FISH HABITAT CHARACTERIZATION
FOR
PROPOSED WABUSH 3 MINE SITE

LABRADOR CITY, NEWFOUNDLAND AND LABRADOR

Submitted to:

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Important Notice

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EXECUTIVE SUMMARY

Two streams within the Dumbell Lake and Beverly Lake watersheds underwent habitat assessment during July 2012. The assessment included riverine surveys, quantitative electrofishing and collection of benthic invertebrates.

Dumbell Lake Watershed

One stream that empties into the northwest side of Dumbell Lake (Dumbell Stream) was sampled/surveyed. Habitat types were surveyed and classified in accordance with both the Beak (1980) and New Classification systems (DFO 2012).

Within the Dumbell Stream the Beak habitat classification quantifies the stream with a total of 2.7 units (1 unit = 100 m^2) of Type I (Spawning and Rearing), 10.49 units of Type II (Rearing, Limited Spawning), 3.46 units of Type III (Migration) and 19.27 units of Type IV (Sheltering and Feeding) habitats. The new classification system (DFO 2012) identifies a total of 11.20 units of Riffle, 8.49 units of Rapids, 7.59 units of Pool, 7.35 units of Cascade and 3.20 units of Run habitats.

No fish were captured in Dumbell Stream; therefore, species suitability for each reach of the stream could not be calculated.

The Shannon-Weiner Diversity Index for benthic invertebrates calculated an average of 1.66 while the average evenness was 0.618.

Beverly Lake Watershed

One stream that empties into the northwest side of Beverly Lake (Beverly Stream) was sampled/surveyed. Habitat types were surveyed and classified in accordance with both the Beak (1980) and New Classification systems (DFO 2012).

The Beak habitat classification quantifies the stream with a total of 1.9 units of Type I (Spawning and Rearing), 2.92 units of Type II (Rearing, Limited Spawning) and 19.52 units of Type IV (Sheltering and Feeding or Pool type) habitats. The new classification system (DFO 2012) identifies 9.05 units of Pool, 6.86 units of Riffle, 2.81 units of Rapids, 2.5 units of Run and 0.07 units of Eddy habitats.

Within Beverly Stream there is a total of 13.99 Habitat Equivalent Units (HEU) for brook trout.

The Shannon-Weiner Diversity Index for benthic invertebrates calculated an average of 1.94 while the average evenness was 0.741.

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1.0 INTRODUCTION

The Iron Ore Company of Canada (IOC) is proposing to construct and operate a new open pit mine, Wabush 3 Mine, at its Labrador West mine site. The development of Wabush 3 will result in some alterations to portions of nearby watersheds (Figure 1.1).

The *Fisheries Act* is currently being amended to provide protection to ongoing aboriginal, commercial and recreational fisheries by protecting the fish and the productivity of the habitat that supports them. The trigger for authorization is being revised from the harmful alteration, disruption or destruction of fish habitat (HADD) to the serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or serious, permanent change to ecosystem productivity that support such a fishery. Furthermore, this activity may be subject to approval under Transport Canada's *Navigable Waters Protection Act* if watercourses are determined to be navigable.

While the trigger for requirement of a *Fisheries Act* Authorization is being revised, the intention of the *Fisheries Act* Section 35(2) will be maintained. The Act allows the Minister to issue an Authorization under Section 35 (2) which will permit the work, undertaking or activity to occur that results in serious harm to fish and/or serious, permanent change to ecosystem productivity. The issuance of an Authorization is at the discretion of the Minister; however, the process for issuing an Authorization is well established. A Section 35(2) Authorization will be issued only with the acceptance of an appropriate Compensation Plan which offsets any serious harm to fish or serious, permanent change to ecosystem productivity that support a fishery. An Authorization must be issued before any action can be taken that would result in serious harm.

The proposed site and operation may also require additional process water sources. Extraction of water from surrounding watersheds may also result in a *Fisheries Act* Authorization; however, the overall degree would depend on many factors such as the habitat quality potentially affected and the volume and rate of water extraction required.

In addition to providing the information required as part of the *Fisheries Act* Authorization process, the freshwater resources of the Project Area may be included within an environmental assessment of the project. In particular, baseline information can be required to assist the proponent in predicting potential effects to Valued Environmental Components (VECs), to assist regulators in determining significance of impacts and to describe baseline conditions for any required Environmental Effects Monitoring (EEM) programs.

This report provides the results of the 2012 freshwater baseline data collection program conducted in support of planning for the Wabush 3 Project Area. This study augments two other studies completed by AMEC and EcoMetrix Inc. in 2011 as part of baseline data collection (see Figure 1.1).

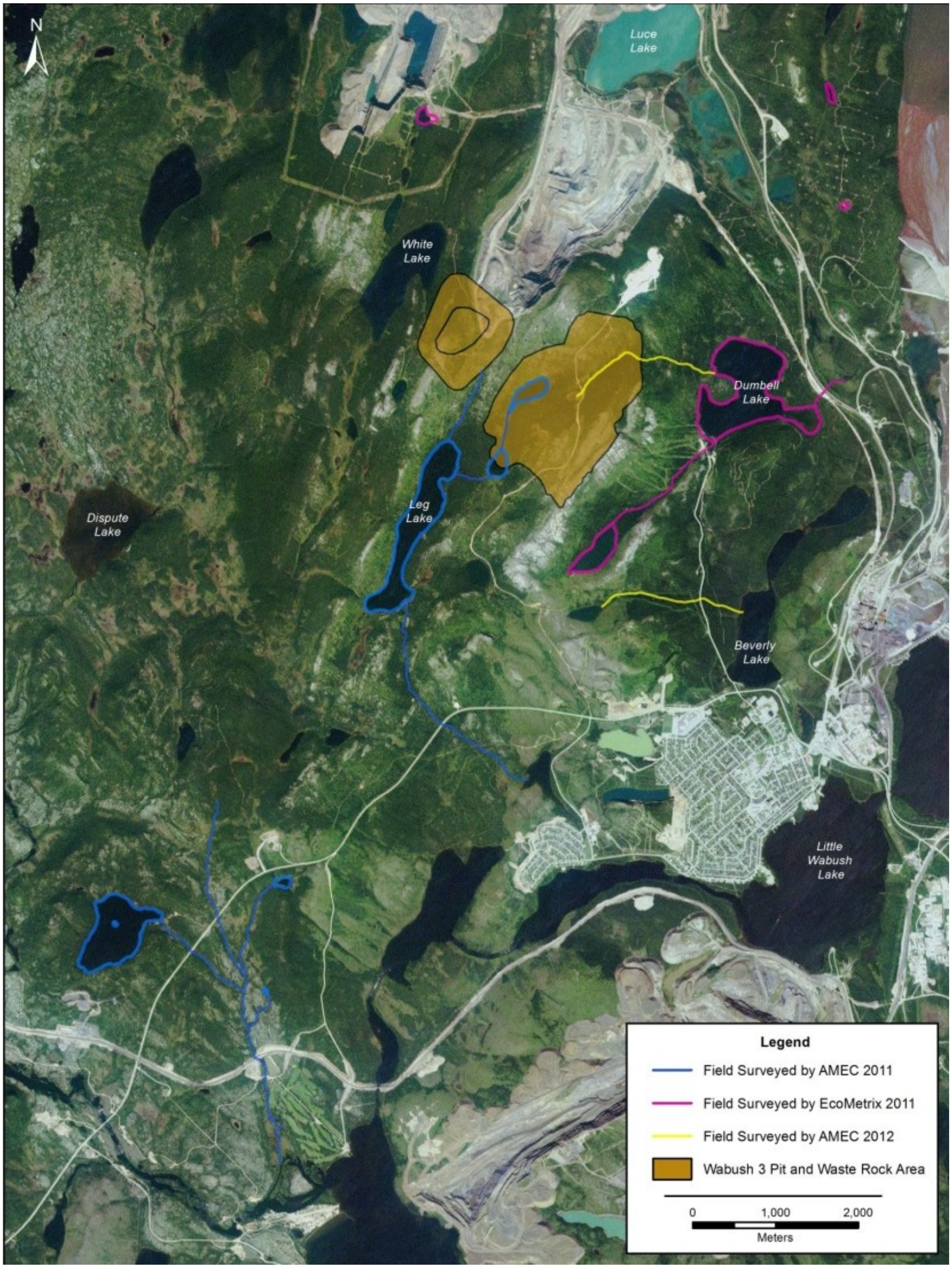

Figure 1.1: 2011 and 2012 surveyed streams and water bodies, Wabush 3 Study Area

2.0 OBJECTIVES

The freshwater resources habitat characterization adds data to IOC's regional baseline information on the freshwater environment and addresses information requirements related to habitat characterization suitable for quantification in the context of potential DFO Fisheries Act Authorization requirements, as well as general aquatic habitat characterization. The specific 2012 work scope was to determine fish baseline habitat characterization of streams that had not been previously surveyed in areas potentially within or around the proposed Wabush 3 project footprint.

Fish habitat characterization includes measurements of physical parameters as well as benthic invertebrates. Sampling for fish species presence, population estimates and habitat utilization has also been included.

2.1. Study Team

Core study team members for this project have been conducting freshwater and groundwater surveys and habitat classification for many years in Newfoundland and Labrador. Key team members are outlined below.

James H. McCarthy, M.Sc. is a Senior Biologist and Project Manager with AMEC St. John's and a Certified Fisheries Professional with the American Fisheries Society with over nineteen years experience in fisheries research and environmental assessment. He has been involved in a wide range of projects in Newfoundland and Labrador, Nova Scotia, British Columbia and Alaska working for private organizations and government agencies.

In addition to assisting the DFO in numerous policy and guideline developments over the past 8 years, he has also participated in most of the larger fish habitat characterizations and monitoring in the province including the Lower Churchill Hydroelectric Generation Project, the Labrador-Island Link Transmission Line, The Long Harbour Processing Plant, the Granite Canal Hydroelectric Development, the Rambler Mines Development, the Rose Blanche Hydroelectric Development, the Menihek Hydroelectric Development, the Sandy Lake reservoir expansion, the Rattling Brook Hydroelectric Development tailrace assessment, the proposed Southern Head Oil Refinery and the LabMag Iron Ore Project (including slurry pipeline).

Mr. McCarthy acted as Project Manager and senior biologist. Jim also led QA/QC on reporting.

Kyle Reid Fairhurst is a fish and wildlife technologist with six years experience in field data collection and record keeping related to wildlife and fish habitat. Mr. Fairhurst has recently joined AMEC and has been involved in fish habitat surveys for various projects including the 2011 Long Harbour Processing Plant Fish Habitat Compensation Construction, IOC's 2011 fish habitat surveys associated with proposed expansion, Lower Churchill Hydroelectric Generation Project's ongoing baseline fish habitat data collection, and Vale NL's Fish Habitat Compensation works associated with the Mine/Mill. Mr. Fairhurst has also participated in field identification of water fowl and nesting habitat, wetland and upland vegetation identification, identifying riparian zones, fish habitat surveys as it applies to forest harvesting and tree removal. He has also assessed culvert placement as it relates to fish movement and stream bank erosion.

Mr. Fairhurst acted as lead field crew member for required stream fieldwork.

Derm Kenny is an environmental technician with over 15 years experience in the environmental field involving monitoring and baseline data. In his time with AMEC he has been involved in numerous fisheries and water quality projects throughout Newfoundland and Labrador such as Lower Churchill Hydroelectric Generation Project's ongoing baseline fish habitat data collection, 5 Wing Goose Bay Base wide Fish Survey, and Vale NL's Fish Habitat Compensation works associated with the Mine/Mill. His efforts on these projects have included the use of a variety of skills, including: collection, consolidation and analysis of data; literature reviews; species identification, classification and description; bathymetric and electrofishing surveys; invertebrate, fish, water, sediment sampling; as well as collecting and assessing data on physical habitats within riverine, lacustrine and marine environments.

Mr. Kenny was a crew member for the field stream work and Field Data Manager.

Suzanne Mullowney is a Biologist with over ten years of applicable work experience in aquatic studies and environmental assessment. Ms. Mullowney is currently situated in the AMEC St. John's office and has acted as a field supervisor and project manager on numerous aquatic habitat assessments, mitigation monitoring programs and baseline studies throughout Newfoundland and Labrador.

Ms. Mullowney provided logistical support and liaison between field crews and various IOC contacts. She also acted as the field data and QA/QC data manager for this project.

3.0 METHODS

Regardless of field measurement or analysis technique, all tasks incorporated the following in their completion.

3.1. Quality Assurance

Work Instructions (WIs) developed by AMEC Environment & Infrastructure for conducting biological studies were implemented during the current program. These included:

- Fish and Benthic invertebrate Sampling

- Electrofishing
- Riverine habitat assessment
- Field Data Management and transfer

WIs serve as established procedures for conducting project tasks ensuring that the work is completed to an acceptable standard and in a prescribed manner. The WIs used by AMEC are maintained on its electronic Quality Management file system. WIs were reviewed by all team members to ensure consistency of sample collection. In addition, as part of each team's Job-Safety Assessment (JSA) was a list of contact numbers for senior biologists and a call-in procedure to ensure that each day's data collection was consistent and accurate. In addition to WIs, Quality Assurance/Quality Control (QA/QC) forms were completed and tracked for all data transfer from field (hard copy) to digital form and any aspect of the project where data validation was deemed necessary. These forms are an integral part of AMEC's QA/QC for data entry.

AMEC's Newfoundland and Labrador Business Units 5210 and 5321 with headquarters in St. John's operate a QMS (Quality management System) in compliance with the applicable requirements of ISO 9001:2008. The QMS in St. John's has been maintained since 2006 with formal registration obtained in December 2010.

The AMEC QMS provides a level of assurance that work performed by AMEC meets client and AMEC requirements, including applicable codes and standards, specifications, and regulations. The QMS is integrated throughout AMEC's management systems using common elements that facilitate planning, execution, monitoring, measurement, continual improvement, control of non-conformance, and enhancement of customer satisfaction.

3.2. Health and Safety

Health, safety, and environment (HSE) is an important part of every participant's overall job performance. Although AMEC has made great efforts in reducing the accident and injury rate, the goal is to have zero accidents and injuries. Obtaining this goal requires developing and maintaining an effective health, safety, and environment management system and a safety culture among all employees. Managers continue to make safety their number one priority by promoting programs that are effective in identifying and reducing hazards in the workplace, providing ongoing training and making safety the primary consideration in all operations. As part of this program, a project-specific Health and Safety (H&S) Plan was developed and implemented. In addition, site-specific risks and challenges during field operations require JSA to be completed prior to remote or changes in activities. JSA documents are working documents that are brought to the work site and reviewed by all participants. Any outstanding issues are identified, documented and addressed as they arise. JSA reports are kept on file upon completion of the program. Daily toolbox meetings are also conducted each morning prior to start of work to highlight risks and review procedures.

3.3. Data Collection

The field data manager was responsible for ensuring that WIs were followed during the collection of data and also for the daily transcription of field data to data forms for subsequent computer entry. At least weekly, all transcribed data was reviewed by the data manager and cross referenced with field note books. Any discrepancies were noted on field data forms and a review of procedure was conducted.

3.4. Technical Reporting

Technical quality assurance extending from field data collection to data review and reporting was provided by field supervisors and senior scientists. Their role included reviewing the data entered for analysis and all subsequent reports for accuracy.

In order to provide context for readers and reviewers, names of streams or ponds as found on 1:50,000 topographic maps or previous reports were used, such as Beverly Lake. All names are provided in the appropriate sections of the report.

3.5. Geo-referencing

All sample locations were geo-referenced using handheld Global Positioning Systems (GPS) (Garmin GPSMap78 models). Each position was recorded on an internal SD chip and also recorded in field notebooks. All field locations were gathered using North American Datum dating from 1983 (NAD83), datum.

All sampling was conducted during July 10-18, 2012. Table 3.1 presents the sampling collection summary for the streams.

Table 3.1: Sampling summary for streams, 2012

Site Name	July 2012	
	Macro-Invertebrate	Electrofishing
Beverly Stream	●	●
Dumbell Stream	●	●

4.0 HABITAT CHARACTERIZATION / QUANTIFICATION

To ensure consistent and comparable results for future work, sampling was conducted using standard methods compliant with known DFO requirements. Additional details or modifications for specific tasks are outlined in the appropriate sections below.

The work comprised a set of clearly defined tasks which were carried out in accordance with the scope of work. Two streams were included for habitat characterization (Figure 4.1) identified generally as Beverly Stream and Dumbell Stream.

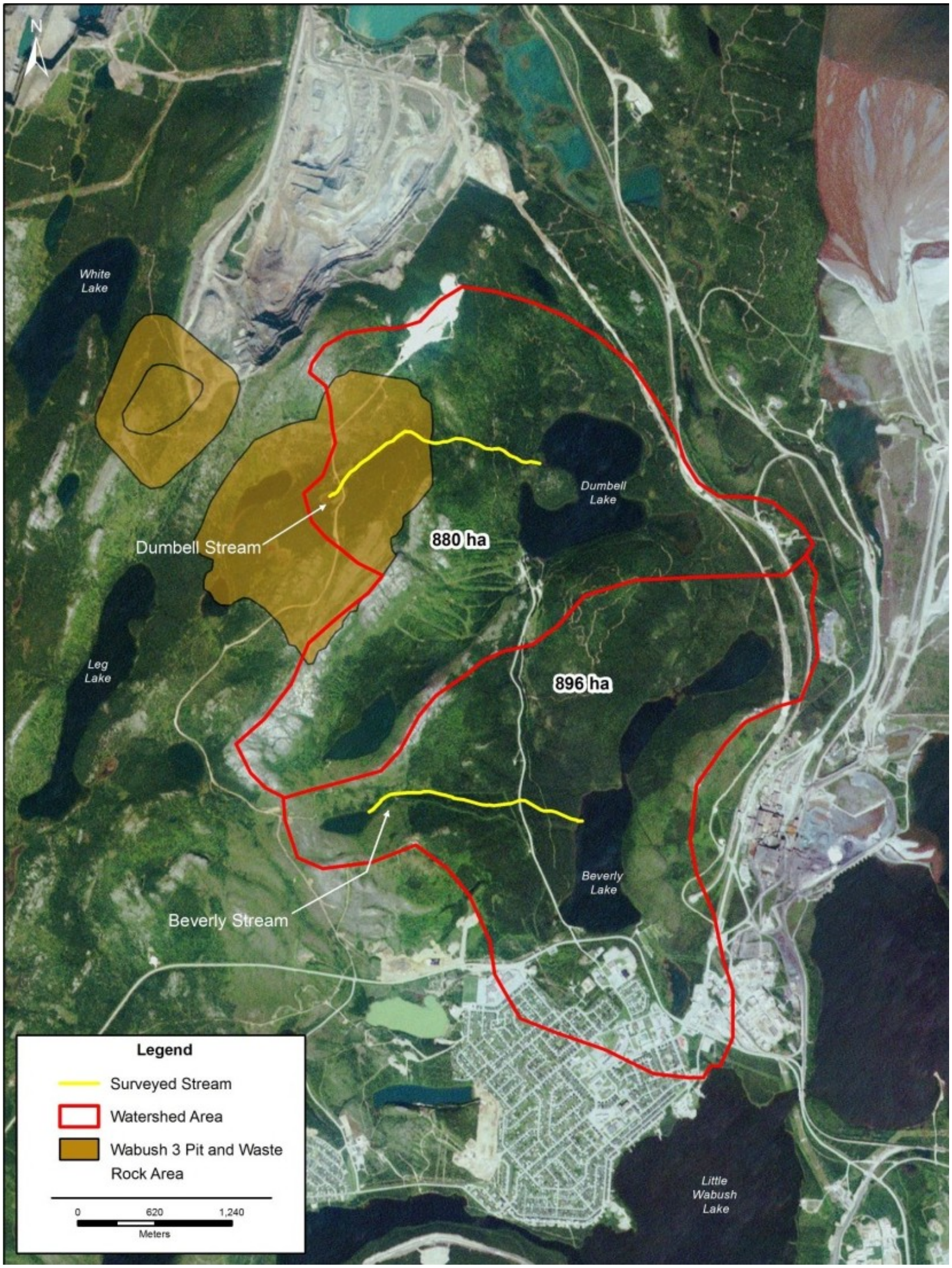

Figure 4.1: Overview of the project area

4.1. RIVERINE HABITAT CLASSIFICATION

Both identified streams within the study area were surveyed and characterized. The methods used to classify and quantify the aquatic habitat was based on standardized DFO methodologies such as Scruton *et al.* (1992), Sooley *et al.* (1998), Bradbury *et al.* (2001) and DFO (2012). Each stream was sub-divided into habitat reaches based on visible and measured changes in habitat characteristics (*e.g.,* streambed slope, water velocity, stream width and/or water depth). Each stream reach was surveyed for numerous parameters such as channel width, wetted perimeter, mean water column velocity, mean water depth, streambed slope and substrate composition. Based on these measurements, each reach was classified into various habitat types.

Two habitat classification systems were used; the Beak (1980) and a new classification system soon to be implemented by DFO (2012). The Beak habitat classification system uses a total of four habitat types based on salmonid life-cycle stages and habitat suitabilities (Table 4.1).

The proposed newer classification system outlined in DFO (2012) takes into account the suitability of the habitat for each species life-cycle stage using the habitat (spawning, young-of-year, juvenile and adult). Table 4.2 provides a description of each habitat type along with the range of parameter values associated with each.

Each defined habitat type has a discrete range of water velocities, substrate types, depths and gradients as possible which have been determined using the described biological 'preferences' outlined in Grant and Lee (2004). While not a defined habitat requirement, gradient is listed as a parameter which can be used in various levels of the system to distinguish between habitat types. It should be noted that not all habitat parameter descriptions are exclusive of all others (e.g., water depth); however, the combined parameters offers a reasonable designation of most habitat types encountered.

Table 4.1: Habitat classifications of Beak (1980)

Habitat Classification	Habitat Description
Type I	Good salmonid spawning and rearing habitat: often with some feeding pools for larger age classes: **flows:** moderate riffles; **current:** 0.1-0.3 m/s; **depth:** relatively shallow, 0.3-1.0 m; **substrate:** gravel to small cobble, some large rocks, boulders; **general habitat types:** primarily riffle, pool.
Type II	Good salmonid rearing habitat with limited spawning usually only in isolated gravel pockets, good feeding and holding areas for larger fish in deeper pools, pockets or backwater eddies: **flows:** heavier riffles to light rapids; **current:** 0.3-1.0 m/s; **depth:** variable from 0.3-1.5 m; **substrate:** Larger cobble/rubble size rock to boulders, bedrock, some gravel pockets between larger rocks; **general habitat types:** run, riffle, pocketwater, pool.
Type III	Poor rearing habitat with no spawning capabilities, used for migratory purposes: **flows:** very fast, turbulent, heavy rapids, chutes, small falls; **current:** 1.0 m/s or greater; **depth:** variable, 0.3-1.5 m; **substrate:** Large rock and boulders, bedrock; **general habitat types:** run, pocketwater, cascades.
Type IV	Poor juvenile salmonid rearing habitat with no spawning capability, provides shelter and feeding habitat for larger, older salmonid (especially brook trout): **flows:** sluggish; **current:** 0.15 m/s; **depth:** variable but often 1 m; **substrate:** Soft sediment or sand, occasionally large boulders or bedrock, aquatic macrophytes present in many locations; **general habitat types:** flat, pool, glide.

Table 4.2: Descriptions of riverine habitat classifications in DFO (2012)

Habitat Type	Habitat Parameter	Description
Fast Water	**Mean Water Velocity** **Stream Gradient**	**> 0.5m/s** **Generally > 4%.**
Rapid	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Considerable white water[1] present. > 0.5 m/s < 0.6 m Usually dominated by boulder (Coarse[2]) and rubble (Medium[2]) with finer substrates (Medium and Fine[2]) possibly present in smaller amounts. Larger boulders typically break the surface. Generally 4-7%

Habitat Type	Habitat Parameter	Description
Falls/Chute/Cascade	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Mainly white water present. The dominating feature is a rapid change in stream gradient with most water free-falling over a vertical drop or series of drops. > 0.5 m/s Variable and will depend on degree of constriction of stream banks. Dominated by bedrock and/or large boulders (Coarse). > 7% and can be as high as 100%.
Run	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Relatively swift flowing, laminar[3] and non-turbulent. > 0.5 m/s > 0.3 m Predominantly gravel, cobble and rubble (Medium) with some boulder (Coarse) and sand (Fine) in smaller amounts. Typically < 4% (exception to gradient rule of thumb)
Moderate Water	**Mean Water Velocity** **Stream Gradient**	**0.2-0.5m/s** **>1 and < 4%**
Riffle	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Relatively shallow and characterized by a turbulent surface[4] with little or no white water. 0.2 – 0.5 m/s < 0.3 m Typically dominated by gravel and cobble (Medium) with some finer substrates present, such as sand (Fine). A small amount of larger substrates (Coarse) may be present, which may break the surface.[5] Generally >1 and < 4%
Steady/Flat	General Description Mean Water Velocity Mean Water Depth Substrate	Relatively slow-flowing, width is usually wider than stream average and generally has a flat bottom. 0.2 - 0.5 m/s >0.2 m Predominantly sand and finer substrates (Fine) with some gravel and cobble (Medium).
	Stream Gradient	> 1 and < 4%
Slow Water	**Mean Water Velocity** **Stream Gradient**	**Generally < 0.2m/s (some eddies can be up to 0.4m/s).** **< 1%.**
Plunge / Trench / Debris Pools	General Description	Generally caused by increased erosion near or around a larger, embedded object in the stream such as a rock or log or created by upstream water impoundment resulting from a complete, or near complete, channel blockage. These pool types may be classified as an entire reach (e.g., pools greater than 60% of the stream width) or as sub-divisions of a fast water habitat.
	Mean Water Velocity Mean Water Depth	< 0.2 m/s > 0.5 m depending on stream size (e.g., may be shallower in smaller systems).

Habitat Type	Habitat Parameter	Description
	Substrate	Highly variable (i.e., coarse, medium or fine substrates)
	Stream Gradient	Generally < 1%
Eddy	General Description	Relatively small pools caused by a combination of damming and scour: however scour is the dominant forming action. Formation is due to a partial obstruction to stream flow from boulders, roots and/or logs. Partial blockage of flow creates erosion near obstruction. It is typically < 60% of the stream width and hence will be a sub-division of a faster-water habitat type (e.g., Run with 20% eddies).
	Mean Water Velocity	Typically < 0.4 m/s, but can be variable.
	Mean Water Depth	> 0.3 m. May vary depending on obstruction type, orientation, streambed and bank material and flows experienced.
	Substrate	Predominantly sand, silt and organics (Fine) with some gravels (Medium) in smaller amounts.
	Stream Gradient	Variable

1 White water is present when hydraulic jumps are sufficient to entrain air bubbles which disturb the water surface and reduces visibility of objects in the water.

2 Coarse, Medium and Fine substrate types are classified according to the Standard Methods Guide for the Classification/Quantification of Lacustrine Habitat in Newfoundland and Labrador (Bradbury *et al.* 2001).

3 Laminar describes the surface of the water as smooth and glass-like with no reduced visibility of objects in the water.

4 Turbulence is present if there are local patches of white water or if water movement disturbs a portion of the surface.

5 Pocket water often constitutes an important component of riffles in Newfoundland and Labrador and is characterized by a predominance of larger substrates (e.g., boulders) breaking the surface. The result is a riffle with many eddies around the boulders.

4.2. Riverine Habitat Utilization

Riverine habitat utilization by fish species and population estimates were completed using quantitative electrofishing techniques (*see* Scruton and Gibson 1995). The fish species captured were used to determine the species habitat utilization and were brought forward for final habitat quantification.

Quantitative electrofishing included the use of barrier nets to isolate a section of stream habitat for electrofishing. Barrier nets were established at the downstream and upstream end of the station prior to electrofishing. Each station was sampled using a Smith-Root electrofisher (model 15-D). Captured fish were retained in aerated buckets for processing at the end of each pass (*i.e.,* a pass is a complete electrofishing effort through the station). Each fish was anaesthetized, identified by species, measured, weighed, and scales collected for age determination, if required. They were then allowed to recover in clean water and released downstream of the station. A minimum of four passes were completed such that population estimates could be generated using the capture data (*i.e.,* depletion method). Population estimates were established (with confidence limits) using Microfish 3.0 (Van Deventer and Platts 1989).

4.3. Riverine Habitat Quantification

The quantification of potentially affected riverine habitat within the identified streams was completed using the data collected and both classification systems. The quantification of habitat using the Beak classification is simply the total area of each habitat type. Under the proposed newer system, the typical species habitat preference ranges contained within Grant and Lee (2004) and the measured habitat parameter ranges are used to derive a more detailed habitat suitability estimate of each habitat type present.

To calculate final suitability values under the newer system, both substrate and velocity ratings were taken into consideration. The preferred range of water velocity listed in Grant and Lee (2004) and the ranges measured within each habitat were compared to determine the proportion available and suitable to each species life-cycle stage. A similar exercise was also conducted using the preferred substrate ranges and the proportions estimated from each habitat type surveyed. In order to keep final suitability calculations similar to the Lacustrine Quantification Methodology (Bradbury *et al.* 1999), the mean of both values were used to derive a final suitability value unless an unsuitable rating (*i.e.*, 0.00) was present for either. In these cases, the habitat suitability would be 0.00. These calculations were completed for all species and life stages present. As a precautionary approach, the highest suitability value of the four life stages was used as the species-specific utilization value for that habitat type in an attempt to ensure that any ‘critical’ habitat requirements that a species/life stage might have would be incorporated to the highest extent possible. Using the final habitat suitability values and the overall area (*i.e,.* availability) of each habitat type, the total Habitat Equivalent Units (HEU) of each habitat type can be calculated for each species. The total HEU is the quantity of suitable habitat for each species within a watershed or specific stream reach.

4.4. Benthic Invertebrates

Benthic sampling was conducted at both streams using standard methodologies. Each sample was collected at moderate depths along a stream transect representative of the watershed using a surber sampler. Three subsamples were taken at each electrofishing site on both streams. The sampler was set on the bottom and the substrate within the grid boundary cleaned. Invertebrates cleaned from the substrate were washed into the mesh downstream of the grid. Once the larger substrate was cleaned and removed, the smaller material was disturbed for at least 30 seconds to dislodge any remaining invertebrates. The sampler was then removed from the stream and cleaned into collection jars with preservative (90% ethanol).

Samples were taken to the lab and cleaned with all invertebrates placed in a clean vial in 70% ethanol.

Organisms in each sample were identified to the lowest possible level (typically to Family) and enumerated. Baseline diversity analyses were completed using standard methods with calculations of richness (total number of families), Shannon-Weiner Diversity Indices (H) and an estimation of Species Evenness (D).

Richness refers to the total number of families identified in the sample. The Shannon-Weiner Diversity Index is a measure of richness and evenness and is calculated as follows:

$$\mathrm{H} = \sum_{n=1}^{n} \mathrm{p_i} \,\mathrm{Log_2}\, \mathrm{p_i}$$

The term p_i refers to the abundance of each family, calculated as the number of individuals of a family divided by the total number of individuals in the sample. The index generally ranges between 1.5 (indicating low richness and evenness) to 3.5 (indicating high richness and evenness).

Evenness refers to how numerically equal species found in the sample are. It is calculated as the Shannon-Weiner Diversity Index (H) divided by H_{max}, which is the maximum possible index number if all species are present in equal numbers.

4.5. Watershed Hydrology

Watershed hydrology is being addressed in a separate report(s). This will include generated hydrographs and flow duration curves suitable for fish habitat characterization.

5.0 RESULTS

Beverly and Dumbell Streams were surveyed in July 2012 (see Figure 5.1). The results of the study are provided below.

5.1. Riverine Habitat Classification

Survey data collected from both Dumbell and Beverly Streams were analyzed to determine the habitat classification of each site.

Dumbell Stream drains into the northwest side of Dumbell Lake. At its outflow, the stream starts as a steady with alders along its banks. It quickly changes into riffles and cascades as the elevation of the stream increases, winding its way through black spruce stands intermixed with alder beds. Two sets of waterfalls, with a 40% slope, were encountered approximately 650 m from Dumbell Lake. At approximately 1160 m upstream from the outfall, a groundwater source feeds into the stream from an outcropping of bedrock. The stream slope begins to level off, creating some riffles and runs which continue through thick alder beds and black spruce. After 200-300 m of riffle-run habitat, the stream emerges onto a marsh, travelling along its southeast side. It then re-enters thick alder beds and black spruce, maintaining riffle and rapid habitat until it terminates at a large bog. In total, Dumbell Stream is approximately 2,100 m in length and contains 37.82 units of riverine fish habitat. Channel widths ranged from 1.15-7.10 m and depths ranged from 0.01-0.47 m. Water velocities ranged from 0.01-1.60 m/s. Detailed field measurements are provided in Appendix A

Table 5.1 presents a summary of habitat characteristics as well as the habitat classification in both the Beak and proposed new riverine classifications for each stream reach. The Beak habitat classification quantifies the river as a total of 2.70 units of Type I (Spawning and Rearing), 10.49 units of Type II (Rearing, Limited Spawning), 3.46 units of Type III (Migration) and 19.27 units of Type IV (Sheltering and Feeding) habitats. The new classification system (DFO 2012) identifies a total of 11.20 units of Riffle, 8.49 units of Rapids, 7.59 units of Pool, 7.35 units of Cascade, and 3.20 units of Run habitats. Appendix B provides a series of photographs of each reach surveyed.

No fish were captured in Dumbell Stream; therefore, a species suitability for each reach of the stream could not be calculated.

Beverly Stream is similar in physical description to Dumbell Stream. It drains into the northwest side of Beverly Lake and, like Dumbell Stream, begins as a small steady with a dense cover of alders. It quickly changes into rapid, riffle and cascade habitat as the slope begins to increase, with black spruce stands becoming more dominant. At approximately one kilometre from Beverly Lake, the elevation begins to decrease and the stream meanders through a transmission cut line, with a cover of very dense alder beds, fallen trees, and shrubs. At this point, the stream habitat begins to change into small pools and riffles. The channel becomes very braided, sometimes disappearing under dense vegetation. At approximately 1750 m from the outflow, the stream flows through a culvert that crosses a narrow woods road. Near its upstream extent, the stream has predominantly rapid habitat, with surrounding vegetation of mostly alders, interspersed with black spruce, until it terminates at a small pond. Overall, Beverly Stream is approximately 2,000 m in length and contains 22.52 units of fish habitat. Channel width ranged from 0.30-4.60 m and depths ranged from 0.01-0.23 m. Water velocities ranged from 0.00-0.61 m/s. Detailed field measurements are provided in Appendix A.

Table 5.2 presents a summary of habitat characteristics and classification for the tributary. The Beak habitat classification quantifies the stream with a total of 1.9 units of Type I (Spawning and Rearing), 2.92 units of Type II (Rearing, Limited Spawning) and 19.52 units of Type IV (Sheltering and Feeding or Pool type) habitats. The new classification system (DFO 2012) identifies 9.05 units of Pool, 6.86 units of Riffle, 2.81 units of Rapids, 2.5 units of Run and 0.07 units of Eddy habitats. Appendix B provides a series of photographs of each reach surveyed.

Table 5.3 summarizes the species suitability for each reach of Beverly Stream for brook trout found in the stream, as well as the calculations of the HEU. For Beverly Stream, brook trout give an overall HEU value of 13.99 units.

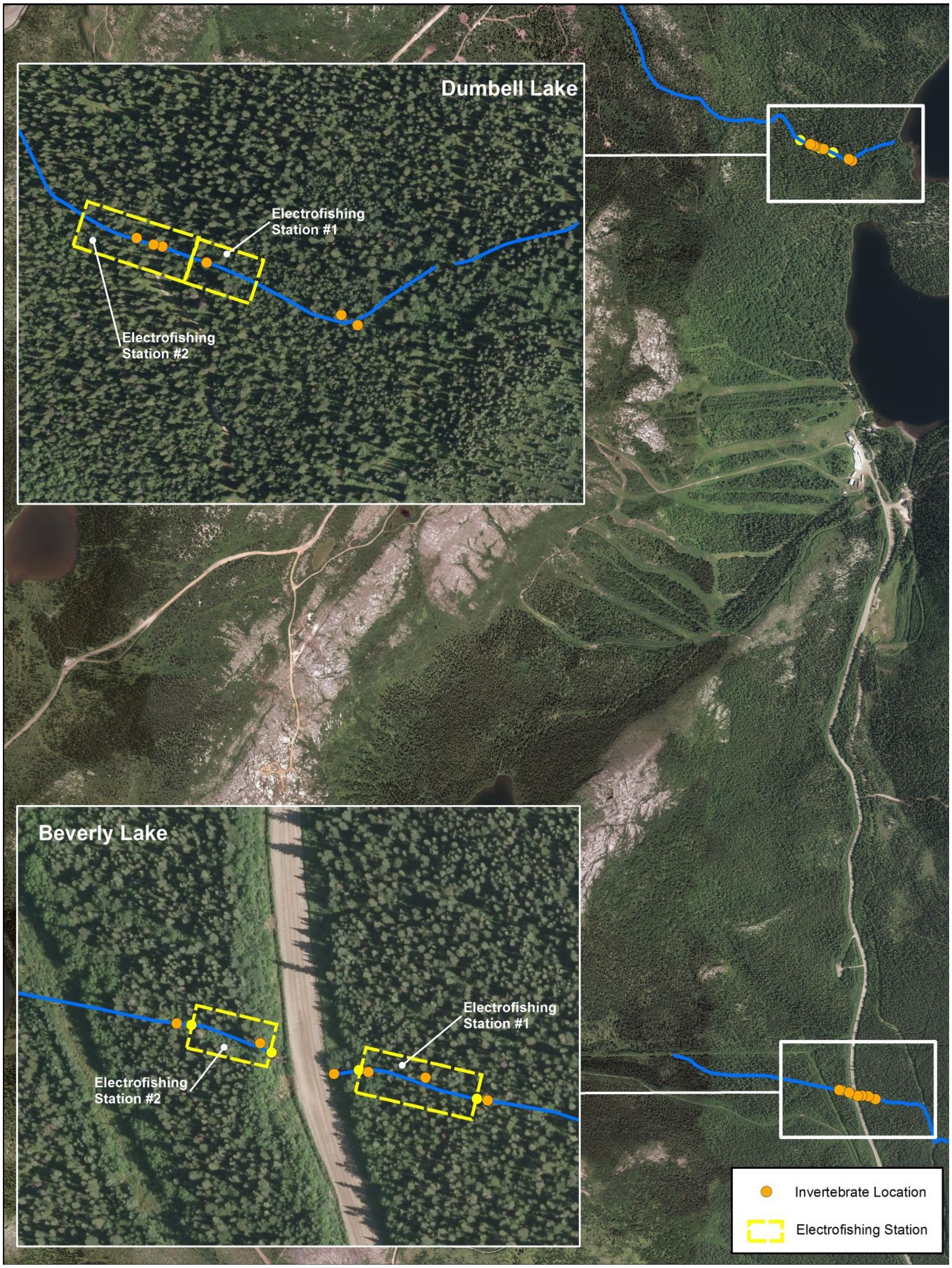

Figure 5.1: Invertebrate and electrofishing sites at Dumbell and Beverly Streams, July 2012

Table 5.1: Summary of habitat measurements and classifications for Dumbell Stream

Transect #	Section Length (m)	Wetted Width (m)	Area (Units)	Bank Height (m)		Average Depth (m)	Average Velocity (m/s)	Slope (%)	Substrate[1] (%)												Classification	
				Left	Right				Be	LgB	SmB	R	C	G	S	St	C	D	M	AqV	Beak	New
1	21	3.5	0.74	0.22	0.24	0.22	0.04	0.00	0	0	0	0	0	5	95	0	0	0	0	0	IV	Pool
2	48	2.1	0.98	0.40	0.43	0.09	0.45	1.17	0	0	0	0	0	15	75	0	0	0	10	0	IV	Riffle
3	100	3.7	3.70	0.52	0.58	0.27	0.10	0.00	0	0	0	0	0	35	60	0	0	5	0	0	IV	Pool
4	100	1.4	1.40	0.33	0.43	0.10	0.82	0.83	0	0	0	0	5	15	75	0	0	0	5	0	IV	Rapids
5	60	1.7	1.04	0.39	0.40	0.13	0.39	1.41	0	0	0	10	40	30	10	0	0	0	10	0	II	Riffle
6	100	2.8	2.80	0.81	0.76	0.06	0.40	5.44	0	10	30	20	20	10	0	0	0	0	10	0	II	Rapids
7	100	3.0	2.95	0.75	0.44	0.13	0.36	14.76	0	20	40	15	15	5	3	0	0	0	2	0	II	Cascade
8	100	2.2	2.20	0.79	0.75	0.11	0.76	11.71	5	25	40	15	10	4	0	0	0	0	1	0	II	Cascade
9	100	1.9	1.90	0.17	0.25	0.07	0.77	4.67	70	10	10	3	5	0	1	0	0	0	1	0	II	Rapids
10	34	3.7	1.26	0.52	0.40	0.10	0.14	6.40	90	0	10	0	0	0	0	0	0	0	0	0	III	Rapids
11	100	2.2	2.20	0.47	0.34	0.11	0.24	2.22	5	5	5	20	20	5	0	0	0	0	40	0	IV	Riffle
12	100	2.7	2.70	0.61	0.61	0.09	0.19	3.00	10	10	10	20	20	20	0	0	0	0	10	0	I	Run
13	45	1.4	0.63	0.24	0.31	0.21	0.12	6.11	30	25	20	5	5	5	5	0	0	0	5	0	IV	Rapids
14	55	0.9	0.50	0.34	0.25	0.22	0.10	2.00	20	0	0	20	15	15	30	0	0	0	10	0	IV	Run
15	100	1.5	1.50	0.28	0.32	0.08	0.46	1.13	40	0	0	0	20	5	0	10	0	0	15	10	II	Riffle
16	100	2.2	2.20	0.43	0.63	0.04	0.23	7.27	50	0	10	0	20	10	0	0	0	0	10	0	III	Cascade
17	100	1.9	1.90	0.32	0.36	0.15	0.00	0.77	10	0	0	30	0	0	20	0	0	0	40	0	IV	Pool
18	100	2.7	2.70	0.38	0.52	0.11	0.02	3.60	15	0	5	20	10	10	10	0	0	0	30	0	IV	Riffle
19	100	0.8	0.80	0.17	0.15	0.04	0.13	1.09	0	0	0	0	0	0	60	0	0	15	20	5	IV	Riffle
20	100	0.7	0.65	0.19	0.18	0.22	0.09	2.81	0	0	0	0	15	0	30	0	0	15	40	0	IV	Riffle
21	100	0.5	0.50	0.44	0.30	0.15	0.06	0.20	0	0	0	10	10	15	25	0	0	0	40	0	IV	Pool
22	100	1.0	0.95	0.19	0.26	0.06	0.08	3.29	0	0	0	10	10	20	40	0	0	0	20	0	IV	Riffle
23	100	0.5	0.50	0.11	0.19	0.03	0.10	4.60	0	0	0	0	5	5	70	0	0	0	20	0	IV	Rapids
24	100	0.8	0.75	0.20	0.14	0.05	0.00	10.75	10	0	0	10	20	5	30	0	0	0	25	0	IV	Pool
25	42	0.9	0.38	0.40	0.35	0.04	0.06	2.18	5	0	0	10	10	5	30	0	0	0	40	0	IV	Riffle
Total	**2105**		**37.82**																			

[1] Be-Bedrock, LgB-Large Boulder, SmB–Small Boulder, R-Rubble, C-Cobble, G-Gravel, S-Sand, St-Silt, D-Detritus, M-Mud, AqV-Aquatic Vegetation

Table 5.2: Summary of habitat measurements and classifications for Beverly Stream

Transect #	Section Length (m)	Wetted Width (m)	Area (Units)	Bank Height (m)		Average Depth (m)	Average Velocity (m/s)	Slope (%)	Substrate[1] (%)												Classification	
				Left	Right				Be	LgB	SmB	R	C	G	S	St	C	D	M	AqV	Beak	New
1	42	0.5	0.21	0.36	0.39	0.15	0.26	0.09	0	0	0	0	5	0	55	0	0	20	20	0	IV	Eddy
2	100	0.8	0.80	0.39	0.48	0.08	0.09	3.40	0	5	10	25	40	10	5	0	0	0	5	0	II	Riffle
3	100	0.9	0.90	0.41	0.50	0.05	0.49	4.69	5	5	5	30	20	5	30	0	0	0	0	0	II	Rapids
4	100	1.1	1.10	0.40	0.40	0.05	0.14	3.67	5	5	10	20	20	0	30	0	0	0	10	0	I	Riffle
5	100	1.4	1.40	0.17	0.21	0.10	0.08	9.70	10	5	5	25	25	0	20	0	0	0	10	0	IV	Pool
6	32	1.6	0.51	0.37	0.40	0.06	0.26	5.60	-	-	-	-	-	-	-	-	-	-	-	-	IV	Rapids
7	100	2.6	2.60	0.48	0.31	0.04	0.34	11.64	10	5	5	30	15	20	0	0	0	0	15	0	II	Riffle
8	100	2.5	2.50	0.35	0.23	0.04	0.09	3.43	0	5	10	15	25	15	25	0	0	0	5	0	IV	Run
9	120	1.0	1.20	0.40	0.30	0.04	0.08	11.30	0	0	5	30	40	5	10	0	0	0	10	0	IV	Pool
10	100	1.0	1.00	0.28	0.17	0.04	0.43	2.25	0	0	0	0	0	0	10	0	0	0	90	0	IV	Riffle
11	100	0.8	0.80	0.19	0.18	0.05	0.18	7.11	0	0	20	25	25	0	20	0	0	0	10	0	I	Pool
12	100	0.3	0.30	0.14	0.22	0.09	0.17	0.25	0	0	0	0	5	5	30	0	0	0	60	0	IV	Pool
13	100	0.7	0.66	0.31	0.33	0.08	0.19	2.67	0	0	0	10	10	0	60	0	0	0	20	0	IV	Riffle
14	100	1.4	1.40	0.33	0.60	0.07	0.07	6.40	0	0	20	10	10	0	30	0	0	0	30	0	IV	Rapids
15	100	0.7	0.70	0.49	0.48	0.06	0.41	2.00	0	0	0	5	5	0	10	0	0	0	80	0	II	Riffle
16	100	0.7	0.65	0.21	0.17	0.04	0.00	0.57	0	0	0	0	0	0	30	0	0	0	70	0	IV	Pool
17	100	0.8	0.80	0.34	0.44	0.04	0.16	0.29	0	0	0	0	5	0	10	0	0	0	85	0	IV	Pool
18	100	0.9	0.90	0.21	0.22	0.12	0.04	0.83	0	0	0	0	5	0	40	0	0	0	55	0	IV	Pool
19	100	1.1	1.10	0.15	0.16	0.12	0.03	0.83	0	0	0	0	10	0	40	0	0	0	50	0	IV	Pool
20	100	1.9	1.90	0.09	0.18	0.11	0.00	0.47	0	0	0	0	5	5	40	0	0	0	50	0	IV	Pool
21	109	1.0	1.09	0.13	0.11	0.06	0.25	1.60	0	0	0	0	10	10	50	0	0	0	30	0	IV	Riffle
Total	**2003**		**22.52**																			

[1] Be-Bedrock, LgB-Large Boulder, SmB–Small Boulder, R-Rubble, C-Cobble, G-Gravel, S-Sand, St-Silt, D-Detritus, M-Mud, AqV-Aquatic Vegetation.

5.2. Riverine Habitat Utilization

During the survey brook trout (*Salvelinus fontinalis*) were collected within Beverly Stream while no fish were collected at the Dumbell Stream.

A total of 17 brook trout were captured and ranged from 20-121 mm in length and 0.10-21.30 g in weight. Figures 5.2 and 5.3 present the length-weight relationships for brook trout recorded in the electrofishing stations completed within Beverly Stream.

Recent DFO documents summarize the general biology of brook trout for use in habitat quantification (*see* Bradbury *et al.* 1999 and Grant and Lee 2004). A brief life history description from the above documents is provided below.

Brook Trout

Brook trout are widely distributed throughout Newfoundland and Labrador. Spawning in Labrador normally occurs between late September and early November in streams and occasionally in lakes. In lakes, spawning typically occurs at depths less than two metres (Bradbury *et al*. 1999 and Grant and Lee 2004).

Optimal brook trout habitat can be characterized as clean, cold spring-fed water; silt free rocky substrate in riffle-run areas; well vegetated stream banks; approximate 1:1 pool-riffle ratio with areas of slow, deep water; abundant instream cover; and relatively stable water flow, temperature regimes and stream banks. Brook trout often seek refuge among rocks, aquatic vegetation, woody debris, overhanging logs and undercut banks (Bradbury *et al*. 1999 and Grant and Lee 2004).

5.2.1. Productivity Estimates

A total of four quantitative electrofishing stations were completed in Dumbell and Beverly Streams (Figure 5.1). Table 5.3 presents the mean standing stock estimates of all fish species from the representative electrofishing stations in Beverly Stream. There was no fish caught in Dumbell Stream. Population estimates in Beverly Stream ranged from 5 to 14 fish per unit (1 unit = 100 m^2).

Table 5.3: Summary of standing stock and biomass estimates for electrofishing stations, July 2012

Station	Area (m^2)	Species	Total Catch	Pop. Est./Unit (N/unit)	Confidence Limits (N/unit)		Estimated Biomass (gm/unit)
					LCL[1]	UCL[2]	
Quantitative Stations : Beverly Watershed							
Beverly Stream Station 1	100	Brook trout	14	14	14	15.31	117.5
Beverly Stream Station 2	100	Brook trout	5	5	5	5.177	3.4

[1] Lower Confidence Limit (LCL). If statistical CI is lower than number of fish actually captured, actual number captured is presented.

[2] Upper Confidence Limit (UCL).

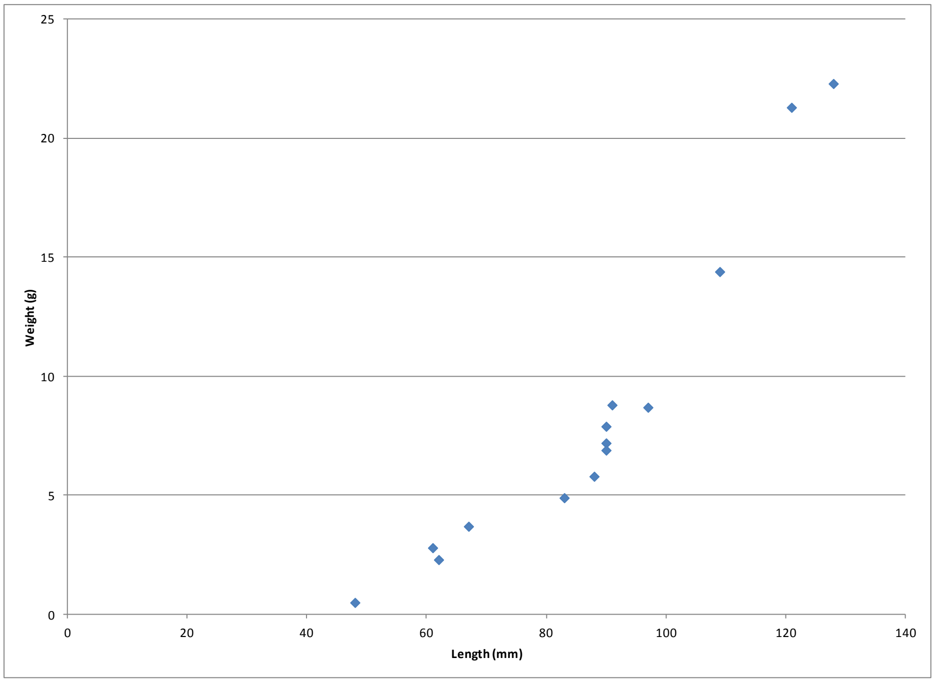

Figure 5.2: Length-weight relationship, brook trout, Electrofishing Station #1 (Beverly Stream), 2012

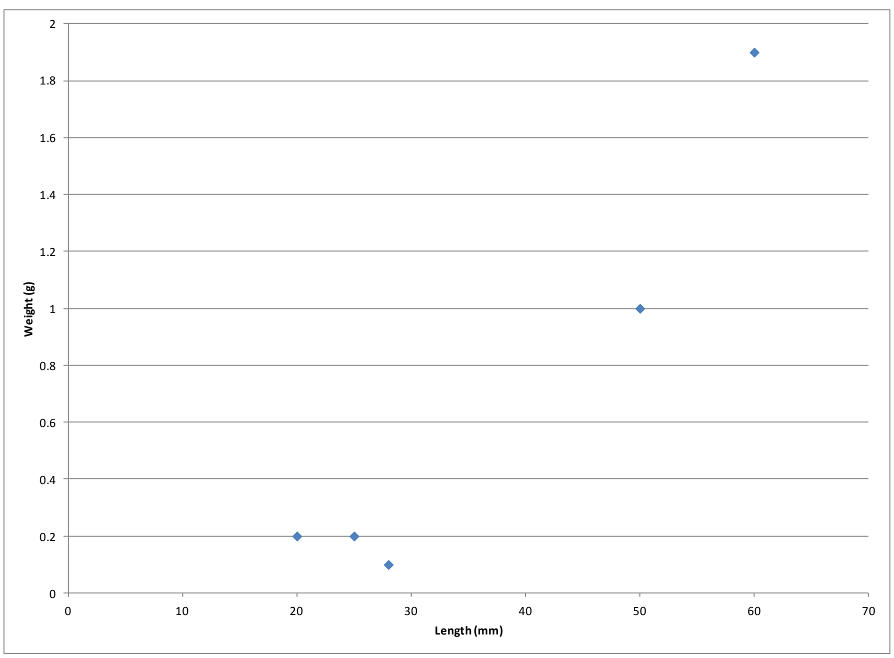

Figure 5.3: Length-weight relationship, brook trout, Electrofishing Station #2 (Beverly Stream), 2012

Table 5.4: Summary habitat suitability information and HEUs for Beverly Stream

Transect	Units	Brook trout	
		Habitat Suitability	HEU
1	0.21	0.87	0.18
2	0.80	0.78	0.62
3	0.90	0.98	0.88
4	1.10	0.80	0.88
5	1.40	0.62	0.86
6	0.51	0.80	0.41
7	2.60	0.71	1.84
8	2.50	0.73	1.81
9	1.20	0.70	0.84
10	1.00	0.70	0.70
11	0.80	0.78	0.63
12	0.30	0.80	0.24
13	0.66	0.90	0.59
14	1.40	0.65	0.91
15	0.70	0.72	0.50
16	0.65	0.00	0.00
17	0.80	0.38	0.31
18	0.90	0.44	0.40
19	1.10	0.50	0.55
20	1.90	0.00	0.00
21	1.09	0.77	0.84
Total	**22.52**		**13.99**

5.3. Benthic Invertebrates

Invertebrate sampling was conducted during the July 2012 surveys as presented in Figure 5.1. Analysis of benthic invertebrates at Beverly Stream, gave a range of 12 to 49 individuals, belonging to 15 families. The Shannon-Weiner index and species evenness ranged between 1.03 to 2.73 and 0.515 to 0.921, respectively. At Dumbell Stream there was a range of 16 to 162 individuals belonging to 15 families. The Shannon-Weiner index and species evenness ranged between 1.22 to 2.02 and 0.471 to 0.940, respectively. Results of the invertebrate collection are provided in Appendix C for all samples collected.

6.0 CLOSURE

This report has been prepared for the exclusive use of Iron Ore Company of Canada. The project was conducted using standard practices and in accordance with verbal and written requests from the client. No further warranty, expressed or implied, is made. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AMEC Environment and Infrastructure accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Regards,

AMEC Environment & Infrastructure,

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APPENDIX A

Habitat Survey Sheets

Beverly Stream Survey

	GPS Coordinates			Section Length (m)	Wetted Width (m)	Channel Width (m)	Length (m)								Depth (m)								Average Depth (m)
Transect #	Zone	Easting	Northing				1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	
0																							
1	19	639999	5869833	42	0.50	1.55	0.00	0.25	0.50	-	-	-	-	-	0.18	0.22	0.06	-	-	-	-	-	0.15
2	19	639942	5869842	100	0.80	0.80	0.00	0.20	0.40	0.60	0.80	-	-	-	0.05	0.11	0.11	0.06	0.07	-	-	-	0.08
3	19	639850	5869844	100	0.90	0.90	0.00	0.30	0.60	0.90	-	-	-	-	0.01	0.07	0.08	0.04	-	-	-	-	0.05
4	19	639782	5869891	100	1.10	2.01	0.00	0.20	0.40	0.60	0.80	1.00	1.10	-	0.01	0.05	0.10	0.10	0.03	0.05	0.01		0.05
5	19	639695	5869927	100	1.40	1.40	0.00	0.30	0.60	0.90	1.20	1.40	-	-	0.15	0.15	0.12	0.06	0.05	0.04	-	-	0.10
6	19	639636	5869936	32	1.60	1.98	0.00	0.30	0.60	0.90	1.20	1.50	1.60	-	0.01	0.02	0.09	0.06	0.08	0.10	0.07	-	0.06
7	19	639588	5869927	100	2.60	3.08	0.00	0.50	1.00	1.50	2.00	2.50	2.60	-	0.01	0.05	0.04	0.00	0.05	0.05	0.05	-	0.04
8	19	639489	5869958	100	2.50	2.68	0.00	0.50	1.00	1.50	2.00	2.50	-	-	0.01	0.00	0.01	0.11	0.06	0.05	-	-	0.04
9	19	639410	5869911	120	1.00	1.00	0.00	0.25	0.50	0.75	1.00	-	-	-	0.02	0.05	0.01	0.00	0.11	-	-	-	0.04
10	19	639315	5869964	100	1.00	1.72	0.00	0.25	0.50	0.75	1.00	-	-	-	0.08	0.05	0.04	0.03	0.01	-	-	-	0.04
11	19	639224	5869986	100	0.80	1.06	0.00	0.20	0.40	0.60	0.80	-	-	-	0.01	0.02	0.07	0.09	0.08	-	-	-	0.05
12	19	639140	5869964	100	0.30	0.30	0.00	0.15	0.30	-	-	-	-	-	0.08	0.12	0.08	-	-	-	-	-	0.09
13	19	639082	5870019	100	0.66	0.87	0.00	0.20	0.40	0.66	-	-	-	-	0.07	0.10	0.07	0.08	-	-	-	-	0.08
14	19	638986	5870062	100	1.40	4.60	0.00	0.30	0.60	0.90	1.20	1.40	-	-	0.08	0.08	0.10	0.12	0.05	0.00	-	-	0.07
15	19	638892	5870063	100	0.70	1.79	0.00	0.20	0.40	0.60	0.70	-	-	-	0.01	0.01	0.05	0.11	0.10	-	-	-	0.06
16	19	638804	5870063	100	0.65	1.32	0.00	0.20	0.40	0.60	0.65	-	-	-	0.01	0.07	0.02	0.05	0.05	-	-	-	0.04
17	19	638723	5870045	100	0.80	0.80	0.00	0.20	0.40	0.60	0.80	-	-	-	0.02	0.05	0.07	0.05	0.00	-	-	-	0.04
18	19	638631	5870043	100	0.90	1.14	0.00	0.30	0.60	0.90	-	-	-	-	0.23	0.12	0.14	0.00	-	-	-	-	0.12
19	19	638545	5870035	100	1.10	1.60	0.00	0.20	0.40	0.60	0.80	1.00	1.10	-	0.03	0.07	0.10	0.17	0.20	0.17	0.13	-	0.12
20	19	638490	5869998	100	1.90	1.90	0.00	0.30	0.60	0.90	1.20	1.50	1.80	1.90	0.08	0.12	0.13	0.18	0.17	0.13	0.05	0.00	0.11
21	19	638427	5869916	109	1.00	1.27	0.00	0.20	0.40	0.60	0.80	1.00	-	-	0.00	0.07	0.11	0.10	0.06	0.01	-	-	0.06

Beverly Stream Survey (continued)

	Velocity (m/s)								Average Velocity (m/s)	Slope			Substrate (%)												
Transect #	1	2	3	4	5	6	7	8		Rise (m)	Run (m)	%	Bedrock	LgB	SmB	Rubble	Cobble	Gravel	Sand	Silt	Clay	Detritus	Muck	Aq Veg	Total
0																									0
1	0.10	0.29	0.40	-	-	-	-	-	0.26	0.01	5.50	0.09	0	0	0	0	5	0	55	0	0	20	20	0	100
2	0.00	0.12	0.16	0.00	0.17	-	-	-	0.09	0.17	5.00	3.40	0	5	10	25	40	10	5	0	0	0	5	0	100
3	n/a	0.56	0.42	n/a	-	-	-	-	0.49	0.30	6.40	4.69	5	5	5	30	20	5	30	0	0	0	0	0	100
4	n/a	0.20	0.23	0.14	n/a	0.00	n/a	-	0.14	0.22	6.00	3.67	5	5	10	20	20	0	30	0	0	0	10	0	100
5	0.00	0.00	0.17	0.22	0.00	n/a	-	-	0.08	0.32	3.30	9.70	10	5	5	25	25	0	20	0	0	0	10	0	100
6	n/a	n/a	0.61	0.41	0.25	0.01	0.00	-	0.26	0.28	5.00	5.60	-	-	-	-	-	-	-	-	-	-	-	-	0
7	n/a	0.50	n/a	0.00	0.55	n/a	n/a	-	0.35	0.64	5.50	11.64	10	5	5	30	15	20	0	0	0	0	15	0	100
8	n/a	0.00	n/a	0.00	0.19	0.16	-	-	0.09	0.24	7.00	3.43	0	5	10	15	25	15	25	0	0	0	5	0	100
9	n/a	0.00	n/a	n/a	0.16	-	-	-	0.08	0.52	4.60	11.30	0	0	5	30	40	5	10	0	0	0	10	0	100
10	0.54	0.32	n/a	n/a	n/a	-	-	-	0.43	0.09	4.00	2.25	0	0	0	0	0	0	10	0	0	0	90	0	100
11	n/a	n/a	0.38	0.15	0.00	-	-	-	0.18	0.32	4.50	7.11	0	0	20	25	25	0	20	0	0	0	10	0	100
12	0.18	0.20	0.14	-	-	-	-	-	0.17	0.01	4.00	0.25	0	0	0	0	5	5	30	0	0	0	60	0	100
13	0.14	0.18	0.31	0.14	-	-	-	-	0.19	0.12	4.50	2.67	0	0	0	10	10	0	60	0	0	0	20	0	100
14	0.00	0.12	0.07	0.14	0.00	n/a	-	-	0.07	0.32	5.00	6.40	0	0	20	10	10	0	30	0	0	0	30	0	100
15	n/a	n/a	n/a	0.49	0.33	-	-	-	0.41	0.08	4.00	2.00	0	0	0	5	5	0	10	0	0	0	80	0	100
16	n/a	0.00	n/a	0.00	0.00	-	-	-	0.00	0.04	7.00	0.57	0	0	0	0	0	0	30	0	0	0	70	0	100
17	n/a	0.47	0.00	0.00	n/a	-	-	-	0.16	0.01	3.50	0.29	0	0	0	0	5	0	10	0	0	0	85	0	100
18	0.00	0.15	0.00	0.00	-	-	-	-	0.04	0.05	6.00	0.83	0	0	0	0	5	0	40	0	0	0	55	0	100
19	n/a	0.01	0.14	0.00	0.00	0.00	0.00	-	0.03	0.04	4.80	0.83	0	0	0	0	10	0	40	0	0	0	50	0	100
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	4.30	0.47	0	0	0	0	5	5	40	0	0	0	50	0	100
21	n/a	0.25	0.22	0.00	0.52	n/a	-	-	0.25	0.08	5.00	1.60	0	0	0	0	10	10	50	0	0	0	30	0	100

Dumbell Stream Survey

Transect #	GPS Coordinates			Section Length (m)	Wetted Width (m)	Channel Width (m)	Length (m)											Depth (m)											Average Depth (m)
	Zone	Easting	Northing				1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11	
0																													
1	19	639729	5872771	21	3.50	4.90	0.00	0.35	0.70	1.05	1.40	1.75	2.10	2.45	2.80	3.15	3.50	0.41	0.38	0.28	0.35	0.41	0.32	0.15	0.07	0.03	0.05	0.01	0.22
2	19	639700	5872780	48	2.05	3.90	0.00	0.40	0.80	1.20	1.60	2.05	-	-	-	-	-	0.00	0.06	0.09	0.12	0.22	0.05	-	-	-	-	-	0.09
3	19	639693	5872767	100	3.70	5.10	0.00	0.70	1.40	2.10	2.80	3.70	-	-	-	-	-	0.17	0.37	0.47	0.41	0.20	0.02	-	-	-	-	-	0.27
4	19	639668	5872772	100	1.40	2.60	0.00	0.20	0.40	0.60	0.80	1.00	1.20	1.40	-	-	-	0.00	0.02	0.06	0.10	0.13	0.16	0.15	0.14	-	-	-	0.10
5	19	639590	5872746	60	1.73	3.93	0.00	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.73	-	0.04	0.11	0.15	0.18	0.21	0.17	0.16	0.16	0.08	0.02	-	0.13
6	19	639529	5872756	100	2.80	7.10	0.00	0.60	1.20	1.80	2.40	2.80	-	-	-	-	-	0.03	0.08	0.17	0.07	0.00	0.02	-	-	-	-	-	0.06
7	19	639438	5872793	100	2.95	4.70	0.00	0.40	0.80	1.20	1.60	2.00	2.40	2.80	2.95	-	-	0.02	0.09	0.18	0.16	0.25	0.07	0.15	0.17	0.11	-	-	0.13
8	19	639366	5872850	100	2.20	3.40	0.00	0.40	0.80	1.20	1.60	2.00	2.20	-	-	-	-	0.09	0.09	0.04	0.02	0.19	0.18	0.14	-	-	-	-	0.11
9	19	639272	5872866	100	1.90	2.77	0.00	0.40	0.80	1.20	1.60	1.90	-	-	-	-	-	0.09	0.10	0.09	0.11	0.01	0.01	-	-	-	-	-	0.07
10	19	639214	5872867	34	3.70	4.70	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	3.70	-	-	0.00	0.10	0.16	0.18	0.17	0.15	0.00	0.11	0.02	-	-	0.10
11	19	639164	5872842	100	2.20	3.68	0.00	0.40	0.80	1.20	1.60	2.00	2.20	-	-	-	-	0.06	0.06	0.10	0.04	0.19	0.13	0.22	-	-	-	-	0.11
12	19	639079	5872775	100	2.70	2.70	0.00	0.60	1.20	1.80	2.40	2.70	-	-	-	-	-	0.10	0.07	0.07	0.00	0.23	0.05	-	-	-	-	-	0.09
13	19	639021	5872753	45	1.40	2.48	0.00	0.30	0.60	0.90	1.20	1.40	-	-	-	-	-	0.23	0.28	0.18	0.25	0.15	0.17	-	-	-	-	-	0.21
14	19	638993	5872786	55	0.90	1.31	0.00	0.20	0.40	0.60	0.80	0.90	-	-	-	-	-	0.24	0.22	0.21	0.22	0.21	0.19	-	-	-	-	-	0.22
15	19	638941	5872806	100	1.50	2.40	0.00	0.30	0.60	0.90	1.20	1.50	-	-	-	-	-	0.01	0.04	0.10	0.14	0.07	0.10	-	-	-	-	-	0.08
16	19	638873	5872861	100	2.20	3.76	0.00	0.30	0.60	0.90	1.20	1.50	1.80	2.20	-	-	-	0.00	0.00	0.11	0.05	0.11	0.00	0.02	0.01	-	-	-	0.04
17	19	638791	5872905	100	1.90	2.53	0.00	0.30	0.60	0.90	1.20	1.50	1.90	-	-	-	-	0.01	0.04	0.12	0.18	0.25	0.26	0.16	-	-	-	-	0.15
18	19	638720	5872933	100	2.70	3.40	0.00	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	-	0.00	0.13	0.18	0.07	0.20	0.18	0.15	0.11	0.10	0.01	-	0.11
19	19	638504	5872864	100	0.80	1.40	0.00	0.20	0.40	0.60	0.80	-	-	-	-	-	-	0.00	0.03	0.08	0.07	0.01	-	-	-	-	-	-	0.04
20	19	638441	5872794	100	0.65	1.15	0.00	0.20	0.40	0.65	-	-	-	-	-	-	-	0.15	0.23	0.26	0.22	-	-	-	-	-	-	-	0.22
21	19	638363	5872743	100	0.50	1.61	0.00	0.25	0.50	-	-	-	-	-	-	-	-	0.07	0.20	0.18	-	-	-	-	-	-	-	-	0.15
22	19	638298	5872669	100	0.95	2.57	0.00	0.35	0.70	0.95	-	-	-	-	-	-	-	0.09	0.06	0.03	0.05	-	-	-	-	-	-	-	0.06
23	19	638230	5872612	100	0.50	2.26	0.00	0.25	0.50	-	-	-	-	-	-	-	-	0.01	0.06	0.01	-	-	-	-	-	-	-	-	0.03
24	19	638186	5872544	100	0.75	2.21	0.00	0.25	0.50	0.75	-	-	-	-	-	-	-	0.01	0.07	0.08	0.02	-	-	-	-	-	-	-	0.05
25	19	638148	5872472	42	0.90	2.73	0.00	0.30	0.60	0.90	-	-	-	-	-	-	-	0.01	0.07	0.06	0.01	-	-	-	-	-	-	-	0.04

Dumbell Stream Survey (continued)

Transect #	Velocity (m/s)											Average Velocity (m/s)	Slope			Substrate (%)												
	1	2	3	4	5	6	7	8	9	10	11		Rise (m)	Run (m)	%	Bedrock	LgB	SmB	Rubble	Cobble	Gravel	Sand	Silt	Clay	Detritus	Muck	Aq Veg	Total
0																												0
1	0.00	0.10	0.00	0.19	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	15.00	0.00	0	0	0	0	0	5	95	0	0	0	0	0	100
2	0.00	0.62	0.66	0.88	0.52	0.00	-	-	-	-	-	0.45	0.07	6.00	1.17	0	0	0	0	0	15	75	0	0	0	10	0	100
3	0.00	0.00	0.52	0.00	0.00	n/a	-	-	-	-	-	0.10	0.00	4.00	0.00	0	0	0	0	0	35	60	0	0	5	0	0	100
4	n/a	n/a	0.56	0.69	0.92	0.93	0.83	0.99	-	-	-	0.82	0.05	6.00	0.83	0	0	0	0	5	15	75	0	0	0	5	0	100
5	0.26	0.39	0.34	0.31	0.20	0.51	0.51	0.57	0.40	n/a	-	0.39	0.09	6.40	1.41	0	0	0	10	40	30	10	0	0	0	10	0	100
6	0.00	0.85	0.28	0.45	n/a	n/a	-	-	-	-	-	0.40	0.49	9.00	5.44	0	10	30	20	20	10	0	0	0	0	10	0	100
7	n/a	0.00	0.00	0.31	0.30	0.22	0.92	0.97	0.13	-	-	0.36	0.93	6.30	14.76	0	20	40	15	15	5	3	0	0	0	2	0	100
8	0.91	0.44	n/a	n/a	0.83	0.00	1.60	-	-	-	-	0.76	0.82	7.00	11.71	5	25	40	15	10	4	0	0	0	0	1	0	100
9	0.18	1.09	0.95	0.85	n/a	n/a	-	-	-	-	-	0.77	0.28	6.00	4.67	70	10	10	3	5	0	1	0	0	0	1	0	100
10	0.00	0.11	0.09	0.11	0.18	0.18	0.00	0.60	0.00	-	-	0.14	0.48	7.50	6.40	90	0	10	0	0	0	0	0	0	0	0	0	100
11	0.20	0.21	0.28	n/a	0.37	0.38	0.00	-	-	-	-	0.24	0.10	4.50	2.22	5	5	5	20	20	5	0	0	0	0	40	0	100
12	0.00	0.48	0.60	0.00	0.07	0.00	-	-	-	-	-	0.19	0.18	6.00	3.00	10	10	10	20	20	20	0	0	0	0	10	0	100
13	0.13	0.16	0.15	0.14	0.14	0.00	-	-	-	-	-	0.12	0.22	3.60	6.11	30	25	20	5	5	5	5	0	0	0	5	0	100
14	0.22	0.15	0.22	0.03	0.00	0.00	-	-	-	-	-	0.10	0.10	5.00	2.00	20	0	0	20	15	15	30	0	0	0	10	0	110
15	n/a	0.20	0.35	0.53	0.80	0.40	-	-	-	-	-	0.46	0.09	8.00	1.13	40	0	0	0	20	5	0	10	0	0	15	10	100
16	0.00	n/a	0.28	0.32	0.32	n/a	n/a	n/a	-	-	-	0.23	0.40	5.50	7.27	50	0	10	0	20	10	0	0	0	0	10	0	100
17	n/a	n/a	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.04	5.20	0.77	10	0	0	30	0	0	20	0	0	0	40	0	100
18	n/a	0.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00	n/a	-	0.02	0.18	5.00	3.60	15	0	5	20	10	10	10	0	0	0	30	0	100
19	0.00	0.04	0.60	0.00	0.00	-	-	-	-	-	-	0.13	0.10	9.20	1.09	0	0	0	0	0	0	60	0	0	15	20	5	100
20	0.00	0.00	0.34	0.00	-	-	-	-	-	-	-	0.09	0.09	3.20	2.81	0	0	0	0	15	0	30	0	0	15	40	0	100
21	0.00	0.12	0.05	-	-	-	-	-	-	-	-	0.06	0.01	5.00	0.20	0	0	0	10	10	15	25	0	0	0	40	0	100
22	0.04	0.19	n/a	0.00	-	-	-	-	-	-	-	0.08	0.25	7.60	3.29	0	0	0	10	10	20	40	0	0	0	20	0	100
23	n/a	0.10	n/a	-	-	-	-	-	-	-	-	0.10	0.23	5.00	4.60	0	0	0	0	5	5	70	0	0	0	20	0	100
24	n/a	0.00	0.00	n/a	-	-	-	-	-	-	-	0.00	0.43	4.00	10.75	10	0	0	10	20	5	30	0	0	0	25	0	100
25	n/a	0.00	0.12	n/a	-	-	-	-	-	-	-	0.06	0.12	5.50	2.18	5	0	0	10	10	5	30	0	0	0	40	0	100

Appendix B

Stream Photos

Photo 1: Dumbell Lake.


Photo 2: Reach 1 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 3: Reach 1 Transect 1 Downstream, Dumbell Stream, July 2012.


Photo 4: Reach 2 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 5: Reach 2 Transect 1 Downstream, Dumbell Stream, July 2012.


Photo 6: Reach 3 Transect 1 Upstream, Dumbell Stream, July 2012.


Photo 7: Reach 3 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 8: Reach 3 Transect 2 Upstream, Dumbell Stream, July 2012.

Photo 9: Reach 3 Transect 2 Downstream, Dumbell Stream, July 2012.

Photo 10: Reach 4 Transect 1 Upstream, Dumbell Stream, July 2012.

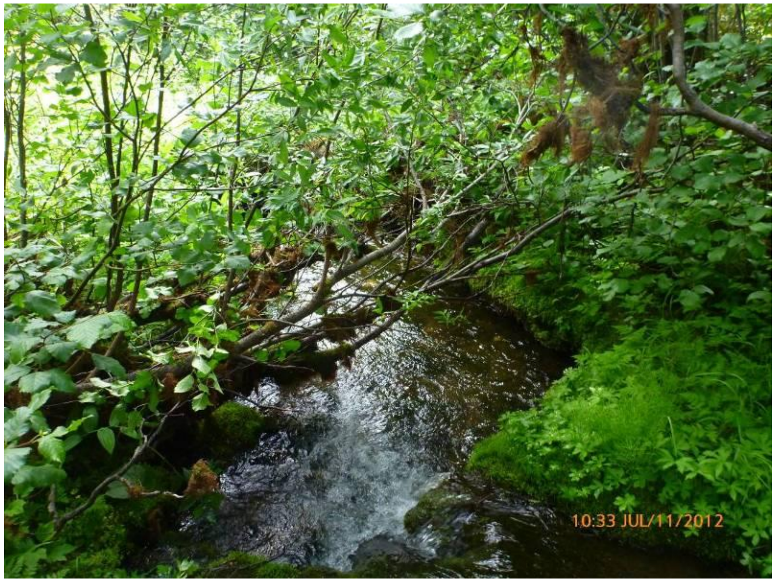

Photo 11: Reach 4 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 12: Reach 5 Transect 1 Upstream, Dumbell Stream, July 2012.


Photo 13: Reach 5 Transect 1 Downstream, Dumbell Stream, July 2012.


Photo 14: Reach 6 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 15: Reach 6 Transect 1 Downstream, Dumbell Stream, July 2012.

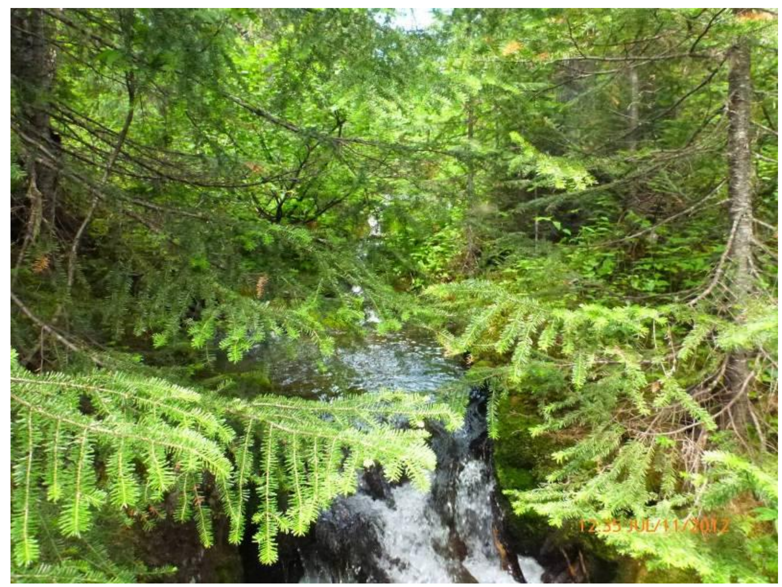
Photo 16: Reach 7 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 17: Reach 7 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 18: Reach 8 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 19: Reach 8 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 20: Reach 9 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 21: Reach 9 Transect 1 Downstream, Dumbell Stream, July 2012.


Photo 22: Reach 10 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 23: Reach 10 Transect 1 Downstream, Dumbell Stream, July 2012.


Photo 24: Reach 11 Transect 1 Upstream, Dumbell Stream, July 2012.


Photo 25: Reach 11 Transect 1 Downstream, Dumbell Stream, July 2012.


Photo 26: Reach 12 Transect 1 Upstream, Dumbell Stream, July 2012.


Photo 27: Reach 12 Transect 1 Downstream, Dumbell Stream, July 2012.


Photo 28: Reach 13 Transect 1 Upstream, Dumbell Stream, July 2012.


Photo 29: Reach 13 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 30: Reach 14 Transect 1 Upstream, Dumbell Stream, July 2012.


Photo 31: Reach 14 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 32: Reach 15 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 33: Reach 15 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 34: Reach 16 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 35: Reach 16 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 36: Reach 17 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 37: Reach 17 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 38: Reach 18 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 39: Reach 18 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 40: Reach 19 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 41: Reach 19 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 42: Reach 20 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 43: Reach 20 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 44: Reach 21 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 45: Reach 21 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 46: Reach 22 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 47: Reach 22 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 48: Reach 23 Transect 1 Upstream, Dumbell Stream, July 2012.

Photo 49: Reach 23 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 50: Reach 24 Transect 1 Upstream, Dumbell Stream, July 2012.


Photo 51: Reach 24 Transect 1 Downstream, Dumbell Stream, July 2012.

Photo 52: Beverly Lake.

Photo 53: Reach 1 Transect 1 Upstream, Beverly Stream, July 2012.


Photo 54: Reach 1 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 55: Reach 2 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 56: Reach 2 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 57: Reach 3 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 58: Reach 3 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 59: Reach 4 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 60: Reach 4 Transect 1 Downstream, Beverly Stream, July 2012.

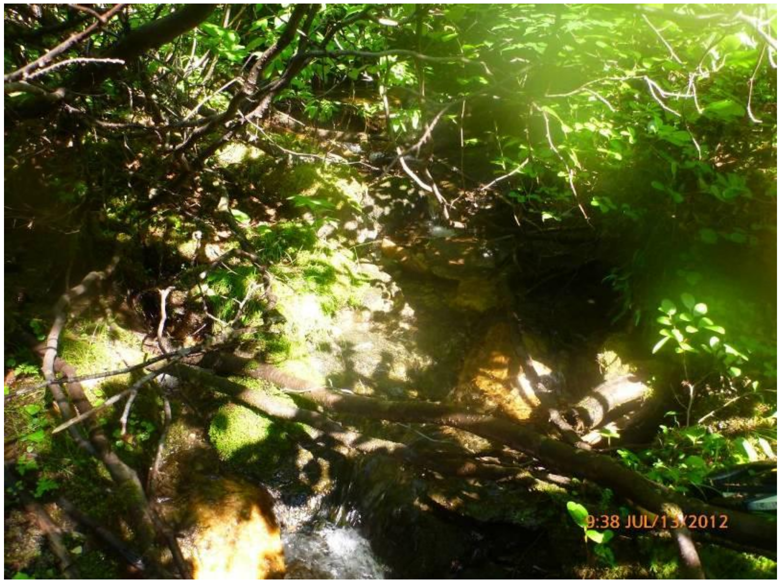

Photo 61: Reach 5 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 62: Reach 5 Transect 1 Downstream, Beverly Stream, July 2012.

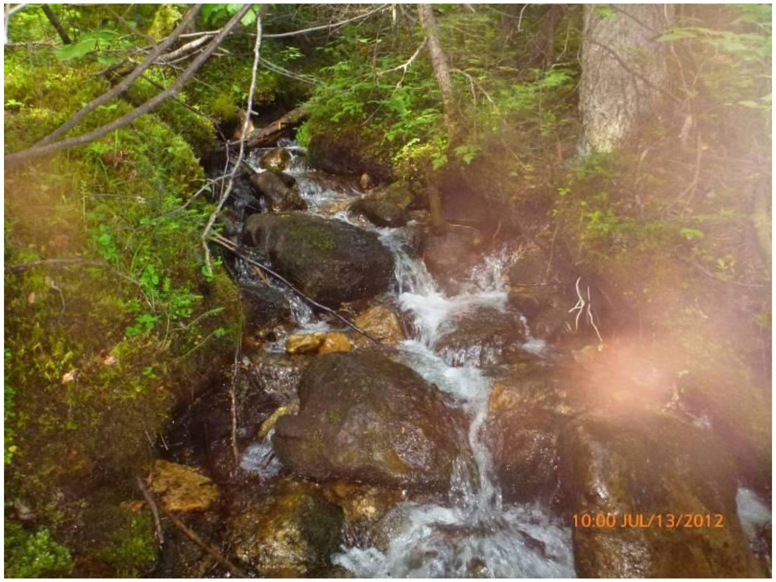

Photo 63: Reach 6 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 64: Reach 6 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 65: Reach 7 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 66: Reach 7 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 67: Reach 8 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 68: Reach 8 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 69: Reach 9 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 70: Reach 9 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 71: Reach 10 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 72: Reach 10 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 73: Reach 11 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 74: Reach 11 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 75: Reach 12 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 76: Reach 12 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 77: Reach 13 Transect 1 Upstream, Beverly Stream, July 2012.

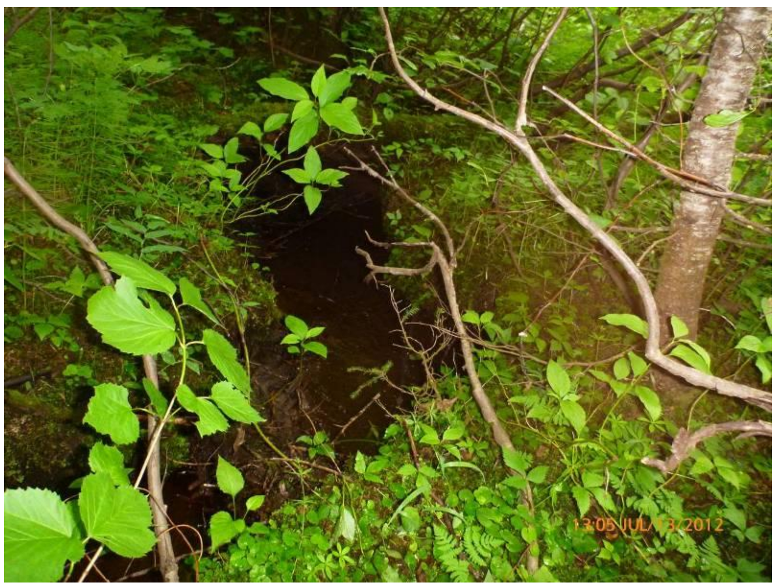

Photo 78: Reach 13 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 79: Reach 14 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 80: Reach 14 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 81: Reach 15 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 82: Reach 15 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 83: Reach 16 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 84: Reach 16 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 85: Reach 17 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 86: Reach 17 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 87: Reach 18 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 88: Reach 18 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 89: Reach 19 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 90: Reach 19 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 91: Reach 20 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 92: Reach 20 Transect 1 Downstream, Beverly Stream, July 2012.

Photo 93: Reach 21 Transect 1 Upstream, Beverly Stream, July 2012.

Photo 94: Reach 21 Transect 1 Downstream, Beverly Stream, July 2012.

APPENDIX C

Invertebrate Sample Results

Invertebrate Sampling				Beverly Lake						Dumbell Lake					
Phylum	**Class**	**Order**	**Family**	**INV-01-A**	**INV-01-B**	**INV-01-C**	**INV-02-A**	**INV-02-B**	**INV-02-C**	**INV-03-A**	**INV-03-B**	**INV-03-C**	**INV-04-A**	**INV-04-B**	**INV-04-C**
Annelida	Hirudinea	-	-												
Annelida	Oligochaeta	-	-				2	2	2		3				
Annelida	Aeolosomata	Aeolosomata	Aeolosomatidae												
Arthropoda	Arachnida	Actinedida	Hydrachnidia							1		5	11	7	3
Arthropoda	Insecta	Coleoptera	Staphylinidae									1			
Arthropoda	Insecta	Diptera	Ceratopogonidae					2	1						
Arthropoda	Insecta	Diptera	Chironomidae		1		2	1	2	32	7	48	99	38	91
Arthropoda	Insecta	Diptera	Simuliidae							24	3	4	33	3	7
Arthropoda	Insecta	Diptera	Empididae		2		2	1		1		1			
Arthropoda	Insecta	Diptera	Tipulidae		2		1								
Arthropoda	Insecta	Ephemeroptera	Caenidae												
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	1											
Arthropoda	Insecta	Ephemeroptera	Ephemeridae												
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		7	6	3	11	2						
Arthropoda	Insecta	Ephemeroptera	Polymitarcyidae												
Arthropoda	Insecta	Ephemeroptera	Siphlonuridae	1											
Arthropoda	Insecta	Ephemeroptera	Baetidae	24	19	4	33	11	5	2		3	3		
Arthropoda	Insecta	Plecoptera	Chloroperlidae							1					
Arthropoda	Insecta	Plecoptera	Nemouridae	5	4	2	5	4	1	12	3	2	11	2	5
Arthropoda	Insecta	Plecoptera	Perlodidae												
Arthropoda	Insecta	Trichoptera	Brachycentridae										2	1	8
Arthropoda	Insecta	Trichoptera	Limnephilidae					1		1		1	2		2
Arthropoda	Insecta	Trichoptera	Polycentropodidae		1										
Arthropoda	Insecta	Trichoptera	Gossosomatidae		1		1								
Arthropoda	Insecta	Trichoptera	Odontoceridae									2			
Arthropoda	Insecta	Trichoptera	Lepidostomatidae												
Arthropoda	Insecta	Odonata	Anisoptera												
Arthropoda	Malacostraca	Amphipoda	-												
Mollusca	Bivalvia	-	-												
Mollusca	Gastropoda	-	-					1	1					1	
Mollusca	Gastropoda	Prosobranchia	Valvatidae						1	1				1	
Nematomorpha	-	-	-										1		