Summary of Pre-Restoration Monitoring Clementsport Dam, Moose River, Nova Scotia

Prepared by Marla Bojarski, Resource Conservation Biologist
2009 Season

Clean Annapolis River Project
151 Victoria St Annapolis Royal, Nova Scotia B0S 1A0
Phone: (902)532-7533 fax: (902)532-3038
E-mail: carp@annapolisriver.ca website: www.annapolisriver.ca

Table of Contents

Table of Figures 2

List of Tables 3

Acknowledgments 5

Introduction 5

Measured Parameters 12

1. Monumented Cross Sections 12

2. Photo Stations 12

3. Water Quality 16

4. Macroinvertebrates 21

5. Fish Habitat Utilization Survey 31

References 41

Appendix A 42

Appendix B 43

Appendix C 45

Table of Figures

Figure 1. Location of Clementsport and the Moose River 7

Figure 2. An aerial photo of the Clementsport dam and impoundment.....9

Figure 3. Moose River study area with the five permanently chosen photo stations.. 13

Figure 4. The Moose River study area with the water quality sampling sites presented. 18

Figure 5. Location of Minilog V3.09 temperature data loggers. 19

Figure 6. Location of the three CABIN sampling stations for aquatic macroinvertebrates. 23

Figure 7. Location of CABIN station one. 25

Figure 8. Shows the location of CABIN station two. 27

Figure 9. Shows location of CABIN station three. 29

Figure 10. Fyke net used for fish survey. 33

Figure 11. Photo of Atlantic salmon parr (*Salmo salar*) down stream in Moose River. 35

Figure 12. Photo of Brook trout (*Salvelinus fontinalis*). 37

Figure 13. Photos of American eel (*Anguilla rostrata*).. 39

List of Tables

Table 1. Five parameters for the pre-restoration monitoring of Moose River at Clementsport Dam. 11

Table 2. Details of the five permanent photo stations established along the Moose River.....15

Acknowledgments

Many thanks are owed to the people and organizations that contributed support to this project. Thanks to Reg and Barb Baird and Roy Bertaux who contributed many hours to conducting the fish survey in Moose River, for and for sharing their excellent photographs and knowledge. The Royal Canadian Legion Branch 122 for granting us access to their historic document files, for hosting the community meeting, and for their general co-operation. The staff and students of the College of Geographic Sciences who established the monumented cross sections, many thanks to you all. To Jeffrey Glenen and Nicole Oliver for their tireless help in the field, it would have been far more difficult and much less fun without you. Many thanks are owed to Eric Hutchins from NOAA and Anita Hamilton of DFO for their support, knowledge and guidance throughout this project and for their continued efforts to restore the Moose River System. To Andy Sharpe for supervising this project and for his constant help and support in field work and administrative leadership. Many thanks to the staff of the Clean Annapolis River Project for all their encouragement and support throughout this project. Financial support for this project was provided by: Gulf of Maine Council on the Marine Environment, the National Oceanic and Atmospheric Administration (NOAA) Award NA07NMF4630157, and the Ecological Monitoring and Assessment Network Science Horizons Internship.

Introduction

The Moose River is a tributary of the Annapolis Basin, which is an embayment of the Bay of Fundy. The river is approximately 11 km (7 miles) in length, from its source at Lake Cady to where it empties into the Annapolis Basin at Clementsport. Figure 1 presents the location of Clementsport in the province of Nova Scotia.

During the 1980's, the Royal Canadian Legion (Clementsport Branch) re-constructed a 2.5 m (8.2 feet) high dam across the river to provide a community swimming pool. The previous structure had been used for water abstraction. The dam is located approximately 1.8 km (1.1 miles) upstream of where the river enters saltwater (Annapolis Basin). While a fishway was added to the dam in 1991, there have been on-going concerns over its effectiveness. The fishway is currently non-functional. Over the past five years, there has been waning local interest in swimming in the river, with the community park adjacent to the dam falling into a derelict condition. Winter ice and high spring flows have subsequently damaged the dam spillway and undermined the structure, resulting in a complete barrier to migratory fish.

Up until 2007, partial fish passage over the Clementsport dam existed at high water levels, with parr and adult salmon being reported above the dam. It has been reported that fish congregating in the pool at the foot of the dam have been subjected to poaching. Figure 2 presents an image of Moose River at the Clementsport dam.

Concern over the condition of the dam and associated fishway have led the Clean Annapolis River Project in partnership with the Gulf of Maine Council on the Marine Environment, to undertake a feasibility study on the restoration of the Moose River.

The project steering committee, drawing on the Stream Barrier Removal Monitoring Guide (Gulf of Maine Council on the Marine Environment) identified five key parameters identified for pre-restoration monitoring of Clementsport dam at Moose River (Table 1). The monitoring data collected according to these parameters during the summer and fall of 2009 by the Clean Annapolis River Project and associated partners, are presented in an Excel spreadsheet meant to be an accompanying document to this summary. The document is entitled "Clem_Dam_PreRestor_Monitoring_2009" and includes separate worksheets for each parameter as well as associated metadata worksheets. Photos are also available in a file named "Clementsport Dam Photostations". It contains two subfolders, one named "full leaf" when photos were taken in September 2009, and the other named "leaf out" when photos were taken in November, 2009.

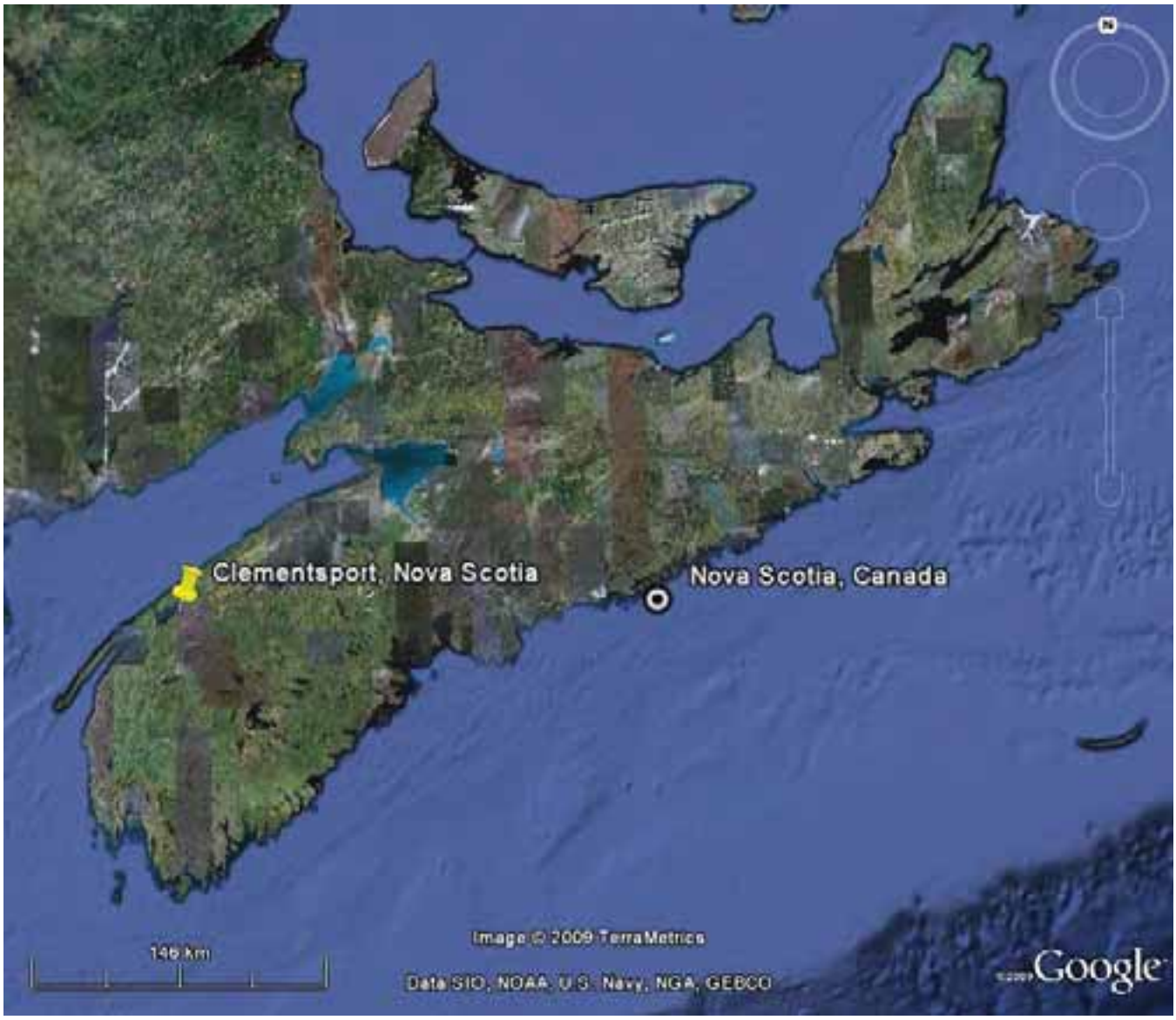


Figure 1. The province of Nova Scotia, Canada and the location of Clementsport and the Moose River.

Figure 2. An aerial photo of the Clementsport dam and impoundment. Direction of water flow is from south to north. The road to the west is Clementsport Road.

Table 1. Five parameters for the pre-restoration monitoring of Moose River at Clementsport Dam.

Parameter	Number of sample stations	Location of sample stations	Sampling duration and frequency
1. Monumented Cross Sections	15	Along the monitoring reach, including downriver, impoundment and upriver areas.	College of Geographics Sciences (COGS) students established the cross sections.
2. Photo Stations	6	1.Downriver view of dam and impoundment 2.Across the dam to the west bank 3.Across the dam the east bank 4. Longitudinal profile view upriver	Permanent photo stations were established and photos taken during "full leaf" September 11th and 25th 2009, as well as "leaf out" in November 2009.
3. Water Quality	3	1.Upriver of impoundment 2.Downriver of impoundment 3. Impoundment (vertical profile locations)	Sampling period began July 29, 2009 continued until October 8th 2009.
4. Macroinvertebrates	3	1.Upriver 2.Impoundment 3.Downriver	One sample per location collected September 2009
5. Fish Habitat Utilization Survey	1	Below the dam, 400m above salt water	One session of fyke net fishing took place from September 7-October 4 2009.

Measured Parameters

1. Monumented Cross Sections

A total of 15 monumented cross sections were established along the Moose River, by students of the Centre of Geographic Sciences (COGS) (Appendix A and B). The cross sections are spread along the river and encompass areas below the dam, across the impoundment as well as upstream of the impoundment. The purpose of theses cross sections are to monitor the horizontal and vertical changes in the river's channel. The cross sections provide data on the elevations and distances of selected areas of the river (Gulf of Maine Council, 2007). Additionally, four control points were also established (one as a drilled hole in the concrete dam abutment and three as rebar stakes on the east bank of the impoundment).

2. Photo Stations

Five permanent photo stations were established to show various views of the monitoring reach;

1. A view down river towards the impoundment and dam
2. A view across the dam to the west bank
3. A view across the dam to the east bank
4. An upriver view towards the impoundment and dam
5. A longitudinal profile view upriver

Recording photos at these stations can help to track visual changes that may occur over time, such as changes to riparian vegetation, or channel cover. The photos were taken September 25th and correspond to the monumented cross sections since their locations are already established, thus making future repetitions easier. Additional geographic contextual notes about each station were recorded. The height at which the camera was held was noted. The bearing each photo was taken at was recorded using a compass (Table 2). The locations of the photo stations are illustrated in Figure 3. (Appendix C).

Figure 3. Moose River study area with the 5 permanently chosen photo stations. Each photo station is represented as a code that corresponds to an associated transect established by COGS students. (See Table 2).

Table 2. Details of the five permanent photo stations established along the Moose River

Code	Photo Location	Point of View	Associated Transect	Side of River	Northing or UTM (20) NAD 83	Easting or UTM (20) NAD 83	Height of camera lens (from ground)	Bearing	Notes
MRPIC 1	West side of transect 12 on the permanent pin	Downstream view towards dam and impoundment	12	West	4946636.575	5413538.676	1.73m	102ºE	Established by COGS students
MRPIC 2	East side transect 4 looking across dam to west side	Across dam to west bank	4	East	4946735.365	5413517.341	1.76m	295ºW	Established by COGS students
MRPIC 3	West side of transect 4, at guard rail, looking across dam to east side	Across dam to east bank	4	West	4946724.769	5413517.341	1.76m	343ºN	Established by COGS students
MRPIC 4	Under guard rail at marker on west side of transect 3	Upriver from impoundment view of dam	3	West	4946745.387	5413491.553	1.71m	124ºE	Established by COGS students
MRPIC 5	Standing on wood beam on Guinea bridge	Longitudinal view of dam (upriver)	None	West side 12.29 m from road	0294576	4948038	2m	200ºS	Marla Bojarski of Clean Annapolis River Project established this photostation and associated GPS Co-ordinates are given in UTM 20 T (NAD 83)

3. Water Quality

The slowing of water movement by dams, as well as the increase in water depth particularly in the impoundment causes stratification of the water temperature as well as oxygen levels (American Rivers, 2002). In low head dams such as the one in Clementsport, the impoundment area can trap heat and when waters flow downstream, it shifts the community towards favouring warm water fish (Walks et al., 2000). As previously mentioned, sediment collects behind the dam and can have a variety of impacts on fauna and their habitat. Turbidity and total suspended solids were added as parameters for pre-removal monitoring since both of these can become elevated for months after a dam is removed (Perrin et al. 2000).

The following water quality parameters were measured every week from July 29th 2009 to October 8th 2009:

- Dissolved oxygen (mg/L and percent saturation)
- Air and water temperature (degrees C)
- Conductivity (mS/cm)
- pH
- Turbidity (NTU)
- E.coli bacteria (CFU/100 ml) (This parameter began August 6th and continued until September 15th)
- Total suspended solids (mg/L)

Initially, two locations were sampled upriver of the impoundment, in the impoundment as well as downstream of the impoundment. However, due to the homogeneity of the water in this particular reach of the river, the sites were amalgamated on August 13th. From this date until the end of the sampling period (October 8th) one site was sampled upriver of the impoundment, one in the impoundment and one downriver of the impoundment (Appendix A). A vertical profile of the water column in the impoundment was measured whenever the water level was high enough to allow. Image 4 reflects the updated water quality sampling sites. Dissolved oxygen, temperature, conductivity, pH and turbidity were recorded *in situ* using a Quanta Hydrolab multiprobe water quality meter. E. coli bacteria were determined following the methodology outlined for the detection of waterborne coliforms and E.coli using Coliscan Easygel. This method allowed the identification of total coliforms present in water as well as E. coli bacteria. The inoculum amount of water used in the Coliscan Easygel medium was 3.0mL. The medium, once inoculated with the water sample, were plated onto petri dishes and incubated at 35ºC for 24 hours. The petri dishes were then inspected for the presence of E.coli bacteria, and were identified through the presence of purple colonies. Blue-green and pink colonies represented non-fecal coliforms (Micrology Laboratories, 2009). Total suspended solids were measured and weighted using standard methods. All other measurements were recorded with the Hydrolab. GPS points were taken using a hand held Garmin GPS map 76CSx device set to NAD83 in UTM zone 20. GPS waypoints were taken at each location for reference as well as for repeatability.

Additionally, two Minilog V3.09 temperature data loggers were deployed, one in the impoundment, and the other placed downriver of the dam (Figure 4) (Appendix C). The loggers were protected in a PVC tube, weighted and placed on the streambed with a retrieval chord running up to a secure

location on shore. The retrieval chords were well hidden and a small note indicating these units were part of a scientific study at CARP were attached to discourage vandalism. Temperature data was recorded every 15 minutes beginning August 6th to 16th.

Figure 4. The Moose River study area with the water quality sampling sites presented.

Figure 5. Location of Minilog V3.09 temperature data loggers in the impoundment area and downstream. Loggers were deployed August 6th and retrieved October 16th.

4. Macroinvertebrates

Monitoring of macroinvertebrates is an important feature in pre-restoration efforts after stream barrier removal as species assemblages; including macroinvertebrates can change within a year (Kanehl et al., 1997, & Stanley et al., 2002).

Three benthic invertebrate samples (upriver of impoundment, impoundment and downriver or impoundment) were collected on September 15th, 2009 (Figure 6). Collection of the macroinvertebrates followed the Canadian Aquatic Biomonitoring Network protocol (CABIN, 2002). Please note that at the time this document was produced, invertebrates had been collected but not sorted, or identified, however when this is done, the procedure will also mirror that outlined by CABIN.

Field collection

A GPS point was recorded for each sampling station (Appendix A). The CABIN procedure employs a timed kicknet collection with a 500μm mesh size. Maps 6, 7 and 8 shows the locations and approximate paths of the samples collected. Note that the direction of the path was always against the current of the river. If there were large boulders or other obstructions in the way, the net was held downstream while the object was brushed by hand, and the current carried any macroinvertebrates into the net. The collector moved upstream in a zigzag pattern across the streambed for 3 minutes. The sample was then preserved in an 85% ethanol solution. Habitat information for each site was collected.

Elements included:

- A geographical description of surrounding land use and dominant surrounding land use
- Reach data (habitat types present in reach, canopy coverage, macrophyte coverage, streamside vegetation, dominant streamside vegetation and periphyton coverage on substrate).
- Grain size analysis (diameter and embeddedness of 100 randomly selected grains)
- Water chemistry
- Slope
- Water velocity

Laboratory Processing

Collected samples will be subsampled using a Marchant subsampling device. Cells are randomly selected for processing until a total of 300 organisms are found. An estimate of the total number of organisms in the entire sample is extrapolated from the subsample.

A low power stereomicroscope will be used to identify the organisms. Organisms are identified to the family level using a taxonomic key, counted and recorded.

Figure 6. Location of the three CABIN sampling stations for aquatic macroinvertebrates.

Figure 7. Shows location of CABIN station one, located upriver of impoundment, as well as the approximate path taken for sample collection. The kicknet and movement of the collector was against the river current and was therefore towards the east.

Figure 8. Shows the location of CABIN station two, in the impoundment and the approximate path taken for sample collection. The direction of movement by the collector was against the river current, and therefore was towards the south.

Figure 9. Shows location of CABIN station three, downstream of the impoundment, and the approximate path taken for sample collection. The kicknet and movement of the collector were against the river current, and therefore was towards the south.

5. Fish Habitat Utilization Survey

Dam removal can have positive effects for restoring cold water fish populations such as salmon, trout, and other species (American Rivers, 2002). The lacustrine conditions that dams create can favour warm water species, and may provide habitat for fish species that prey on other species such as salmon (Wik, 1995).

Local experts, Reg Baird and Roy Bertaux surveyed fish species that use the Moose River area for habitat. Reg Baird is a field technician with over 40 years of experience in trout research. He is a certified fly fishing instructor as well as field guide. He is the author of "Living with Trout A Lifelong Adventure" and has served as a magazine field editor. He has contributed over 6000 hours as a volunteer researcher at Keijimkujik National Park and Historic Site earning him the title of Platinum Volunteer.

Roy Bertaux is also a valued volunteer researcher at Kejimkujik National Park and Historic Site. He has worked closely with Reg Baird on many projects. He has also been involved in wildlife studies and projects in New Brunswick, including a restocking project of Canada Geese in New Brunswick. He has worked on many projects with the Adopt-a-Stream program and has contributed many articles about trout and habitat to outdoor publications.

Barbara Baird is a field assistant with decades of outdoor experience and assisting in field research particularly with trout. She is an active photographer and has much experience in this area.

Equipment included placing one fyke below the Clementsport dam approximately 400 meters from salt water (the Annapolis Basin). The net was deployed September 7th and was checked every 24 hours. Fish were measured, identified to the species level and returned to the river. The net was retrieved on October 4th, 2009. Figure 10 shows the fyke net in place. Results from this exercise confirmed the presence of Atlantic salmon (*Salmo salar*) (Figure 11), Brook trout (*Salvelinus fontinalis*) (Figure 12), and American eel (*Anguilla rostrata*) (Figure 13).

Figure 10. Fyke net in place 400 meters from the Annapolis Basin positioned to capture fish moving upstream. Roy Bertaux (left) and Reg Baird (right) were the local experts conducting the survey. Image by Barb Baird.

Figure 11. Photo taken of Atlantic salmon parr (*Salmo salar*) down stream in Moose River. The angle of the fyke net used was such that it caught fish moving upstream. Image by Barb Baird.

Figure 12. Photo of Brook trout (*Salvelinus fontinalis*) caught moving upstream in the Moose River. Image by Barb Baird.

Figure 13. Photos of American eel (*Anguilla rostrata*). The same specimen is shown, the photo on the left is a view of the head, while the photo on the right shows the majority of the body with the head obscured. This specimen was found just above one wing of the fyke net. Image by Barb Baird.

References

American Rivers. 2002. *The Ecology of Dam Removal A Summary of Benefits and Impacts*. Washington DC.

Canadian Aquatic Biomonitoring Invertebrates Network Field Manual (2002). Environment Canada.

Collins, M., K. Lucey, B., Lambert, J. Kachmar, J. Turek, E. Hutchins, T. Purinton, and D. Neils. 2007. Stream Barrier Removal Monitoring Guide. Gulf of Maine Council on the Marine Environment.

Fisheries and Oceans Canada (DFO). 2007. Oceans and Fish Habitat: Frequently Asked Questions. Retrieved July 30,2009 from http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/faq/index_e.asp?#5

Kanehl, PD., Lyons, J., & Nelson, J.E. 1997. Changes in the habitat and fish community of the Milwaukee River, Wisconsin, following removal of the Woolen Mills Dam. *North American Journal of Fisheries Management* 17: 387-400.

Perrin, C.J., Ashley, K.I., & Larkin G.A. 2000. Effects of drawdown on ammonium and iron concentrations in a coastal mountain reservoir. *Water Quality Research Journal of Canada* 35: 231-244.

Walks, D.J, Li, H.W., Reeves, G.H. 2000. Trout, summer flows, and irrigation canals: A study of habitat condition and trout populations within a complex system. Pages 115-125 in Cowx IG, ed. Management and Ecology of River Fisheries. London: Blackwell Science.

Wik, S.J. 1995. Reservoir drawdown: Case study in flow changes to potentially improve fisheries. *Journal of Energy Engineering* 121(2): 89-96.

Appendix A

Table of GPS co-ordinates in latitude and longitude of the 15 monumented cross sections established by students of the College of Geographic Sciences (COGS).

West Side of River

Point Table

Point #	Description	Northing	Easting	Elevation
1200	Transect 1	4946806.262	5413476.071	26.365
1204	Transect 2	4946781.696	5413483.872	26.270
1208	Transect 3	4946745.387	5413491.553	25.657
1213	Transect 4	4946724.769	5413492.773	28.101
1216	Transect 5	4946718.530	5413494.004	28.157
1217	Transect 6	4946712.840	5413494.911	28.282
1219	Transect 7	4946706.680	5413496.113	28.204
1222	Transect 8	4946698.580	5413497.937	28.203
1223	Transect 9	4946689.618	5413499.923	28.423
1227	Transect 10	4946674.574	5413503.317	28.245
1233	Transect 11	4946657.172	5413508.666	28.161
1249	Transect 12	4946636.575	5413538.676	27.579
1250	Transect 13	4946624.923	5413561.482	28.090
1258	Transect 14	4946569.911	5413601.785	30.650
1259	Transect 15	4946563.935	5413677.153	30.750

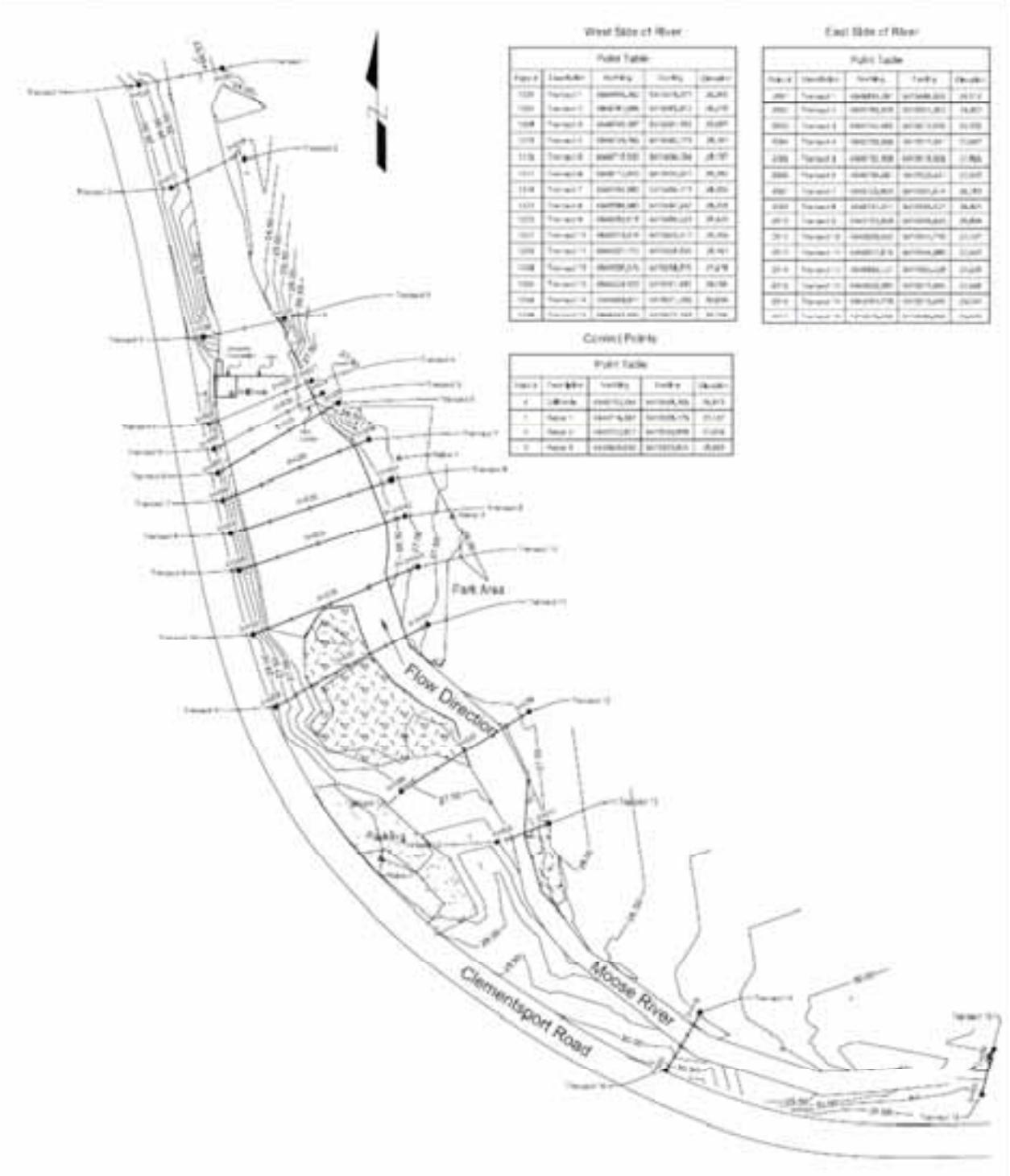
East Side of River

Point Table

Point #	Description	Northing	Easting	Elevation
2061	Transect 1	4946810.261	5413496.025	24.012
2002	Transect 2	4946788.308	5413501.302	24.301
2003	Transect 3	4946750.482	5413510.635	25.329
2004	Transect 4	4946735.365	5413517.341	27.607
2005	Transect 5	4946732.398	5413519.926	27.655
2006	Transect 6	4946730.061	5413523.641	27.543
2007	Transect 7	4946720.863	5413531.014	26.783
2009	Transect 8	4946711.511	5413536.527	26.901
2010	Transect 9	4946703.039	5413539.623	26.894
2012	Transect 10	4946690.493	5413542.730	27.147
2013	Transect 11	4946677.015	5413545.089	27.543
2014	Transect 12	4946656.121	5413569.228	27.626
2015	Transect 13	4946629.383	5413573.955	27.656
2016	Transect 14	4946583.779	5413610.045	29.043
2017	Transect 15	4946575.255	5413680.005	30.630

Appendix B

Map of Moose River with 15 transects established by the College of Geographic Sciences.



Appendix C

List of all GPS Points excluding the 15 transects of the monumented cross sections. Points are presented in either UTM Zone 20 (T) or latitude and longitude. College of Geographic Sciences (COGS) students established those presented in latitude and longitude.

Parameter/Identifier	Description of location	UTM (20)	UTM (20)	Northing	Easting	Notes
Photo stations						
Pic 1	East bank across dam to west bank (transect 4 east side)			4946735.365	5413517.341	
Pic 2	West bank across dam to east bank (transect 4 west side)			4946724.769	5413492.773	
Pic 3	Downriver of impoundment view of dam (transect 12)			4946636.575	5413538.676	
Pic 4	Upriver from impoundment view of dam (transect 3)			4946745.387	5413491.553	
Pic 5	Longitudinal view upriver of impoundment (12.29m from west side of	0294576	4948038			The co-ordinates for this photo station were established by Marla Bojarski of CARP and recorded in UTM Zone

	road)					20 using NAD83
Water quality sampling stations						
MRUP	Upriver of impoundment (Behind Alistair's house)	0294715	4947753			
MRIMP	Impoundment (off concrete block)	0294610	4947952			
MRDN	Downriver of impoundment (after the merging of the east branch of the river)	0294572	4947986			
Macroinvertebrates						
Upriver of impoundment				44º39 14	065º35 18	These co-ordinates are presented in degree minute seconds. The associated Environment Canada station code for this is NS01DC0209
Impoundment				44º 39 18.8	065º35 26.0	These co-ordinates are presented in degree minute seconds. The associated Environment Canada station code for this is NS01DC0210
Downriver of				44º39 22	065º35 27	These co-ordinates are

impoundment						presented in degree minute seconds. The associated Environment Canada station code for this is NS01DC0211