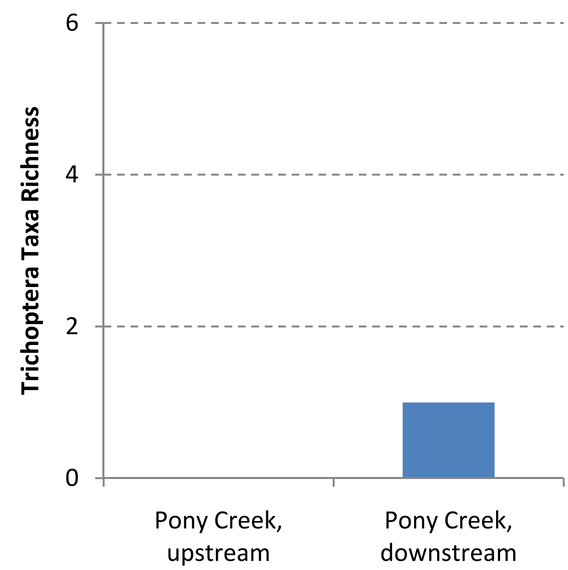

Figure 11. Trichoptera taxa richness at both sampling locations.

4 DISCUSSION

4.1 ORDER LEVEL RELATIVE ABUNDANCE ANALYSIS

Field water quality indicates that both the upstream and downstream site locations had clear, well oxygenated water, with pH and EC that were both within normal ranges. One difference between the sites was substrate type; while the upstream site was dominated by fines, the downstream site was comprised of gravel with some cobble. It is believe that gravel / cobble substrate at the downstream site was sourced from the waste rock pile immediately upstream. The upstream site was largely unaffected by mining activities as it is not downstream of any tailings or waste materials. The downstream site, however, was heavily affected. Beginning with mining activities in the late 1960s, and carried on in the 1990s, mine waste rock was deposited directly on top of Pony Creek, and subsequently, the creek flowed under / through this waste rock pile. This pathway for Pony Creek continued through to July 2008, when the waste rock was removed. Though water quality results note that many total metals concentrations were, and continue to be elevated in Pony Creek downstream of the waste rock pile, there is no evidence that sediment loading, and/or turbidity of the water was affected by the presence of the waste rock.

The relative abundance of the four major orders was very similar among the two sampling sites on Pony Creek. Diptera was the most abundant order, and Plecoptera was the second most abundant. When compared with data gathered the previous season from Dome and Victoria creeks (EDI 2008a), it can be noted that Diptera were the dominant order of benthic invertebrates in both sampling locations on Dome Creek, which has very similar physical stream characteristics with Pony Creek, particularly the upstream site. Aquatic invertebrates of the order Diptera have diverse life histories and are adapted to a variety of conditions. In a summary of published and unpublished data, Oswood (1989) describes Diptera as the dominant order in interior Alaskan streams, followed by Ephemeroptera and Plecoptera, with Trichoptera being very scarce. Plecoptera are generally restricted to streams with high dissolved oxygen content and cool temperatures, both of which are characteristics of Pony Creek. They are also sensitive to siltation, and therefore their presence in Pony Creek is indicative of a clear water, low turbidity trend, despite the recent removal of waste rock from the watercourse, and inevitable short-term pulse siltation caused by that event. Ephemeroptera were absent from both sampling locations. Ephemeroptera seek out fast flowing water habitat with abundant cobble substrate. Their preferred habitat is beneath rocks or logs, both of which were largely absent from the areas sampled. Their absence at the sampling sites in Pony Creek may be due to a lack of appropriate habitat rather than a water quality concern. Very few Trichoptera were noted in the sample from the downstream, and none were found at the upstream location. Trichoptera are also characteristic of cool, fast-flowing streams. Like Ephemeroptera, the absence of Trichoptera at the upstream site in Pony Creek may be due, in part, to a lack of suitable habitat. The downstream site had higher flow velocity and more suitable substrate, which likely explains the presence of Trichoptera at that site.

Results from kicknet sampling for benthic invertebrates in 1997[1] in Pony Creek (at a site close to the downstream site sampled as part of this report) show that Diptera was the dominant order, comprising 35%, of the community composition at this location (Environment Canada, 2008). However, a large number of animals collected as part of this sample belong to the phylum Nematoda. When Nematodes are removed from the abundance calculation, Diptera comprise 58 % of the total abundance, and when only the four main orders are considered, Diptera comprise 98% of the abundance. An overwhelming majority of the Diptera (96%) belonged to the family Chironomidae. Chironomidae are often found across all habitat types, and seem to be impervious to changes in water quality including sediment loading. Weber (1986) has found Chironomidae to be common across all sites, including undisturbed sites and those disturbed by placer mining.

The 1997 sampling data also found only one animal of each Ephemeroptera and Plecoptera, and no Trichoptera. As noted previously, members of the order Plecoptera are considered to be sensitive to disturbance, including exposure to contaminants associated with hard rock mining (Maret et al., 2003). Their increased presence in both upstream (36%) and downstream (43 %) areas of Pony Creek over the results found in 1997 (<1 %) may be an indication of slowly improving water quality and habitat conditions.

4.2 FUNCTIONAL FEEDING GROUP ANALYSIS

The relative abundance of benthic invertebrates in each of the five functional feeding groups was remarkably similar between the two sampling sites on Pony Creek. Collector-gatherers were the most abundant (38 and 40%), due to the heavy presence of Diptera. Collector-gatherers feed on fine organic material (plant, animal, and fungal in origin) from the surfaces of substrates. The next most abundant functional feeding group was shredders, due to the presence of the family Nemouridae (order: Plecoptera). Shredders often work together with collector-gatherers, as shredders feed on the more coarse organic material, including leaves and twigs, creating fine organic material in the process. The upstream site on Pony Creek resembles Dome Creek in that it is a slower moving and narrower stream; thus, leaves and other plant material accumulate more readily. This presence of additional vegetation likely results in greater deposition of coarse plant material into the stream; in turn, this plant material provides an abundant food source for shredders. In 2007 in Victoria Creek, shredders ranged from 12 to 17% of relative functional feeding abundance, while in Dome Creek (2007 data) they comprised 53%, and in Pony Creek (2008 data)

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[1] Using a mesh size 363 µm kicknet.

they comprised 32% at the upstream (only 27% at the downstream site). The slight decrease in shredder abundance at the upstream Pony Creek site, as compared to the Dome Creek site may have been due to sampling date. The 2007 sampling was done a few weeks later in the fall and more organic material including leaf and twig matter had entered the watercourse when compared to the 2008 sampling in Pony Creek, which was conducted in early September.

Predators comprise 18 and 12% of the abundance at the upstream and downstream sites, respectively, making them the next most abundant.

Scrapers and collector-filterers are the least abundant at the Pony Creek sites. The water in Pony Creek is quite clear, with low concentrations of suspended matter. Therefore, the water provides a very low supply of food sources to collector-filterers. Scrapers feed on attached periphyton that develops on submerged substrate. Because Pony Creek is a narrow channel surrounded by heavy willow growth, little sunlight reaches the substrate, retarding periphyton growth. Therefore a lack of food source appears to limit the abundance of scrapers within this system.

4.3 TAXA RICHNESS ANALYSIS

Total taxa richness was low in both sites on Pony Creek; less than was determined in either Dome or Victoria creeks in 2007 sampling. Reduction in benthic invertebrate species diversity has been linked to sedimentation (Shaw and Richardson, 2001); however, water in Pony Creek has historically been clear with low sediment loads. Data from the 1997 sampling event on Pony Creek show a total of 18 different taxa, double the number found at the downstream site (closest to the 1997 sampling location) in 2008. However, no large turbidity events were noted in Pony Creek throughout the summer of 2008. Aside from large sedimentation events, abnormally moderate to high water levels can lead to increased invertebrate drift away from an area, leading to a decrease in abundance and diversity (Quinn and Hickey 1990). Finally, the presence of high concentrations of contaminants including metals can affect the presence of some benthic invertebrate species.

Precipitation and subsequent surface runoff as well as groundwater input, was extremely high through 2008 open water season. This high water may have led to increased benthic invertebrate drift from Pony Creek at the two locations sampled. Work on a number of rivers in New Zealand found that watercourses that experienced maximum flows of greater than 20X their median flows had markedly lower median taxonomic richness, density and biomass than less-flooded areas (Quinn and Hickey 1990). This phenomenon was also investigated in a regulated river in Norway. In 1989 the discharge was 4.8 times higher than in 1988, and the corresponding change in biomass was a decrease of 270 and 800% in the two study areas (Fjellheim et al. 1993). A large amount of this biomass reduction was in Diptera; chironomid species. Accurate discharge data for Pony Creek from before and after the 2008 open water season is not available. However, it was noted on a number of field visits to the Mt. Nansen mine site, from July through early September that water levels were very high, and many areas on the Mt. Nansen mine site showed evidence of recent flooding.

Sampling on September 3 noted that a flood event was severe enough to alter channel patterns (creation of and removal of some side channels) on Victoria, Back and Dome creeks. The culvert at the road crossing on Pony Creek (between the upstream and downstream sampling locations) was nearly full for a large portion of the summer, and the pond upstream of the culvert was larger than in previous years (Photo 1, see culvert in red square).

Photo 1. High water in July 2008, in Pony Creek upstream of the culvert at the road crossing.

Another factor potentially affecting the number of total taxa in Pony Creek is its small size. Smaller streams are known to have lower benthic invertebrate diversity than larger streams (Slack et al., 1979). Sampling results from Dome and Victoria creeks in 2007 provided evidence for this as well; benthic invertebrate taxa richness has consistently been found to be lower in Dome Creek (a comparatively smaller watercourse) than in Victoria Creek in past sampling events (EDI 2008a).

Physical habitat was more conducive to benthic invertebrate colonization at the downstream site when compared to the upstream site. The substrate composition at the upstream site was largely composed of silty fines, with some gravels, while the downstream site was dominated by gravels with some cobble. The gravel/cobble substrate provides a more complex three-dimensional habitat, leading to a wider range of microhabitats and more refuge from predation by other invertebrates, fish and birds, as well as protection from scouring during high flows (Quinn and Hickey 1990). This microhabitat diversity is expected to contribute to greater taxonomic richness and density.

Water quality was sampled at this site over the 2008 season, beginning a number of months before the waste rock removal, and continuing following removal. Concentrations of a number of different metals were higher downstream of the waste rock when compared to samples taken upstream of the culvert. Arsenic, cadmium copper, and zinc all routinely exceeded the CCME guideline for the protection of aquatic life. Also, in the samples taken on 16 July 2008 (during waste rock removal) there was a sharp increase in total metals concentration in samples taken downstream of the site (EDI 2008b). In addition to water sampling, Environment Canada sampled sediment at two locations downstream of the waste rock pile in 1997 (Environment. Canada 2008). Metals concentrations at these locations exceeded CCME interim sediment quality guidelines for arsenic, cadmium, lead, and zinc; concentrations of copper fell below the guideline. Arsenic and lead concentrations, in particular, exceeded CCME guidelines by a large margin.

The presence of the waste rock, and the subsequent effects on water and sediment quality in Pony Creek do not appear to have affected the benthic invertebrate communities, as more species richness was found at the downstream compared to the upstream sampling location. It is possible, however, that any negative effect attributable to changes in water or sediment quality was over-shadowed by the effects of increased water levels and habitat differences between the two sampling locations.

5 CONCLUSIONS

Based on the results of this study, we offer the following conclusions.

- Both diversity (richness) and abundance were both low in Pony Creek, at both the upstream and downstream sampling locations. This may have been due, in part, to a very high water season throughout 2008 spring, summer and fall.

- The community composition of benthic invertebrates present in Pony Creek resembled Victoria Creek, with Diptera being the dominant order, followed by Plecoptera, as is typical of northern streams. However, there was a complete absence of Ephemeroptera, and a limited presence of Trichoptera.

- Diptera was the dominant order in 1997 and 2008 sampling, and it can be assumed it was the dominant order in the intervening time as well.

- Functional feeding group analysis showed highly similar composition of the five functional feeding groups among both sites on Pony Creek; collector gatherers were the most abundant, followed by shredders. The group composition closely resembled what was found on Dome Creek in 2007 sampling. The relative abundance of plant material in Pony and Dome creeks is suggested as a factor that may support this greater abundance of shredders.

- Total taxa richness was unexpectedly higher at the downstream 'impacted' sampling location than at the upstream sampling site, despite high contaminant loading in sediment and water at the downstream location. This may have been due to more useable habitat at the downstream site with respect to substrate and less cover due to willow and shrubs.

These results provide a good basis for future comparisons that may be valuable in determining the success of reclamation at the Mt. Nansen mine site. The data from Pony and Dome creeks are useful used as a measure of reclamation success, as they are both isolated from placer mining activity.

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Appendix A. Photos

Photo 2: Upstream sampling location on Pony Creek.

Photo 3. Upstream sampling location on Pony Creek, note heavy cover due to grasses and willows.

Photo 4. Downstream sampling location on Pony Creek, looking upstream toward site of historical waste rock pile (note sampling was completed downstream of disturbed area).

Photo 5: Downstream sampling location on Pony Creek, looking downstream.

Appendix B. Stream Attribute Data

Pony Creek, downstream of waste rock (P-1)

Location: N62° 03.087, W137° 07.195
Flow state: riffle / pool
Macrophytes: Instream grasses
Canopy coverage: 0 %
Riparian vegetation: Shrubs and willow (98%), Coniferous (Black spruce 2%)

Area kicked: 6 X bank full = 6 x 0.95 m = 6 m
Average depth: 0.12 m
Time: 2 minutes
Dominant substrates: Gravel with some cobble
Average degree of embeddedness: 45 %

Substrate dimensions:

Rock Number	Length	Width	Height	Rock Number	Length	Width	Height
1	89	57	32	**6**	34	24	11
2	37	26	6	**7**	23	19	13
3	50	44	19	**8**	24	16	10
4	73	59	44	**9**	13	10	6
5	69	54	23	**10**	100	53	35

(all measurements in mm)

Stream Velocities:

Horizontal Distance (m)	Depth (m)	Velocity (m/s)
0.00	0.04	0.00
0.25	0.08	0.56
0.50	0.08	0.67
0.75	0.08	0.33
1.0	0.02	0.0
Average:	**0.06**	**0.31**

Velocity along Thalweg (m/s):

Velocity along thalweg was not measured as stream was very narrow, and therefore could not be measured with any accuracy.

Water Quality Parameters:

Temperature: 2.5°C
Conductivity: 345 µS/cm
pH: 7.06
DO: 11.1 mg/L

Pony Creek, downstream of waste rock - B Replicate

Distance Sampled: 6 m
Time: 2 min

Pony Creek, upstream of culvert (P-2)

Location: N62° 03.135, W137° 07.564
Flow state: riffle / pool
Macrophytes: 0 – 5% coverage, composed of instream grasses
Canopy coverage: 0 %
Riparian vegetation: Shrubs and willow

Area kicked: 6 X bank full = 6 x 1.0 m = 6 m
Average depth: 0.25 m
Time: 2 minutes
Dominant substrates: Fines with some gravel
Average degree of embeddedness: 20 %

Substrate dimensions:

Rock Number	Length	Width	Height
1	31	17	4
2	21	12	7
3	12	6	5
4	9	5	3

(all measurements in mm)

Stream Velocities:

Horizontal Distance (m)	Depth (m)	Velocity (m/s)
0.00	0.26	0.00
0.25	0.30	0.23
0.50	0.12	0.12
0.75	0.10	0.00
Average:	**0.20**	**0.09**

Velocity along Thalweg (m/s):

Velocity along thalweg was not measured as stream was very narrow, and therefore could not be measured with any accuracy.

Water Quality Parameters:

Temperature: 2.3°C
Conductivity: 302 µS/cm
pH: 7.05
DO: 11.1 mg/L

Pony Creek, downstream of waste rock - B Replicate

Distance Sampled: 6 m
Time: 2 min

Appendix C. Benthic Invertebrate Data

Table 1. Benthic Invertebrates at the Pony Creek downstream location, P-1.

Order	Family	Number
Diptera	Simuliidae	8
	Dolichopodidae	2
	Ceratopogonidae	1
	Chirononidae	49
	Muscidae	1
Plecoptera	Nemouridae	53
Trichoptera	Hydroptilidae	8
Ephemeroptera		0
Hymenoptera		2
Unknown Adult		43
TOTAL		**167**

Table 2. Benthic Invertebrates at the Pony Creek upstream location, P-2.

Order	Family	Number
Diptera	Simuliidae	2
	Dolichopodidae	2
	Ceratopogonidae	0
	Chirononidae	19
	Muscidae	0
Plecoptera	Nemouridae	13
Trichoptera	Hydroptilidae	0
Ephemeroptera		0
Hymenoptera		0
Unknown Adult		14
TOTAL		**50**