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May 1st 2020

St'at'imc Government Services

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Attention: **Nadine Gray**
SGS Heritage Project Coordinator
heritage@statimcgs.org

Subject: **SLEMP / BRGMON-15 Seton Lake Shoreline Erosion Overview Assessment
Report Summary and Update**

Please find enclosed a project summary prepared for the SLEMP / BRGMON-15 Shoreline Erosion Overview Assessment project completed by Northwest Hydraulic Consultants Ltd. as requested by St'at'imc Government Services Heritage. As part of this work, we have revised the final report to correct a few inconsistencies that were noted in the final draft released in 2016.

As you are aware, the terms of reference for the BRGMON-15 study were modified by BC Hydro after submission of the first draft Hydro. We have attached the original terms of reference to this letter and can provide an electronic copy of the revised final report.

Background

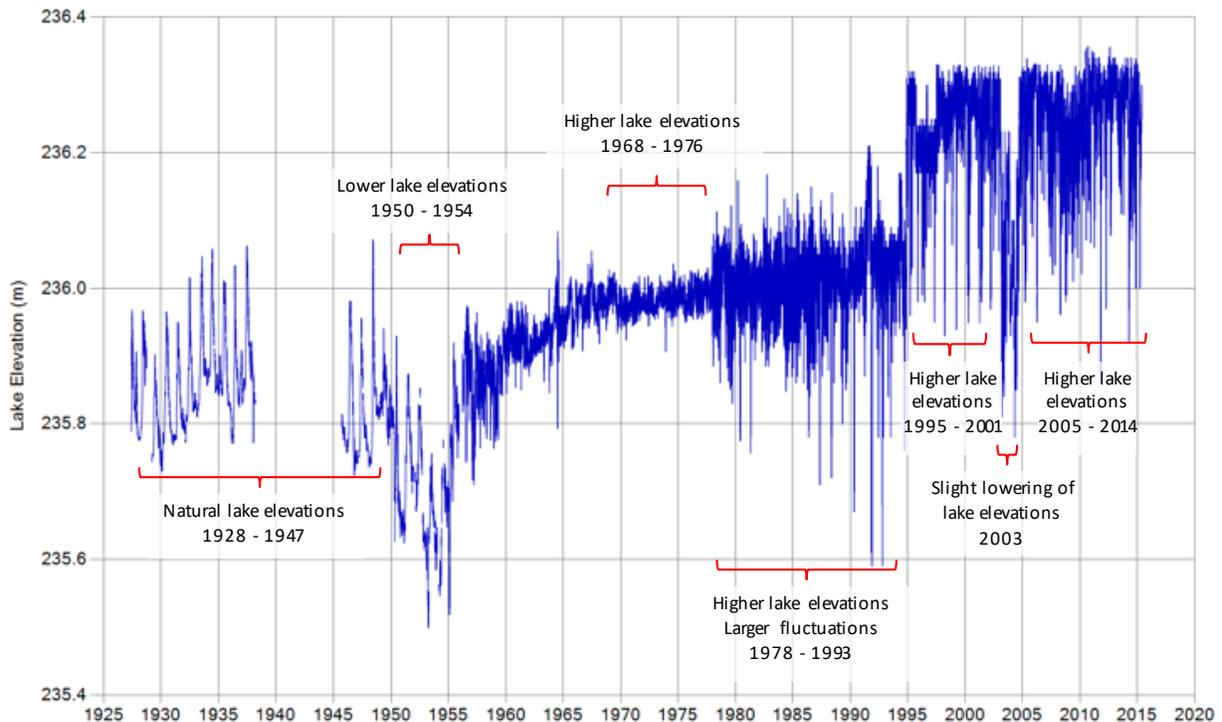
The St'at'imc Participating Communities Settlement Agreement (Section 5.3) and the *Water Act* Order issued by the Comptroller of Water Rights to BC Hydro on March 30th 2011 (Schedule A, Clause 12 and 13) identify the requirement for BC Hydro to develop the Seton Lake Erosion Management Program (SLEMP). The primary objective of SLEMP was to address high and moderate risk shoreline erosion sites, focusing on potential impacts to heritage, cultural and aesthetic resource sites. The first phase of SLEMP would require an assessment phase which would review historical shoreline erosion and relevant background information.

Proposed as a monitoring program under the Bridge River Generations (BRG) Water Use Program (WUP), BRGMON-15 Seton Lake Erosion Mitigation builds upon previous work and studies in a multi-year, multi-phase program that includes assessment, design, implementation and monitoring. The study was unique in that it incorporates existing issues and knowledge associated with St'at'imc heritage and cultural sites, along with shoreline erosion and methods for assessing potential effects of BC Hydro operations. BRGMON-15 project provides some of the key background information for SLEMP, although it was not directly initiated under that program.

In 2017, Northwest Hydraulics completed the draft report: Seton Lake Erosion Mitigation Program / BRGMON-15 Seton Lake Shoreline Erosion Overview Assessment for St'at'imc Eco-Resources Ltd. (SER) and BC Hydro. This summary outlines the study data, methods and findings.

Historical Water Levels on Seton Lake and the influence on Shoreline Erosion

The increase in the water elevation from construction of the Seton Dam in the 1950's and the operation of the Bridge River Generating Station on the west end of Seton Lake resulted in higher mean water levels (VanDine, 1999) in Seton Lake:



Adjusted daily record of Seton Lake water surface elevations based on data presented in VanDine (1999) and re-analyzed for selected time periods

The increased exposure to wave run-up on erodible shorelines, may have initiated increased shoreline erosion resulting in changes to the foreshore and backshore areas. There is no information available to determine whether the period since construction of the Seton Dam and the operation of the Bridge River Powerhouse has been sufficient for the erodible shorelines to reach a new equilibrium to the modified lake hydrograph.

There are no wind data on Seton Lake itself, and the regional wind patterns are highly influenced by topography, especially the valley orientation in this glaciated mountainous region. Westerly and easterly prevailing winds are likely dominant and subdominant, and with considerable fetch¹ lengths significant open water wave heights can be developed along Seton Lake that could impact shorelines.

A range of significant wave heights were calculated for deep water wave conditions in the study. The future direct measurement and collection of meteorological and climate data on Seton Lake would support the further assessment of potential wind wave impacts to erodible shorelines.

¹ Fetch length refers to the length of water over which a given wind speed has blown.

Shoreline Assessment Conducted under BRGMON-15

An initial site assessment was undertaken in August 2014, and consisted of a photo inventory of the current shoreline around Seton Lake linked to a GIS-based chainage around the perimeter. For this project, five categories of shoreline type were defined and mapped in GIS for this assessment: Man-made, Rock, Colluvium, Alluvium and Riparian Vegetation.

The five categories were further classified in terms of erodibility into three classes: Non-erodible shoreline consisted of functional man-made structures or competent bedrock; potentially erodible shoreline consisted of derelict or unmaintained man-made structures or riparian vegetation at the shoreline; and erodible shoreline was typically non-vegetated, relatively unconsolidated alluvium or colluvium:

Erodible Shoreline (24%)	Potentially-erodible Shoreline (53%)	Non-erodible Shoreline (23%)
Non-vegetated or unconsolidated alluvium	Unmaintained man-made structures	Man-made structure
Non vegetated or unconsolidated colluvium	Riparian vegetated shorelines	Competent Bedrock

Based on the initial site assessment, approximately 24% of the shoreline of Seton Lake was classified as erodible. About half (53%) of the shoreline was identified as potentially erodible and the remaining 23% was classified as non-erodible.

A total of 142 erosion sites were identified in the field.

This identification included spatial analysis using a minimum area threshold for the observed erosion and assuming it was visible in the collected study images. Some of these sites are discrete and some extend for some distance along the shoreline, but all sites occur within areas identified as erodible or potentially erodible. The majority of the erosion sites are within areas with riparian vegetation, in comparison to bare colluvium and alluvial areas.



Shoreline erosion observed and recorded along Seton Lake.

A spatial analysis of the current erosion sites relative to known cultural sites, as identified in the provincial Remote Access to Archaeological Data (RAAD) information system and Ms. Ida Mary Peter, Tsal'alh Lands and Resources, was undertaken as part of the work. Site assessments were accompanied and guided by the St'át'imc Government Services (SGS) Heritage crew² and Nadine Gray, GWR Heritage Consulting.

Study Results

The findings with respect to the program management objectives of BRGMON-15 are:

1. What erosion sites, other than cultural and heritage sites, around Seton Lake are affected by Seton Lake fluctuations resulting from operation of the generating facilities?

A total of 142 erosion sites were identified and none were identified impacting major infrastructure areas of concern. Recreational sites and areas of value for wildlife habitat were not included in the assessment, or this type of information was not available. Some of the identified erosion sites affect upland backshore areas.

2. What actions are required to protect those sites from further erosion?

² SGS Heritage Crew consisted of Leanne Narcisse (Heritage Field Assistant), Chester Alec (Heritage Field Technician) and Heritage Team Lead, Nadine Gray (GWR Heritage Consulting).

An assessment of the degree and significance of the shoreline erosion at these sites could be undertaken in future work to assess whether or not actions are required to protect those upland sites from further erosion.

3. What mitigation plans can be developed to address such erosion sites?

Any mitigation plans should be based on a process that considers the values to be protected, the significance of potential impacts, and the scale of mitigation required to address the assessed effects. Typically this is undertaken on a site-by-site basis considering social, environmental and engineering issues.

A wide variety of effective erosion mitigation techniques are available for a range of site conditions and materials, and a range of concepts have been presented in Appendix E of NHC (2017). Mitigation plans may be considered by BC Hydro as a future phase of work.

4. Are the actions implemented to mitigate erosion at the site(s) effective?

There are currently several locations along Seton Lake where constructed shoreline erosion protection works were identified³:

- a. Area 1 / KM 19+650 – where 40 m of double stacked lock blocks have been installed along the shoreline to prevent erosion of the toe of slope along a side road off Shalalth Road
- b. Area 2 (Whiteslide) / KM 16+600 – where 100 m of double stacked rock-filled gabion have been installed to prevent shoreline erosion and slope destabilization protecting a cemetery at the eastern limit of Silicon IR2
- c. Area 3 (Seton Beach) / KM 50+500 – where rock protection has been installed along 425 m of shoreline at the Former Seton IR5 along the public beachfront.

The works identified at Area 3 are the subject of a separate study, which was not provided for the BRGMON-15 study. Designs or documentation for Area 1 and Area 2 were not provided by BC Hydro and could not be located during the background research for BRGMON-15.

The effectiveness of the constructed shoreline erosion project works at Area 1 and Area 2 could not be determined as no design information was available. However the works at Area 1 appear to be undermined at the eastern end of the wall and appear unstable.

Additional slope stabilization works have been constructed by others, notably the CN rail line along the north shore of Seton Lake. These works were predominantly along non-erodible rock faces or consisted of large non-erodible rock fills.

Study Hypothesis

The reporting on the primary hypotheses, as developed in the original Terms of Reference, are provided below:

- Hypothesis 1 there are no significant impacts to erosion on Seton Lake or River related to BC Hydro operations.

³ A map has been provided with this report.

The findings of the shoreline erosion overview assessment do not support this hypothesis. There are shoreline erosion processes occurring. Presently, there is not enough information available to determine the significance of these processes to St'át'imc cultural resources because there are gaps in the available data.

Hypothesis 2 Maintaining Seton Lake levels between El. 235.76 metres above sea level (masl) and El. 236.36 masl has not resulted in reduced erosion along the lake shoreline.

The findings of the shoreline erosion overview assessment are inconclusive with respect to this hypothesis. There are no substantive data that support the hypothesis of reduced erosion along the Seton Lake shoreline. This is due to the lack of baseline information and available data.

Overview Assessment Findings and SLEMP

Substantial changes to the scope of work and the contents of this report were made after submission of the draft final report in March 2016. This was a result of changing priorities of both BC Hydro and the St'at'imc, and the desire to integrate what was originally a Water Use Planning monitoring and works projects into SLEMP.

The phases of the program, which have changed from the initial Terms of Reference (TOR), were modified to include:

1. Inventory and overview of affected erosion sites, including cultural sites previously identified by St'at'imc (Phase 1– subject of this report)
2. Identification and prioritization of sites with heritage and cultural significance through input and discussions with St'át'imc Communities (Phase 2)
3. Additional assessment of priority sites where required (Phase 3)
4. Completion of site-specific conceptual mitigation options for priority sites where appropriate (Phase 4)
5. Feasibility and final design of mitigation plans for priority sites including potential resourcing, implementation and construction plans for erosion mitigation options (Phase 5)
6. Potential monitoring of and/or maintenance planning for mitigation undertaken along Seton Lake and the Seton River (Phase 6).

The NHC report (2017) addresses only Phase 1, whereas the initial terms of reference included Phase 2. These changes of scope were identified by Jeffrey Walker (BC Hydro) on the direction of the St'át'imc Communities at a meeting in September 2016, after submission of the draft final report by NHC in March 2016. As a result, this final report has been modified from its original version, and has resulted in the removal of the risk assessment and ranking of heritage erosion sites identified in the original study.

The original terms of reference (TOR) for BRGMON-15 were developed independently of SLEMP, and this led to two separate erosion programs on Seton Lake. The discussion regarding shoreline erosion and heritage has evolved since the inception of BRGMON-15 with input from St'át'imc Communities and discussions with BC Hydro (Jeffrey Walker, BC Hydro, *pers. comm.*).

Now proposed as a monitoring program and a physical works project under the Water Use Plan (WUP), SLEMP will build upon previous work and studies in a multi-year, multi-phase program replacing the original TOR and deliverables of the BRGMON-15 program. SLEMP will have the primary objective to address high and moderate hazard shoreline erosion sites, focusing on potential impacts on heritage, cultural and aesthetic resource sites.

The program will provide the potential for a substantive, structured assessment of potential shoreline erosion effects that was suggested as an important outcome by both BC Hydro and St'át'imc Communities. This would include further approaches to protect known heritage resources from shoreline erosion, as well as a program to identify other potential sites that may be at risk.

Significant data gaps were encountered in this study that affected the assessment of the management objectives and study hypotheses under BRGMON-15. This included a lack of coordination with respect to concurrent BC Hydro shoreline assessment and monitoring work and a lack of fundamental data.

Additional data collection and technical recommendations include:

1. Installation of enhance meteorological sensors at existing BC Hydro climate stations at Shalalth, Bridge River Generating Station and Seton Dam for collection of comprehensive data sets for future wind and erosion studies under SLEMP, and other long-term monitoring studies in the Seton Basin,
2. Collection and inventory of the Seton Lake shoreline using more advanced RTK GPS UAV imagery that can be more readily utilized for both assessment, survey and design.
3. Selection of inactive and active shoreline erosion sites on various slope materials and aspects to provide long-term shoreline erosion monitoring stations, implemented as part of a structured monitoring program under SLEMP.
4. Implementation of trial bioengineering and riparian revegetation stabilization measures as a long-term, costs effective mitigation at remote, active erosion sites along Seton Lake where convention shoreline stabilization methods would not be cost effective.
5. Assessment and mitigation of significant shoreline erosion as determined through a risk assessment, hazard analysis and prioritization scheme based on ongoing long-term erosion monitoring under SLEMP.

Closure

If you have any questions, please do not hesitate to contact me at your convenience.

Sincerely,

northwest hydraulic consultants

original signed by

Barry Chilibeck, M.A.Sc., P.Eng.
Principal

ENCLOSURES

NOTIFICATION

This report has been prepared by **Northwest Hydraulic Consultants Ltd.** for the benefit of **St'at'imc Government Services** for specific application to the **SLEMP / BRGMON-15 Project on Seton Lake**. The information and data contained herein represent **Northwest Hydraulic Consultants Ltd.** best professional judgment in light of the knowledge and information available to **Northwest Hydraulic Consultants Ltd.** at the time of preparation and was prepared in accordance with generally accepted engineering practices. Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by **St'at'imc Government Services**, its officers and employees. **Northwest Hydraulic Consultants Ltd.** denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents.