LOTIC ENVIRONMENTAL
SPECIALISTS IN FRESHWATER ECOSYSTEMS

LOTIC ENVIRONMENTAL LTD
2193 MAZUR ROAD
CRANBROOK BC, V1C 6V9
P. 250.421.7802
WWW.LOTIC.CO

Slocan River Streamkeeper Society
Site #1 Comp #8 RR#1,
Winlaw, BC
V0G 2J0
c/o Shanoon Bennett (shanoonoftheforest@gmail.com)

May 15, 2017

Subject: Columbia Basin Water Quality Monitoring Program, 2016 Lemon Creek - Data Review

Lotic Environmental Ltd. (Lotic Environmental) has completed the review of data collected by the Slocan River Streamkeeper Society (SRSS) at Lemon Creek Site 3 (NJLEM03), through the Columbia Basin Water Quality Monitoring Project (CBWQMP). This review included analysis of data collected in 2016 for the four components of the project: 1) water quality data, 2) continual temperature data, 3) hydrometric data (velocity and flow), and 4) Canadian Aquatic Biomonitoring Network (CABIN) data. All data and initial analyses for these components were summarized by the SRSS. Lotic Environmental's objective was to conduct a quality assurance/quality control review (QA/QC) of data, compare water quality results to applicable guidelines, interpret results, and make recommendations.

1 Water Quality

Water quality data was transposed into the master spreadsheet by the CBWQMP (See Excel attachment). The following data were collected in 2016:

a. Monthly (spring through fall) - nutrients, total suspended solids (TSS), dissolved chloride, *Escherichia coli,* and *in situ* (field measured) data. *In situ data* were dissolved oxygen (DO), temperature, specific conductivity, pH, turbidity, and air temperature.
b. Once in the fall, in addition to data above, inorganics, and metals.

1.1 *Water Quality QA/QC*

Water quality data are typically first subjected to a quality control evaluation to assess the accuracy and precision of the laboratory and field methods. However, no duplicate or field blank water quality data were collected. The data provided in the master spreadsheet was for two separate dates: 28-09-2016 and 26-04-2016. Duplicate samples are to be collected at the same time in accordance with Province of BC (2003). The results presented in Sheet 1 should be deleted.

1.2 *Guideline updates*

A guideline is a maximum and/or a minimum value for a characteristic of water, sediment or biota, which in order to prevent specified detrimental effects from occurring, should not be exceeded (BC MoE 2017). The guidelines for the protection of aquatic life, and drinking water were updated to reflect changes since 2012, when they were last summarized for the CBWQMP. This involved updating threshold values, where applicable, and streamlining the review process by just presenting one guideline per parameter for each use category. This was done by applying the following hierarchy to guideline determination (BC MoE 2016):

a. Use the BC Approved Water Quality Guideline (BC MoE 2017), and if one did not exist then use;
b. BC Working Water Quality Guidelines for British Columbia (BC MoE 2015), and if one did not exist then use;
c. The Canadian Environmental Quality Guidelines (Canadian Council of Ministers of the Environment [CCME] 2017), or Health Canada (2017).

When both a long-term (30- day average or chronic) and short-term (maximum acute) exposure guideline was available, the long-term guideline was used in the review, since sampling was assumed to have occurred under 'normal' conditions. Exceedances of these guideline thresholds were flagged to provide an understanding of the potential risks.

1.3 *Water quality results*

Water quality results for NJLEM03 were very good. In particular it was noted that turbidity stayed very low (< 1.0 NTU) even during the high flow or spring freshet period. This indicates that the system is very stable, and undisturbed. If not done as a standard practice already, the stewardship group should ensure the turbidity meter is functioning properly by testing it against calibration solutions of known concentrations. Ensure these solutions have not been frozen in the past, and are not past their expiration date.

All but one parameter, pH, met the aquatic life and/or drinking water guidelines. Details are as follows:

pH: The BC approved water quality guideline for the protection of aquatic life for pH allows for an unrestricted change within the range of 6.5-9.0 (BC Ministry of Environment [BC MoE] 2017). The pH ranged from 6.2 to 7.2 pH units, and was below the guideline in one sample. This value is not concerning if it reflects background conditions and was not low as a result of a particular anthropogenic influence/discharge to the watercourse. However, if there is a discharge into the watercourse, then pH should be monitored more thoroughly in accordance with the BC guidelines to ensure guidelines are met and there are no impacts on the aquatic environment. The stewardship group should also ensure that their field meter is properly calibrated daily, using concentrations of calibration solution.

2 Stream Temperature

Stream temperature was not collected in Lemon Creek.

3 Hydrometric data (velocity and flow)

Hydrometric data was not collected in Lemon Creek.

4 CABIN

CABIN data were collected following standard methods in the CABIN Field Protocols Manual (Environment Canada 2012) at NJLEM03 in the fall of 2016. The CBWQMP completed a RCA analysis on collected CABIN data using the Analytical tools in the CABIN database. Here, we reviewed the CABIN output, and summarized and interpreted the results.

4.1 *Reference Condition Approach: BEAST Analysis and Site Assessment*

The Reference Condition Approach (RCA) in CABIN is used to determine the condition of the benthic invertebrate community at the test sites (as sampled by CBWQMP groups), by comparing each site to a group of reference sites with similar environmental characteristics. The RCA in CABIN determines whether the benthic community at the test sites falls within the normal range of community variability defined by pristine sites, or sites in “reference condition”.

The Benthic Assessment of Sediment tool (BEAST) was used to predict sites to a reference group from the preliminary Okanagan-Columbia reference model. BEAST uses a classification analysis that determines the probability of test site membership to a reference group based on habitat variables (Rosenberg *et al.* 1999). Habitat variables used to predict group membership in the Okanagan-Columbia reference model include: latitude, longitude, percent of watershed with a gradient <30, percent of watershed with permanent ice cover, and average channel depth (cm).

The reference model used in the RCA analysis was the Preliminary Okanagan-Columbia Reference Model provided in the online CABIN database (Environment Canada 2010). Because the model is still considered preliminary, with some potential data gaps, caution must be exercised when interpreting RCA results. However, CABIN results can investigated in multiple ways, including by examining the test site’s water chemistry, habitat and invertebrate community metrics. These additional assessments are used to supplement ordination assessments, and they provide essential information for evaluating the CABIN model outputs.

CABIN model hybrid multi-dimensional scaling ordination assessment was used to evaluate benthic community stress based on divergence from reference condition. This analysis places test sites into assessment bands corresponding to a stress level ranging from unstressed to severely stressed. The assessment is based on how different the benthic community at the test site is from the reference communities. In the ordination assessment, sites that are unstressed fall within the 90% confidence ellipse around the cloud of reference sites which means that their communities are similar or equivalent to reference (Rosenberg *et al.* 1999). Potentially stressed, stressed and severely stressed sites fall outside of the 90%, 99% and 99.9% confidence ellipses and indicate mild divergence, divergence, or high divergence from reference condition (Rosenberg *et al.* 1999).

For NJLEM03, CABIN BEAST analysis determined the highest probability of reference group membership was to Group 4 (probabilities found in Table 1). The site was thus compared with Reference Group 4, which includes 12 streams, mostly from the Columbia Mountains and Highlands Ecoregion. The average channel depth of Reference Group 4 is 23.6 ± 11.1 cm (SD - standard deviation), which is near the test site’s average depth of 31.8 cm. A comparison of other individual test site habitat attributes with those of the reference model, and the ordination plots are included in the Site Assessment Reports. The CABIN model assessed NJLEM03 as potentially stressed.

Table 1. CABIN model assessment of the test site against reference condition as defined by the preliminary Okanagan-Columbia reference model; assessment, prediction of reference group and probability of group membership.

Site	Description	2016
NJLEM03	Lemon Creek, Site 3	**Potentially stressed** Group 4; 79.0%

4.2 *RIVPACS Analysis*

River Invertebrate Prediction and Classification System (RIVPACS) ratios were calculated in the Analytics tools section of the CABIN database. RIVPACS is a measure that describes the presence or absence of specific taxa. The RIVPACS ratio determines the ratio of observed taxa at test sites, relative to taxa expected to be present (at a >70% probability) at reference sites. A RIVPACS ratio close to 1.00 indicates that a site is in good condition, as all or most taxa expected were found at the test site. A RIVPACS ratio >1.00 can indicate community enrichment, while a ratio <1.00 can indicate that a benthic community is in poor condition.

The RIVPACS ratio at NJLEM03 was 0.97. This value indicates good conditions at the test site, only one family of taxa not present that was expected.

4.3 *Community Composition Metrics*

Benthic community composition metrics were calculated in the CABIN database using the Analytical Tools. A collection of measures (metrics) of community richness, abundance, diversity and composition were selected to describe the test site communities and are summarized in the Site Assessment Reports. The following metrics of special interest were reviewed in further detail (Table 2): total abundance; percent composition of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) orders (EPT); percent composition of Chironomidae (midges) taxa; percent composition of the two dominant taxa; and total number of taxa.

Table 2. Summary of select metrics of interest for reference and test sites

Metric	Reference Group 4 (Mean +/- SD)	NJLEM03 2016
Total abundance	587.4 ± 299.1	1031.3
% EPT taxa	87.7 ± 7.4	74.8
% Chironomidae	7.4 ± 6.4	10.6
% of 2 dominant taxa	57.9 ± 14.2	47.6
Total number of taxa	19.3 ± 3.7	25

Total abundance of organisms found at the test site can be influenced by many factors including type of stress and the organisms involved (Rosenberg and Resh 1984). Abundance may increase due to nutrient enrichment but decrease in response to toxic effects such as metals contamination or changes in pH, conductivity and dissolved oxygen. The total abundance at NJLEM03 (1031.3 organisms) was slightly higher than the reference group mean (587.4 ± 299.1 organisms). However, there was no evidence of nutrient enrichment in the water quality results. This level of abundance does not likely indicate an unhealthy benthic invertebrate community.

The percent of the community made up by individuals of any taxon, either at the family or order level, will vary depending on the taxon's tolerance to pollution, feeding strategy and habitat requirements (Rosenberg and Resh 1984). EPT orders of insects are typically indicators of good water quality. The % EPT at the test site (74.8 %) was slightly lower than the reference group mean (87.7 ± 7.4 %). Conversely, the Chironomidae family of insect (non-biting midges) are generally tolerant of pollution. Percent Chironomidae at the test site (10.6 %) was similar to the reference group mean (7.4 ± 6.4 %).

Relative occurrence of the two most abundant taxon is a metric that can relate to impacted streams, since as diversity declines, a few taxa end up dominating the community. Opportunistic taxa that are less particular about where they live replace taxa that require special foods or particular types of physical habitat (Environment Canada 2012b). The percent of two dominant taxa at the test site (47.6 %) was slightly lower than the reference group (57.9 ± 14.2 %), indicating a healthy community.

Taxa richness is the total number of taxa present for a given taxonomic level. There is usually a decrease of intolerant taxa and an increase of tolerant taxa with disturbance. However, overall biodiversity of a stream typically declines with disturbance (Environment Canada 2012b). Taxa richness at the test site (25 taxa) was slightly higher than the reference mean (19.3 ± 3.7 taxa), further indicating that the benthic invertebrate community at NJLEM03 was healthy.

5 Conclusions

Overall, the water quality was very good at NJLEM03, with only one aquatic life guideline nominally exceeded (pH in one sample). As outlined in the results, the guideline exceedance should only be reviewed further if there is concern of anthropogenic influences relating to them in the watershed. Otherwise it may simply represent normal background conditions. We feel that these results do not correspond with the CABIN model determination of the site being potentially stressed in 2016. Overall, although there were some differences from the reference group in the invertebrate community results, which lead to the site being identified as potentially stressed, the metrics indicate a healthy community.

6 Recommendations

We recommend considering collecting continuous instream temperature measurements as Lemon Creek supports a wide distribution of fish species, including the cold-water Bull Trout (BC MoE 2017a). Since there were few water quality parameters of potential concern, expanding on the current water quality sampling program is currently not recommended. We recommend continuing with annual water quality sampling, since it provides a good understanding of current conditions and is key pathway to biota. However, once baseline data has been attained, sampling should be focussed to locations experiencing ongoing development pressures. A few additional considerations are to:

a) In the future, include a duplicate and blank water quality sample annually.

b) Ensure the accuracy of the turbidity and pH meters, by calibrating using solutions of known concentrations daily during sampling.

c) Update water quality data entered into the CABIN database for accuracy in units. In particular, we noted that metal results were entered into CABIN as µg/L (as provided by the lab), and should have been converted to mg/L.

Closing

The Slocan River Streamkeeper Society has completed very good monitoring work, which will be a valuable base to measure changes over time. We hope that this review provides useful information to help your organization with understanding the results of your efforts, and planning for future monitoring.

Sincerely,

Sherri McPherson
Senior Aquatic Biologist, (BSc, RPBio)
250.464.4564
sherri.mcpherson@lotic.co

Kamila Baranowska
Aquatic Ecologist (MSc, RPBio)
705.977.0306
Kamila.baranowska@lotic.co

7 References

BC Ministry of Environment (BC MoE). 2015. British Columbia Working Water Quality Guidelines. Government of BC. Accessed at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/bc_env_working_water_quality_guidelines.pdf

BC Ministry of Environment (BC MoE). 2016. *Environmental Management Act* Authorizations, Technical Guidance 4: Annual Reporting Under the Environmental Management Act. Version 1.3. Accessed at: http://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/annual_reporting_guidance_for_mines.pdf

BC Ministry of Environment (BC MoE). 2017. British Columbia Approved Water Quality Guidelines. Accessed at: http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

BC Ministry of Environment (BC MoE). 2017a. Habitat Wizard mapping tool. Available: http://maps.gov.bc.ca/ess/sv/habwiz/.

Canadian Council of Ministers of the Environment (CCME). 2017. Canadian Water and Sediment Quality Guidelines for the Protection of Aquatic Life – Summary Table. Accessed at: http://st-ts.ccme.ca/en/index.html .

CCME. 2004. Canadian water quality guidelines for the protection of aquatic life: Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. In: Canadian environmental quality guidelines, 2004, Canadian Council of Ministers of the Environment, Winnipeg.

Environment Canada. 2012. Canadian Aquatic Biomonitoring Network: Wadeable Streams Field Manual. Accessed at: http://ec.gc.ca/Publications/default.asp?lang=En&xml=C183563B-CF3E-42E3-9A9E-F7CC856219E1

Environment Canada 2012b. CABIN Module 3 – sample processing and introduction to taxonomy and benthic macroinvertebrates.

Health Canada. 2017. Guidelines for Canadian Drinking Water Quality. Accessed at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php .

Province of BC. 2003. British Columbia field sampling manual: 2003- for continuous monitoring and collection of air, air emission, water, wastewater, soil sediment and biological samples. Available at: http://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/field_sample_man2013.pdf.

Rosenberg, D.M. and Resh, V.H. 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall, New York. pp.199

Rosenberg, D.M., T.B. Reynoldson and V.H. Resh. 1999. Establishing reference conditions for benthic invertebrate monitoring in the Fraser River Catchment British Columbia, Canada.

Fraser River Action Plan, Environment Canada, Vancouver BC Accessed at: http://www.rem. sfu.ca/FRAP/9832.pdf

Wetzel, R.G. 2001. Limnology – Lake and River Ecosystems (third edition). Academic Press, San Diego, USA. 1006 pp.