INFRASTRUCTURE SERVICES COMMITTEE

Thursday, February 16, 2017
SCRD Boardroom, 1975 Field Road, Sechelt, B.C.

AGENDA

CALL TO ORDER: 9:30 a.m.

AGENDA

1. Adoption of Agenda

PETITIONS AND DELEGATIONS

REPORTS

2.	Chief Administrative Officer - Chapman Lake Water Supply Expansion Project Environmental Assessment Report **(Voting – A, B, D, E, F, Sechelt)**	Annex A pp 1 - 180
3.	Sustainability and Education Coordinator Water Demand Management Rebate Program **(Voting – A, B, D, E, F, Sechelt)**	Annex B pp 181 - 184
4.	Manager, Solid Waste Services Waste Reduction Initiatives Program Update **(Voting – All)**	Annex C pp 185 - 188
5.	Manager, Solid Waste Services and Chief Administrative Officer SCRD Solid Waste – Proposed Next Steps **(Voting – All)**	Annex D pp 189 - 190
6.	Sr. Mgr. Administration & Legislative Services and GM Planning & Community Development Sunshine Coast Regional District (SCRD) 50th Anniversary **(Voting – All)**	Annex E pp 191 - 196
7.	Transportation Advisory Committee Minutes of January 19, 2017	Annex F pp 197 – 199

COMMUNICATIONS

NEW BUSINESS

IN CAMERA

ADJOURNMENT

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – February 16, 2017

AUTHOR: Janette Loveys, Chief Administrative Officer

SUBJECT: **CHAPMAN LAKE WATER SUPPLY EXPANSION PROJECT ENVIRONMENTAL ASSESSMENT REPORT**

RECOMMENDATION(S)

THAT the report titled Chapman Lake Expansion Project Environmental Assessment Report be received.

BACKGROUND

The SCRD applied for an amendment to its Chapman Lake Park Use Permit (PUP) on April 13, 2016 and Water License Amendment on April 18, 2016, to allow the installation of a gravity-fed withdrawal system to provide additional water supply from Chapman Lake.

The Board was informed at the June 9, 2016 Special Infrastructure Services Committee meeting that the SCRD received formal notice from BC Parks, by letter received June 6, 2016, requiring further investigative environmental work in order to fully adjudicate the proposal and issue the Park Use Permit Amendment.

In addition to the BC Parks requirement, the Ministry of Forest, Lands and Natural Resource Operations (FLNRO) formally requested on June 20, 2016, that a new water license application be submitted along with an Environmental Flow Needs (EFN) study as part of the Chapman Lake Water Supply Expansion project.

On July 21, 2016, the SCRD Board approved an additional $123,425 expenditure from the Regional Water Service capital budget for the studies and environmental assessment work required by the Province of BC and the respective Ministries as outlined in their communications.

This decision effectively moved any capital work on the additional water supply to 2017.

DISCUSSION

Attached to this cover report is the Environmental Assessment Report which includes the Environmental Flow Needs Study. This report is on the SCRD website and serves as an update to the project.

As part of the requirements for the Permit Amendment, the attached report was forwarded to the shíshálh and Sḵwx̱wú7mesh Nations for their review and comment to the Province.

BC Parks and FLNRO Ministry staff also received a copy of the report and their technical staff and biologist are in the review process.

SCRD staff have no further information to provide at this time, only provincial process. The comments from the partners and referral agencies do not come back to the SCRD, only a collective summary. No date has been provided by the Province as to when the SCRD might receive the summary.

Once SCRD staff have more communication from BC Parks and FLNRO, the intent would be to bring AECOM to a Committee meeting and provide more information and timing with respect to the next steps for the project. It would also be helpful for FLRNO staff to attend a meeting and provide an overview to their analysis.

Staff are fully aware of the complexities to the project and good public communications. Upon hearing back from the Province, staff will work towards ensuring inclusive and clearly understood communications are in place.

As well, a report will be forthcoming with respect to engagement once more information is provided.

STRATEGIC PLAN AND RELATED POLICIES

This report directly links to the set of values identified in the Strategic Plan.

In addition, this report aligns with the following Strategic Priorities:

Strategic Priority: Enhance Collaboration with the shíshálh and Sk̲wx̲wú7mesh Nations by respecting their review/comment process and their rights.

Strategic Priority: Embed Environmental Leadership through the responsible management of the regions' water supply.

CONCLUSION

The Board was informed at the June 9, 2016 Special Infrastructure Services Committee meeting that the SCRD was required to conduct additional environmental assessment which included a flow needs study. On July 21, 2016, the SCRD Board approved additional funds to carry out this requirement.

The attached Environmental Assessment report has been forwarded to shíshálh and Sk̲wx̲wú7mesh Nations for their review and comment. Staff have respected their process.

The report has also been received by the Provincial Ministries.

A further report will be forthcoming with respect to engagement once more information is provided by the Province.

ATTACHMENT: Chapman Lake Expansion Project Environmental Assessment Report

This report provides information Reviewed by:			
Manager		Finance	
GM		Legislative	
CAO	X- JL	Other	

Sunshine Coast Regional District

Chapman Lake Water Supply Expansion Project Environmental Assessment

Prepared by:

-AECOM
3292 Production Way, Floor 4
Burnaby, BC, Canada V5A 4R4
www.aecom.com

604 444 6400 tel
604 294 8597 fax

November, 2016

Project Number: 60485918

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Revision History

Revision #	Date	Revised By:	Revision Description

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by AECOM represent AECOM's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since AECOM has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, AECOM, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by AECOM and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

AECOM accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of AECOM to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2015-04-13

Quality Information

Report Prepared By:

Melissa Mukai, RP. Bio, P. Bio, EP. Bio
Aquatic Biologist

Report Prepared By:

Keith Bell, RPF
Senior Ecologist

Bruce Ford, MRM, RP. Bio
Senior Environmental Biologist

Report Reviewed By:

Brett deWynter, P. Eng.
Project Manager

Table of Contents

Figures

Tables

Executive Summary

The SCRD's Chapman Water System supplies potable water to approximately 10,000 Sunshine Coast service connections between Gibsons and Secret Cove with the main source being Chapman Creek and includes two headwater alpine lake reservoirs. The primary reservoir is Chapman Lake with a concrete dam and valve located on the outlet which is operated remotely by the SCRD to control releases into Chapman Creek. The existing dam on Chapman Lake is three metres high fitted with a sluice gate at the bottom of the structure. The amount of water that can be released annually from Chapman Lake is currently limited by the water licence to 906,600 m^3, however, the current estimates indicate that the amount of water actually available is slightly less at 905,000 m^3. The current maximum drawdown of Chapman Lake is 3.0 m and during a typical year, water stored behind the dam is allowed to overflow naturally until the water level drops below the dam crest and which point the SCRD begins to manage the release from the sluice gate. A portion of the total flow released from Chapman is conveyed down Chapman Creek to the point of diversion for the SCRD water treatment plant. In addition to the flow diverted for the drinking water needs of the community, a minimum additional flow of 0.2 m^3/s is released to accommodate the hatchery and the in-stream requirements for fish. The SCRD also manages the water demand through restrictions that are brought into effect in summer months. The current water control structures are permitted under an existing BC Park Use Permit and various Water Licences.

The Chapman Lake Supply Expansion Project is designed to access additional water from Chapman Lake for release into Chapman Creek during times of drought. The infrastructure required includes a gravity fed system with a 190-m long, 900-mm diameter pipe buried beneath the existing outlet channel. The intake for the pipe would have an invert elevation of 965.1 m which would allow access to an additional 1 million m^3 of water. In September 2015 the SCRD Board adopted a resolution that in part stated that this new infrastructure would "only be utilized during periods of drought and until the long term source development projects specified in the SCRD's Comprehensive Regional Water Plan are constructed".

In August 2016 a field campaign was conducted to augment the environmental assessment study done in 1998 (Whitehead 1999) to complete an environmental assessment for the project. Findings from 2016 included:

- Rock samples from the area of the existing dam were collected and submitted for geochemical analysis. The results from the samples indicate that the rock is not acid generating.
- Additional fish sampling support the findings in the Whitehead (1999) report, only Dolly Varden Char (DV) were caught and all but one large fish were similar in size to the fish caught by Whitehead. Also the gill netting catch per unit effort was very similar between the 2 studies. Note, we have confirmed that fish samples from the 1998 study were sent to BC MOE for analysis and they were confirmed to be DV (Dave Bates, pers. Comm.). EVS (1999) reported that Chapman Lake may have historically supported cutthroat trout but suggests that rainbow trout were stocked into the lake before the province maintained stocking records and they may have out-competed the cutthroat trout. The report also suggests that the DV may be a result of fish stocking. We could find no information to substantiate these suggestions. Overall conclusion is that Chapman Lake supports a mono culture of Dolly Varden Char.
- Fish sampling indicates that juvenile rearing takes place in tributary streams and young of the year do not enter the lake. The tributary that flows into the lake from the north into the east end of the lake appears to be the most productive stream for spawning DV. The other large stream at the east end of the lake (flowing in from the south, yielded no juvenile DV during sampling. The small stream channels such as the one near the helipad at the west end of the lake also appear to be spawning and nursery areas for DV.

- Water samples were submitted to a lab for analysis of standard parameters. The only parameter that exceeded Canadian Council of Ministers of the Environment (CCME) was total aluminum reported at 0.111 mg/L just above the criteria of 0.1 mg/L. Water chemistry and other parameters (i.e. secchi reading) indicates the lake is oligotrophic (low productivity), which is expected for this high elevation lake.
- Whitehead (1999) commented on a rotten egg smell emanating from the mud substrate suggesting the presence of hydrogen sulfide. We analyzed water samples for hydrogen sulfide and the results indicate that H_2S levels in the lake are below detection.
- All water samples analyzed for total mercury were below the detection limit of 0.005 micrograms/L (parts per billion).
- 2016 temperature and dissolved oxygen profiles of the Chapman Lake water column were very similar to the 1998 data.
- Muscle tissue from 5 fish were analyzed for total mercury and results ranged from 0.029 to 0.184 mg/Kg wet weight. This compares to the BC Tissue Residue Guidelines to Protect Wildlife from Mercury Toxicity, which is 0.033 mg/kg wet weight for methyl-mercury. The majority of the mercury in fish tissue would be in the form of methyl-mercury. This is provided as a measure of current conditions for comparison with future samples.
- The field program collected data on vegetation and ecological communities to complete Terrestrial Ecosystem Mapping for the area within 500 m of the lakeshore.
- Plant surveys in August did not identify any rare plants within the proposed construction area.
- Opportunistic observations of wetland areas and creeks did not reveal any SARA listed amphibians that could be present including the western toad or the coastal tailed frog.

A summary of the project effects, mitigation measures and determination of residual impacts of the project were completed in order to assess the construction and operational impacts for the project. The assessment focused on seven environmental and social aspects associated with the construction and operation of the new system. The following table provides a summary of the findings. The construction phase will employ standard construction techniques for which there are mitigation measures that are effective for containing and managing the effects of earth moving, blasting and other general requirements (fuel handling, waste management, etc.). Because this work is being carried out in a provincial park environment the residual effects of some construction activities have been rated moderate but the effects are only present during construction and will revert to pre-construction conditions once construction is finished. A site remediation plan will be developed to return all disturbed areas to pre-construction conditions and the remediation work will be monitored to track the effectiveness of the work and, if necessary, identify additional work that might be required to achieve proper restoration.

The operational phase will result in increased drawdown of the lake during summer drought conditions with the main issue being the frequency that the lake will be drawn down below the current maximum of 3 m. Studies in 2013 indicated that the SCRD would require storage of 2,090,000 m^3 to meet water demand for the projected population in 2036 during a 1 in 25 year drought. This exceeds the existing combined storage capacity of Edwards and Chapman Lake by 394,000 m^3 and would require drawing Chapman Lake down to approximately -4.5 m. Recent climate change modelling conducted by Metro Vancouver for the lower mainland suggests that annual precipitation will increase by the 2050s but the summer months through September will experience an average reduction in precipitation of 19% and May snow packs could diminish by 50%. This combination will change the summer hydrology of the Chapman Lake watershed and likely cause the current 1:25 year drought conditions to occur more frequently by the 2050s, however the SCRD is planning on developing alternative water sources to augment the Chapman system well before 2050.

In a more immediate time frame, the existing storage capacity of the Edwards and Chapman Lakes system is still not sufficient to meet current water demand under drought conditions. The 2013 analysis suggests that current storage could satisfy a 1 in 21 year drought event. This is due to the required water release to maintain the environmental base flow and the per capita demand for water in the Chapman System. The SCRD is taking steps to reduce the per capita demand through the installation of water meters and a more rigorous application of the drought management plan (i.e. water use restrictions). There is also anecdotal information that suggests that the 2015 drought could be in the order of a 1 in 100 year drought, however this result was based on an analysis of the 2015 conditions on St Mary's Lake on Salt Spring Island which typically experiences dry summer conditions. In the near term, the combination of water demand management and potential severity of the 2015 drought suggest that drawing Chapman Lake down below -3 m will be an infrequent event and a full draw down of 8 m would only occur under the most extreme drought conditions. The expected drawdown of Chapman Lake to meet severe drought conditions is between 4 and 5 m.

The residual impacts of the operation of the proposed system and drawing the lake down by a full 8 m has been rated as negligible or low, primarily because it is expected to occur infrequently and the lake would refill within a short time once the fall rains begin. Also, there should be several years between drought conditions that will allow recovery from any detrimental effects caused by significant drawdown below -3 m. However, monitoring of biophysical parameters in and around Chapman Lake during periods of draw down below -3 m is recommended to confirm the assessment of the effects presented here.

Project Effects, Proposed Mitigation Residual Effect and Assessment of the Proposed SCRD Water Project

Component	Mitigation Measures	Residual Effect	Magnitude	Geographic Extent	Temporal Bound	Overall Impact
Geophysical: Blasting	Blasting plan to be developed by a certified blaster Limit blasting overpressures to a maximum of 133 dB (follow DFO guidelines http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html)	Construction: Vibration and Noise	L	L	L	Low
		Operation: No residual effect	-	-	-	-
Air Quality	Use well maintained equipment Apply dust suppression when required On site fuel containers to be have proper caps and to be covered Minimize helicopter flights to the area	Construction: Degraded air quality from heavy equipment, helicopter use and dust	L	M	Low	Low
	Monitor effects during drawdown	Operation: Increase of dust from lake drying	L	L	L	Negligible
Noise	Typical mitigation measures may not be practical due to the need to complete the work within a defined period. Use proper and well maintained equipment Minimize flights required to the area Work outside of sensitive breeding windows Avoid areas with species sensitive to noise Early and late day work to be avoided Some mitigation measures may not be practical	Construction: noise from blasting, helicopter and construction equipment	M	M	L	Medium
		Operation: No residual effect	-	-	-	-
Terrestrial Resources	Develop a vegetation remediation plan Proper camp design and set up Erosion and sediment control plan Fence off the work and laydown areas Ensure appropriate construction timing to avoid wildlife breeding season or conduct appropriate surveys prior to clearing (i.e. birds and amphibians) Proper management of potential wildlife attractants	Construction: Temporary loss of vegetation/wildlife habitat and change in biodiversity, camp wildlife attractant, disruption of wildlife, Draw down effects on wildlife such as amphibians	L	M	L	Medium

Component	Mitigation Measures	Residual Effect	Magnitude	Geographic Extent	Temporal Bound	Overall Impact
		Operation: Potential effect on amphibians from lowered water levels in wetlands	L	M	L	Low
Aquatic Resources	Emergency spill response plan/spill cleanup equipment and properly trained staff Installation of sediment and erosion control measures Installation of intake pipe in the dry Salvage fish from any areas where water is cut-off from the lake and will be dewatered	Construction: Release of sediment or other deleterious substances, resuspension of sediment, contamination with wastes. Potential restriction of access to spawning areas	M	M	L	Medium
	Water demand reduction programs (e.g. metering) Infrequent drawdown below -3 m Maintain current water release requirements to maintain fish habitat downstream during low water Provide sufficient plunge pool at base of dam to avoid harm to fish going over the dam and dropping 8 m	Operation: Instability of shoreline or creek mouths causing sedimentation and erosion, Changes in lake dynamics including temperature profiles Drying of exposed shoreline below -3 m and associated changes to lake side and aquatic vegetation. Downstream effects unchanged Temporary restriction of access to spawning areas for Dolly Varden	M	M	L	Low
Socio-Community: Recreation	See air quality and noise for mitigation Installation of information signage Screening of construction areas Minimize duration of construction	Construction: Reduced quality of recreational experience due to equipment noise and other activities related to construction	L	L	L	L
	Infrequent drawdown of lake below -3 m	Operation: Altered viewscapes leading to diminished quality of recreational experience	L	L	L	Low
Heritage Resources	Confine work areas to sites disturbed during the original dam and channel construction in 1978 Monitor for artifacts of archaeological significance during excavation Conduct archaeological survey of shoreline when draw down for construction is at its lowest level	Preliminary field reconnaissance did not identify a significant potential for archaeological resources to be present in the construction area	-	-	-	-

1. Introduction

The Sunshine Coast Regional District (SCRD) operates a number of water distribution facilities within its jurisdiction between Egmont and Langdale. One of the systems, the Regional Water Service Area, supplies 90% of the Sunshine Coast residents with Chapman Creek being the main source of water. The Chapman Creek system includes two headwater lakes which are managed to provide water during low flow summer conditions. The SCRD has installed outlet structures on both lakes to control the release of water.

Chapman Lake and the upper Chapman Creek watershed are located in Tetrahedron Provincial Park a Class A park which is protected under the Park Act and subject to conditions of the park's management plan (MELP 1997). The lake is also in the shíshálh Nation territory (formerly Sechelt Indian Band).The SCRD license for water storage in Chapman Lake pre-dates the creation of Tetrahedron Provincial Park, and once the park was established, the park management plan (BC Parks 1997) included the continued use of the lake as a community water supply for the SCRD. The current water control structures are permitted under an existing Park Use Permit and Water Licences. There is also a temporary Park Use Permit and temporary short-term Water Use Permit in place for a temporary syphon system (both of which expire in August 2017).

In 2013 the SCRD Board approved a Comprehensive Regional Water Plan (CRWP) that was developed by Opus Dayton Knight (2013). The CRWP identified that under current conditions the Chapman Creek system did not have the capacity to provide water during drought conditions. The CRWP made recommendations for both short term water supply requirements and options for longer term needs to meet projected population growth and water demand in 2036. The short term plan recommended accessing additional water from Chapman Lake to mitigate the risk of water shortages during drought conditions. The plan recommended establishing a floating pump or alternative design on Chapman Lake to draw water into Chapman Creek. The CRWP was made available to the public and was the subject of public consultation before it was approved by the SCRD Board in 2013.

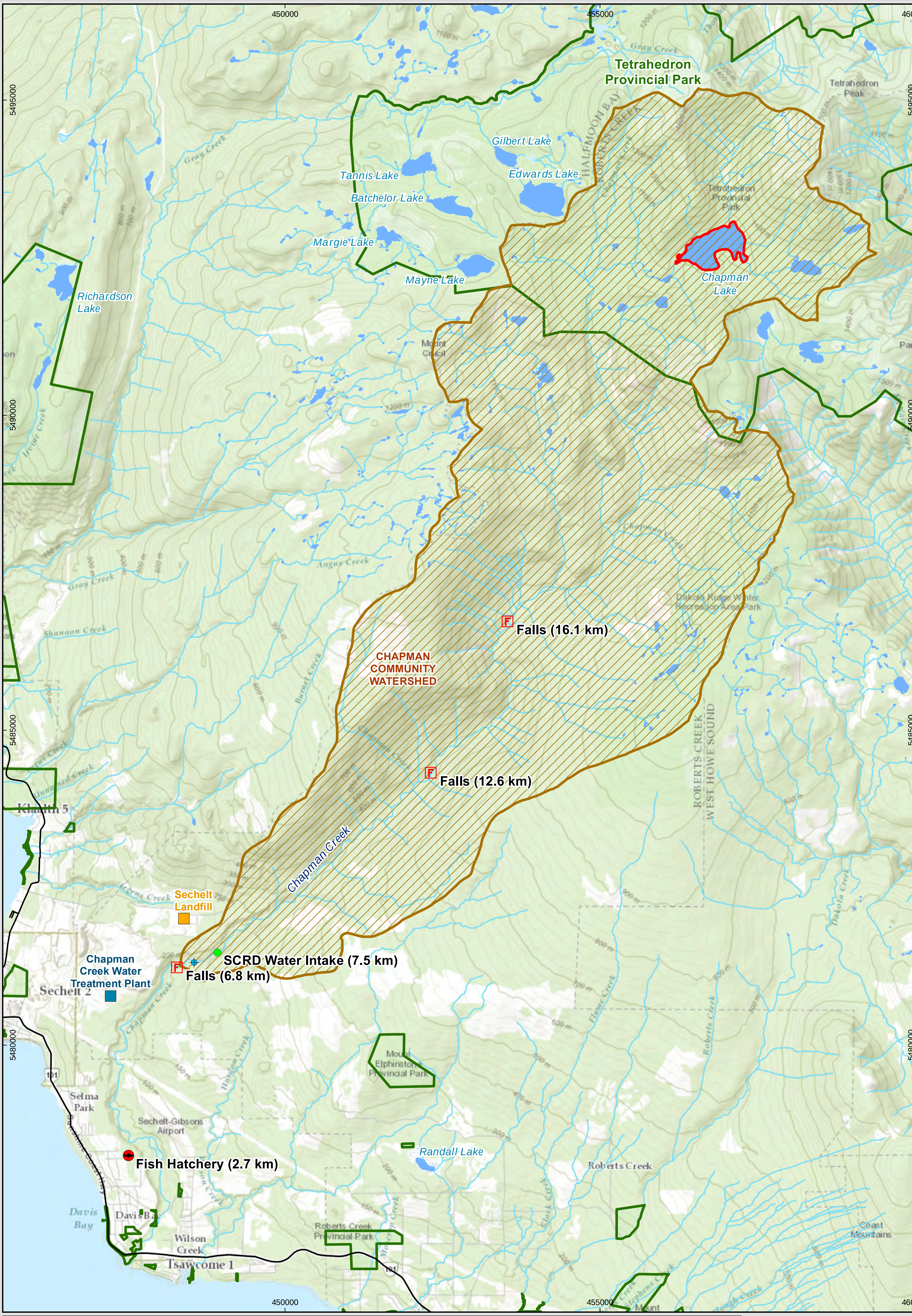
In 2015 much of BC including the Sunshine Coast experienced a series of record conditions (low snow pack, low rainfall and high temperatures) resulting in a severe shortage of water in Chapman Creek with Chapman Lake coming within a few days of running out of accessible water. The exceptional circumstances of the summer of 2015 resulted in the SCRD imposing Stage 4 water restrictions in the area serviced by the Chapman water system. To alleviate the acute water shortage, the SCRD was granted approval for Short Term Use of Water by the Province, permitting a maximum diversion of an additional 1.0 million m^3 of water from the Chapman Lake by installing a series of pipes that would syphon water out of the lake. However, water restrictions were lifted in early September after 4.5 days of rain refilled Chapman Lake. Given this experience the SCRD Board decided to implement the plan approved in its 2013 CRWP and install a permanent gravity fed system that would be capable of accessing an additional 1 million m^3 of water from Chapman Lake. The following resolution adopted by the SCRD Board at its September 10, 2015 meeting implementing a revised Drought Mitigation Option:

> THAT the General Manager Infrastructure Services' report dated August 25, 2015 titled Drought Mitigation Options be received;
>
> AND THAT the SCRD move forward with the design and approval process for the Deepen Channel option, recognizing that the system will only be utilized during periods of drought and until the long term source development projects specified in the Comprehensive Regional Water Plan are constructed;

AND FURTHER THAT the design, engineering and environmental impact assessment of the Deepen Channel option be presented to the Board for consideration.

The Board committed to use the additional water from Chapman Lake only during periods of drought and not to meet long term demand. Other solutions would be investigated to meet the water demand for the growing population on the Sunshine Coast.

AECOM Canada Ltd. was hired by the SCRD to complete the engineering, public consultation, and environmental assessment work associated with the implementation of the Project. This report is provided to support the permitting process that is required to obtain approval from the provincial government, specifically for an amendment to the SCRD's Park Use Permit, and a water licence under the Water Sustainability Act.



Basemapping from ESRI Online Topographic,
Spatial Data from SCRD, 2015
Note: Distances are upstream from the mouth

N
W E
S

0 1 2 3
Kilometres

1:60,000

NAD 1983 UTM Zone 10N

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced, or relied upon by third parties, except as agreed by AECOM and its client, as required by law, or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Legend

- Study Area
- Hydrometric Station
- Falls
- Fish Hatchery
- SCRD Water Intake
- Chapman Creek Water Treatment Plant
- Sechelt Landfill
- Community Watershed
- Park and Protected Area
- Main Road (Arterial / Collector / Highway)
- Stream

Overview Map

Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

General Location

15 November 2016

AECOM

Figure 1

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\2016-04-11-GeneralLocation\Figx-2016-04-12-GeneralLocation-60485918-003.mxd Date Revised: November 15, 2016 Reviewed By: Paper Size: 11"x17" Scale is referenced to the specified paper size.

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

1.1 Regulatory Requirements

The Sunshine Coast Regional District has had a Park Use Permit in place since the park was created in 1995 that allows the SCRD to occupy and use areas at the outlet of Chapman and Edwards Lakes for the purpose of managing the drinking water supply for the Sunshine Coast. The current Park Use Permit for Chapman Lake (No. 102714) was issued on February 1, 2014 for a period of 10 years. However, in order to construct the new infrastructure and manage additional drawdown of Chapman Lake an amendment to the existing Park Use Permit will be required. In April 2016 the SCRD filed an application to amend the permit. In June 2016 BC Parks provided the SCRD with a review of the materials submitted and requested additional data be collected and summarized to facilitate the assessment of the application. Additional information requested required the SCRD to confirm and update the data collected in 1998 and presented in the report "*Impact Assessment. Sunshine Coast's Proposed Water Storage Project (Floating Pump Station) on Chapman Lake, in Tetrahedron Provincial Park*" (Whitehead 1999). The proposal to withdraw additional water from Chapman Lake was originally approved in 1999 but was not proceeded with by the SCRD Board at the time but has been resurrected and approved by the current Board to address the shortfall in the Chapman System to supply adequate water during drought conditions as predicted by studies (Opus DaytonKnight 2013) and experience during the summer of 2015. The Park Use Permit application requires that an environmental assessment (EA) report be prepared and consultation be carried out.

The SCRD will also require licences and approvals under the Water Sustainability Act (WSA). The approval to make changes in and about a stream will be required for the works required to install the gravity system and any other associated works in Chapman Lake or immediately downstream in Chapman Creek. A new water licence will be required to withdraw the additional 1 million m^3 of water out of Chapman Lake. This EA will also be used as part of the application for the WSA approval and in partial fulfillment of the water licence application which requires an assessment of environmental flow needs to ensure aquatic resources are not put at risk. This report includes discussion of the effects of additional water withdrawal from Chapman Lake and any alterations to flows in Chapman Creek immediately downstream of the lake. The SCRD has undertaken studies of the lower or anadromous section of Chapman Creek to determine the minimum flow requirements for fish that utilize that section of the creek which will be summarized in Section 5.3.

1.2 Watershed Administration

The Chapman Creek watershed intersects with the Coast Forest Region and the Sunshine Coast Forest District, the Sunshine Coast Timber Supply Area, and Tree Farm Licence Area 39 (MOF 2005 in Triton 2006). The majority of Chapman Creek watershed is designated as a Community Watershed under the Forest and Range Practices Act. As the primary source for drinking water on the Sunshine Coast, the Vancouver Coastal Health Authority is responsible for ensuring that the relevant portions of the provincial Health Act and the Drinking Water Protection Act are applied to the watershed.

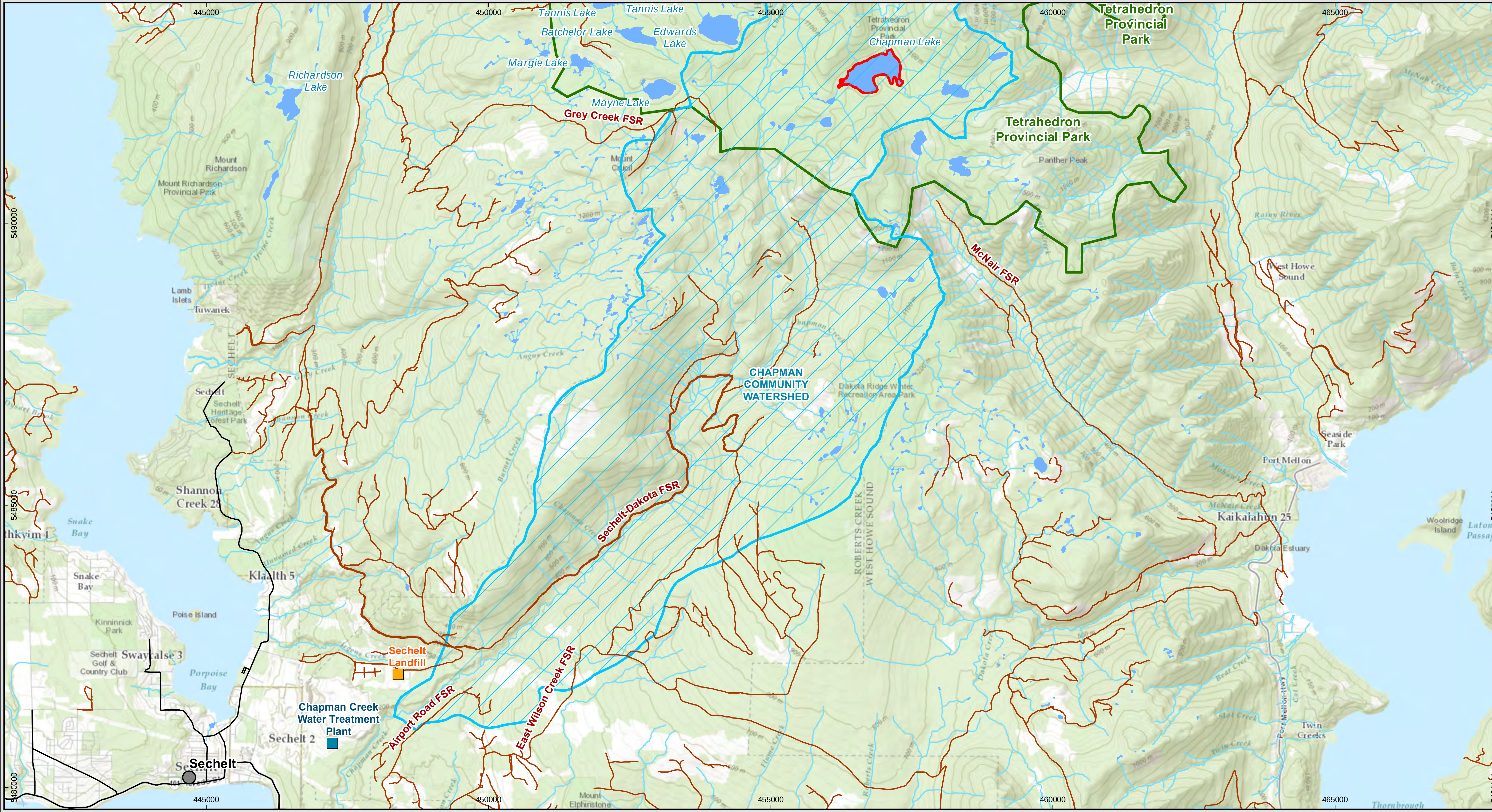
The portions of the watershed above 800 m elevation are located within Tetrahedron Provincial Park (Figure 1). The middle portions of the watershed are mostly provincial Crown land. The lower portions of the watershed above the SCRD water intake are also mainly Crown land, with five private legal parcels (District Lot 2461, 2463, 2462, 7613 and 3374).

The watershed is also located within the Chapman Landscape Unit, which is managed under the Chapman Landscape Unit Plan (MSRM 2002 in Triton 2006). This plan specifies Old Growth Management Areas (OGMA) in which timber harvesting and road construction cannot occur unless no other practicable options exist, in which case there is a provision for replacement of these areas. There are at least seven OGMAs within the assessment area.

1.3 Access Description

The main access points into the lower watershed include the Sechelt-Dakota FSR, the Airport Road FSR and the East Wilson Creek FSR (Figure 2). Access roads within the watershed are gravel and vary in width (1 or 2 lanes) and accessibility. Since 2001 a number of access roads in the lower and mid-portions of the watershed have been deactivated and rehabilitated.

Access to the lakes and cabins in the upper watershed in Tetrahedron Provincial Park is by foot from trail heads accessed via West Main Road to Gray Creek Mainline, which is located within the Gray Creek watershed and from the east along the McNair FSR.



Basemapping from ESRI Online Topographic,
Spatial Data from SCRD, 2015, FSR from GeoBC, 2015

N
W E
S

0 500 1,000 1,500
Meters
1:65,859

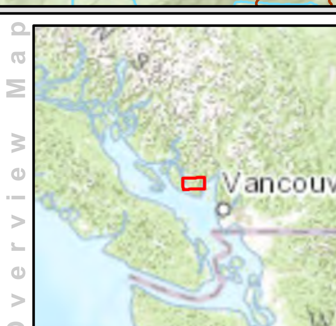
NAD 1983 UTM Zone 10N

Legend

- Study Area
- Park and Protected Area
- Community Watershed
- Waterbody
- Stream
- Main Road (Arterial / Collector / Highway)
- City
- Chapman Creek Water Treatment Plant
- Sechelt Landfill
- Forest Service Road

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Overview Map



Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

Access Roads

15 November 2016

AECOM

Figure 2

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\Study Area\2016-03-04-AccessRoads\Figx-2016-03-04-AccessRoads-60485918-001.mxd Date Revised: November 15, 2016 Reviewed By: AM
Paper Size: 11"x17" Scale is referenced to the specified paper size.

2. SCRD Water Supply

2.1 Overview of SCRD Water Supply

The SCRD operates multiple water systems to supply the residents and businesses of the Sunshine Coast with potable water. The largest system is the Chapman Water System which supplies potable water to approximately 10,000 Sunshine Coast service connections servicing 23,000 customers between Gibsons and Secret Cove. The water source is Chapman Creek and surrounding watershed, which includes two headwater alpine lakes that have been modified to serve as reservoirs. The primary reservoir is Chapman Lake and Edwards Lake is a secondary source and both lakes are within Tetrahedron Provincial Park. Dams have been built on the outlet of each lake which allows the SCRD to control the flow of water into Chapman Creek for withdrawal 17 km downstream at the intake for the Chapman Creek Water Treatment Plant.

The existing dam on Chapman Lake is three metres high and from fall to spring water flows freely over the top of the dam. When water levels drop below the dam crest a sluice gate at the bottom of the structure is used to control the release of water from the lake. The sluice gate can be remotely operated from Regional District offices through Supervisor Control and Data Acquisition (SCADA). The amount of water that can be stored in Chapman Lake is prescribed in water license No. C050724 at 906,600 m^3. However, more recent estimates have calculate the volume to be slightly less at 905,000 m^3. The amount of water that can be released is governed by the configuration of the outlet channel and control structure. The release of the maximum volume from Chapman Lake results in a vertical drawdown of approximately 3.0 m below the outlet crest height. Photographs provided in the Photograph Section of the report show the area of the existing dam, the outlet channel and immediately downstream in Chapman Creek. The SCRD has a similar water release structure on Edwards Lake that has the capacity to release 791,000 m^3. The combined capacity of Edwards and Chapman Lakes is 1,696,000 m^3.

During a typical year, snow melt and rainfall ensure that the lake is at the full pool elevation of 974 m and the water stored behind the dam is allowed to overflow naturally until the water level drops below the crest. At this point the SCRD opens the existing low flow outlet and the flow from the outlet pipe is regulated to maintain sufficient flow for fish and water supply. The current operating procedure is to maintain at least 0.3 m^3/s in the creek below the water intake for the water treatment plant (Figure 3) under normal conditions and 0.2 m^3/s under low flow conditions. The amount released from Chapman Lake is determined by the amount of flow measured at the stream flow gauge located downstream of the SCRD water intake. The Water Treatment Plant has a design capacity to treat 0.3 m^3/s or 24,500,000 liters per day.

Since 2014 SCRD has been able to monitor the water levels and flow releases from Chapman Lake in real time and adjust the water flow from the lake remotely. This monitoring now allows the SCRD to accurately manage the flow from Chapman Lake to meet the drinking water demands and to supply the flows required for fish. Prior to 2014 flow from the lake was adjusted manually and required SCRD staff to fly up to the lake and make the necessary adjustments which was done on an as needed basis. Figure 3 shows the drawdown and refill of Chapman Lake for 2014 – 2016.

The fish hatchery located downstream of the SCRD intake also has a water licence on Chapman Creek and it typically uses up to 0.1 m^3/s of the instream flow but their water licence allows them to take a maximum of 0.28 m^3/s. The hatchery use of the water is a flow through situation with water extracted from the creek, it passes through the hatchery and is released back into the creek less than 100 meters downstream of the intake.

2.2 Hydrology of Chapman Creek

A detailed analysis of the hydrology of Chapman Creek can be found in Chapman and Reksten (1991). This report summarized the stream flow data from two Water Survey of Canada gauges that were operated on Chapman Creek; 08GA046 was located at the lower end of the creek near Wilson Creek Community and operated from 1959 to 1970. Station 08GA060 was established on the creek upstream of the original SCRD water intake and ran from 1970 to 1988. A third station not included in this study, 08GA078, was established downstream of the current SCRD water intake and operated from 1993 to 2003. Chapman and Reksten (1991) analyzed the data from 1959 to 1988 which includes 9 years of data after the flow control was established on Chapman Lake in 1979. The fact that flows out of Chapman Lake were managed is not anticipated to have a significant effect on the overall hydrologic analysis as the Chapman Lake watershed is just 8.6 km^2 (13%) of the entire watershed captured by Station 08GA060 of 64.5 km^2. The biggest influence would have been during the summer low flow periods when the SCRD releases the water held in Chapman Lake to augment flows.

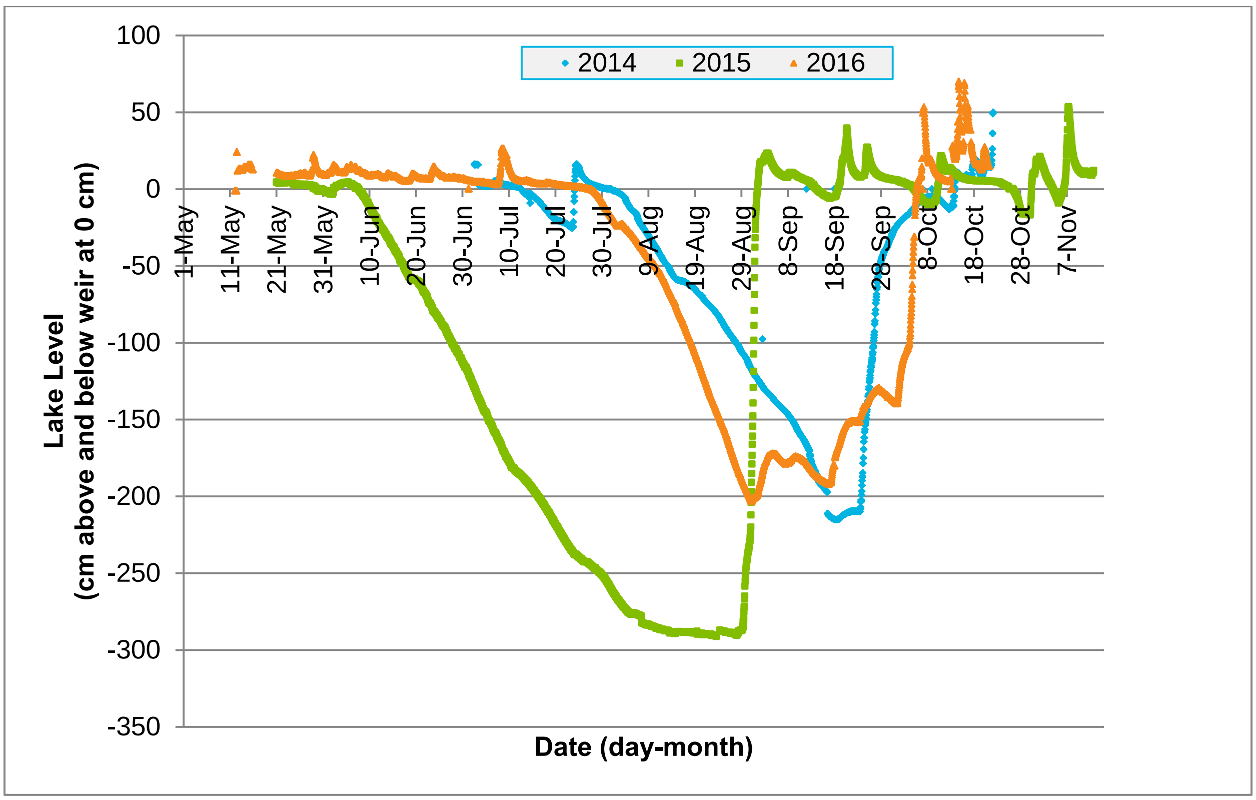


Figure 3: Chapman Lake water levels May to October, 2014 to 2016

The following summarizes the results from Chapman and Reksten (1991) based on the gauging station located above the SCRD intake (Sta 08GA060). Mean annual discharge was 4.53 m^3/s with the months of peak flow being May and June with an average flow of approximately 7 m^3/s and the month of lowest average flow was August at 1.18 m^3/s (Figure 4).

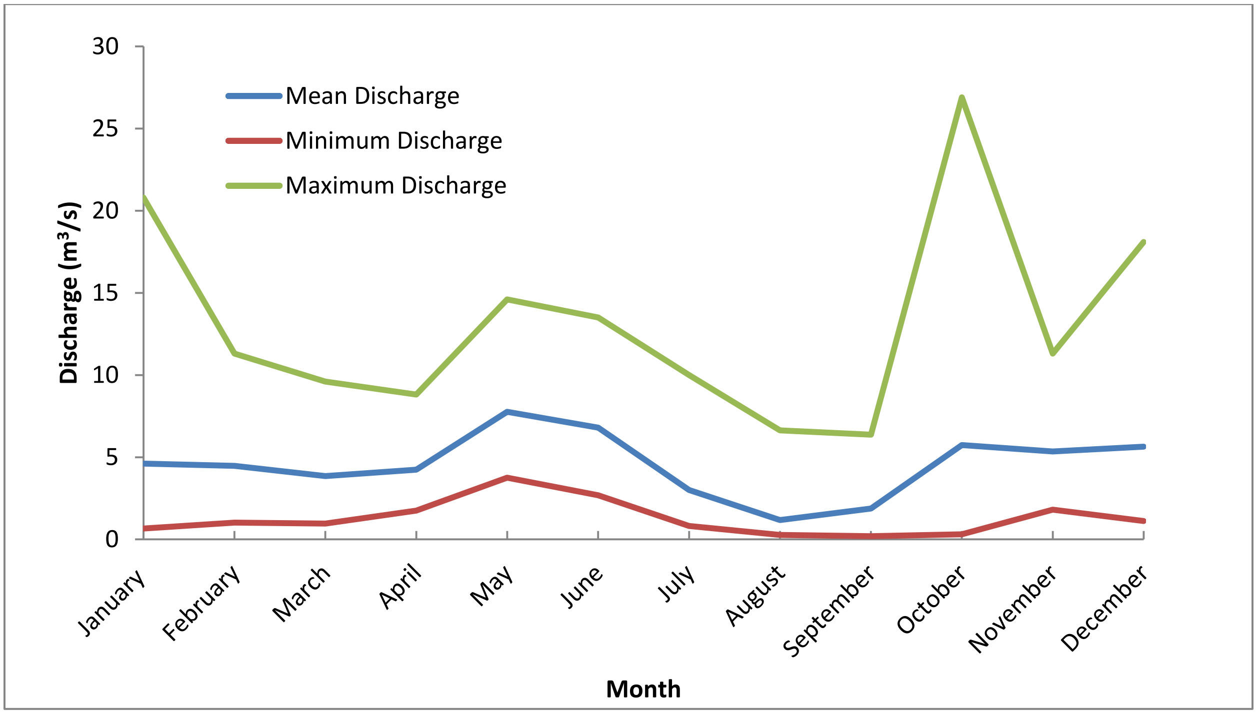


Figure 4: Chapman Creek Hydrograph (Station 08GA060)

Chapman and Reksten (1991) calculated flows for various low flow return periods for Chapman Creek at the station above the SCRD intake (08GA060) using data from 1970-1988. The results estimated the frequency of low flows in Chapman Creek for June 1 to September 30. The normal 7 day low flow was 0.21 m^3/s (i.e. with a 2 year return period) and the 7 day low with a 10 year return period was 0.06 m^3/s.

Table 1 provides the flow values for the summer months for the Chapman Lake watershed area estimated by prorating the Chapman Creek data by the proportion of the Chapman Lake watershed.

Table 1: Estimated monthly mean, maximum and minimum flow into Chapman Lake based on 1959 – 1988 data for Chapman Creek (calculated from Chapman and Reksten 1991 data)

Month	Discharge m^3/s		
	Mean Flow	Maximum	Minimum
May	1.03	1.95	0.50
June	0.91	1.80	0.36
July	0.40	1.33	0.11
August	0.16	0.88	0.04
September	0.25	0.85	0.03
Annual	0.604	0.91	0.39

The existing capacity for Chapman and Edwards Lakes has been demonstrated to be limited based on the conditions during the summer of 2015. Continuous, controlled water release from Chapman Lake began on May 30th and the lake was down to -2.9 m by August 5th. Had the proposed gravity release system been in place in 2015 and SCRD had not gone to stage 4 water restrictions and the ongoing release from Chapman Lake followed the same rate as the 10 days prior to the start of stage 4 (average 3.5 cm per day), Chapman Lake would have been lowered to -3.8 m.

Using the minimum estimated inflows into Chapman Lake (Table 1), Table 2 provides an estimate of the amount of water that is available during low water conditions based on lowest recorded flows over 29 years of flow measurements on Chapman Creek. The estimated total amount of water available between June 1 and September 30 assumes that the lake is full on May 31.

Table 2: Estimate of total monthly flow into Chapman Lake under low flow conditions

Month	Low Flow m^3/s	Month Total m^3
June	0.36	933,100
July	0.11	296,600
August	0.04	107,100
September	0.03	77,800
Total		1,414,600 m^3
Current Available Storage (Chapman + Edwards)		1,696,000 m^3
Total Available water June 1 – Sept 30		3,110,600 m^3

The CRWP estimates that the current annual average daily water demand over the year for the Chapman Water System to be 14,300 m^3/day with summer demand ranging from 18,000 to 25,000 m^3/day. The fish flow 0.2 m^3/s amounts to 17,280 m^3 per day. Using an average summer demand of 21,000 m^3/day, the Chapman system would be able to supply 38,280 m^3 per day for approximately 81 days. This is considered a conservative estimate as it only accounts for the contribution from the Chapman and Edwards Lake areas of the Chapman Creek watershed and not the other 83% of the watershed that also contributes flow to lower Chapman Creek. However, to provide certainty of fish flows and drinking water supply in more severe drought conditions, i.e. 1 in 25 year drought access to additional water from Chapman Lake is required.

2.3 Meeting Future Demand

In 2013 the SCRD issued a Comprehensive Regional Water Plan to provide guidance for water conservation and system expansion to accommodate the growth identified in various Official Community plans through to the year 2036 (Opus Dayton Knight 2013). The CRWP evaluated the capacity of Chapman and Edwards Lakes to provide water through a 1 in 25 year return period drought, a level of service recommended by provincial guidelines for managing drought (MOE 2016). Analysis provided in the CRWP considered the projected population growth and associated water requirements under a scenario of intensive management of water demand through to 2036 (i.e. use of water metering). The scenario included a population growth of 2% per year and an average water usage of 480 litres per capita per day based on implementation of intensive demand management measures. Under this scenario the projected storage volume required to meet the water demand during a 1 in 25 year drought was 2,090,000 m^3 of water (Opus DaytonKnight 2013). This indicated that the Chapman system was 350,000 m^3 short of being able to meet the water demand in 2036 under drought conditions. Withdrawing another 350,000 m^3 of water from Chapman Lake would draw the lake down to approximately -4.5 m.

The CRWP also concluded that the existing storage in Chapman and Edwards Lakes was only capable of suppling water through a 1:21 yr. drought. This analysis was based on the existing per capita demand for water from the Chapman System. The SCRD is taking steps to reduce the water demand through the installation of water meters (to be operational in 2018), more rigorous application of a drought management plan and education. The water metering program is expected to reduce the existing demand by 25% (Opus DaytonKnight 2013). The current project to access additional water from Chapman Lake was developed to address this short fall over the short term while additional sources of drinking water were developed.

2.4 Climate Change

Climate change is an important consideration in the assessment of Chapman Lake being able to provide sufficient water in the future. A study by Staats (2014) indicated that the data suggests that the Chapman Creek watershed is shifting from a snowmelt dominated system to one more reliant on rain fall. The hydrologic analysis of the Chapman Creek watershed by Chapman and Reksten (1991) shows that the months with the highest mean flows are May and June, likely due to snow melt, however, higher maximum flows are reported for January and October, driven by rain and rain on snow events. In September 2016, Metro Vancouver released “Climate Projections for Metro Vancouver” which used various climate models to develop predicted changes in climate parameters such as temperature, precipitation, and snow pack by the years 2050 and 2080. AECOM has reviewed this report and provided a summary in the context of Chapman Lake which is provided in Appendix A. This report confirms the findings by Staats including the prediction for smaller snow packs by up to 50% by the year 2050, and longer and drier summers extending into September with increased rainfall in the fall, winter and spring months.

Chapman Lake responds relatively quickly to rainfall events, for example over 829,000 m^3 of water flowed into Chapman Lake over 4.5 days of rainfall to fill the lake quickly in the fall of 2015. This suggests that even under climate change rainfall will continue to fill the lake quickly in the fall and would keep it full through the spring months. The local rainfall weather station at Gower Point in Gibsons, the closest station with a long record of weather data collected by Environment Canada[1] shows evidence of decreasing summer rainfall. Figure 5 shows the rainfall from June through September for various time periods. The average July rainfall in the 2011 – 2016 period is 6% less than in the period from 1981 – 2010. August rainfall has decreased 11% over the same period. This supports observations from SCRD staff that summer conditions have been drier in recent years and flows in Chapman Creek have been lower.

The effect of the reduced base flow from a smaller snow pack resulting from climate change is difficult to quantify without stream and precipitation gauges in the upper reaches of Chapman Creek. This along with an average decrease in rain of 19% by 2050 and another 10% by 2080 during the summer period will result in what is currently considered to be a 1:25 year drought to occur more frequently. The analysis in Section 2-2 indicates that the current water supply will last for 81 days under low flow conditions. If the 19% reduction in rainfall estimated to occur with climate change is applied, the available water will drop to 66 days. The additional 1,000,000 m^3 of water available in the lake if it is drawn down to -8 m would extend the water supply for another 26 days for a total of 92 days of water available under extreme drought conditions.

[1] *http://climate.weather.gc.ca/historical_data/search_historic_data_e.html*

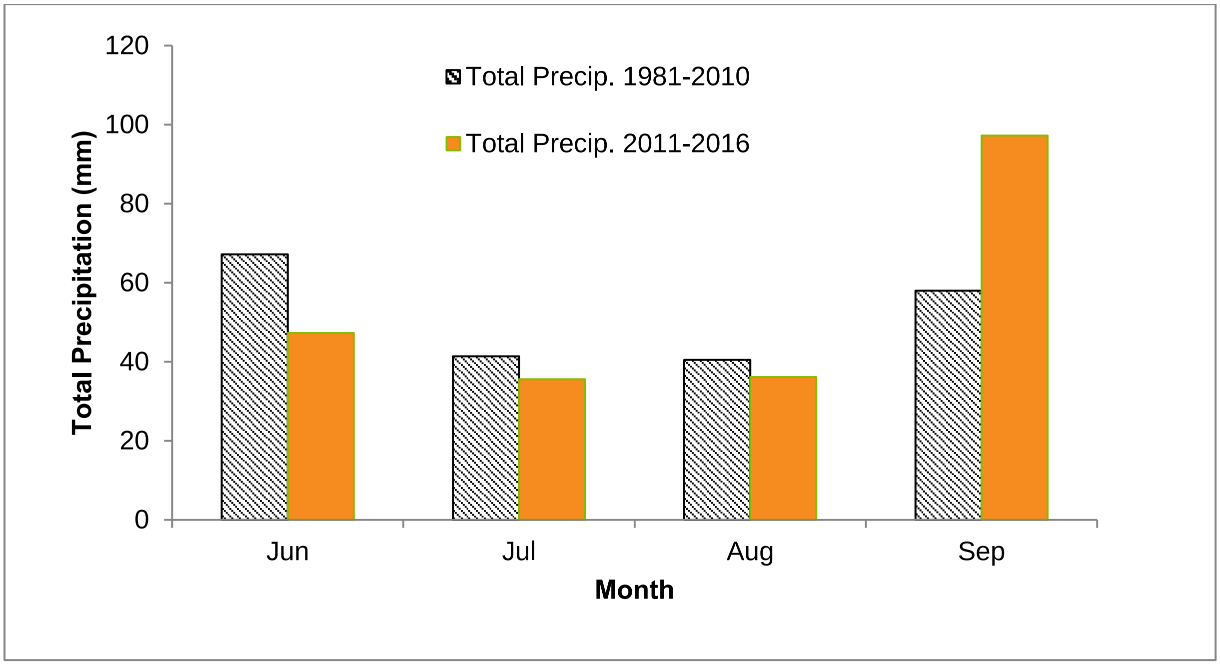


Figure 5 Precipitation recorded at Gower Point Gibsons from 1981 - 2016 (from Environment Canada)

While climate change is predicted to further reduce the available water supply that can be provided by Chapman Lake during summer conditions, the predicted values used here are not expected to be reached until 2050. Also, the analysis provided has been done conservatively using current low flow levels, assuming no contribution of water from the rest of the Chapman Creek watershed and without any efforts to reduce the water demand on the Chapman Water System.

2.5 Summary

The CRWP has predicted that the current Chapman Creek system does not have sufficient capacity to meet demands under drought conditions. This was evident in 2015 when the SCRD was required to implement Stage 4 water restrictions. There is some evidence that the drought in 2015 was much more severe than the 1 in 25 year condition assessed in the CRWP. A study of drought conditions on St Mary Lake on Salt Spring Island estimated that the return period of the 2015 drought was in excess of a 1 in 100 year event (Hodgins 2015). Had the SCRD been able to draw water out of Chapman Lake below the -3 m level, analysis suggests that the lake would have been drawn down to -3.8 m in 2015. Climate change analysis indicates that conditions could get more severe with drier, warmer summers but there will be plenty of water over the rest of the year to refill the lake should significant summer drawdown be required to satisfy water demand during droughts. The analysis presented here used predicted conditions in 2036 and 2050 but the SCRD continues to carry out the recommendation in the CRWP which includes the development of additional water supply and storage in order to meet the projected population growth through to 2036. While future conditions will increase the possibility of drawing Chapman Lake drawn to -8 m, the 2015 experience and the CRWP analysis of 2036 drought conditions suggest that the drawdown of -4 m to -5 m will be sufficient to meet 1:25 year drought conditions. However, for purposes of this assessment it will be assumed that a full 8 m draw down could occur on a frequency of 1 in 25 years.

3. Project Description

3.1 Plan

In order to access additional water during times of drought the SCRD has chosen to augment the existing outlet infrastructure at Chapman Lake by adding a gravity fed system. This includes a 900 mm diameter, 210 m long pipe buried beneath the existing outlet channel. The pipe intake would be located at an elevation of 966 m or 8 m below the current “full” water elevation of the lake (974 m). The pipe will be installed using an open cut excavation in the existing soil and bedrock complete with cutting through the existing concrete outlet weir. With the proposed new intake pipe installed at a deeper location SCRD will have access to another 1 million m^3 of water. Drawings of the proposed layout are provided in the Drawings section of the report.

The new 900 mm dia. pipe will be fitted with a T–shaped intake providing two openings to keep intake velocities to a minimum (Drawing C-103). The two 1.9 m diameter intakes will be fitted with a 25 mm open area trash rack. Calculations indicate that the velocity around the intake will be 0.14 m/s for this configuration. The objective of this design is to reduce velocities that would pull debris toward the intake and entrain the fish that could be present. The cover is intended to prevent sticks and debris from entering the diversion pipe, while minimizing the opportunity for plugging.

The existing 3 m deep outlet structure will be maintained and the deeper outlet will be located just to the left (looking downstream as shown on drawing C-100) with a separate valve and operating mechanism. As shown on the drawings, the channel downstream of the outlet will be deepened to receive the water from the low level pipe. The discharge channel will be extended approximately 25 m downstream and will provide a 2 m deep pool at the base of the 8 m high dam. The pool will provide protection to fish that pass over the weir

The control of the flow from Chapman Lake will be achieved with 2 valves located on the cast-in-place concrete weir wall constructed at the existing outlet of the lake. The existing -3 m control valve and water supply channel will be maintained and used as the primary mechanism for the controlled release of water from Chapman Lake. Once the water levels drop below - 3 m a new valve located at the outlet of the 900 mm diameter diversion pipe will be opened. This valve will control the flow of water through the new 900 mm diameter diversion pipe that will allow water access to the available water down to -8 m.

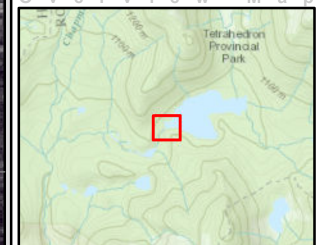
Downstream of the existing weir the plan is to enhance the existing channels to provide defined flow paths during the overflow events and the operation of both the -3 m and -8 m diversion valves. During the overflow events the water will be diverted into a plunge pool. The overflow plunge pool will also be the outlet for the -8 m diversion. The -3 m diversion and downstream channel will be maintained as a path for fish during the operation of this valve. The -3 m diversion channel will discharge into the -8 m pool prior to entering the existing Chapman Creek channel to ensure there is always flow within the plunge pool. This plan is intended to improve the current situation that results in fish being trapped in the pools downstream of the existing weir after overflow events.

Figure 6 identifies the existing Park Use Permit area and the additional area that will be required to construct the new intake. The yellow area is the extra space needed for construction, laydown and worker camp that represents a land area of approximately 1,500 m^2 and an in-lake area of approximately 11,700 m^2 for a total of 13,700 m^2 that would be required for the pipe installation

Legend

- Chapman Lake Current Park Use Permit Area (0.344 ha)
- Temporary Use Area (Approximate)

Overview Map



Basemapping from BING Online Imagery, Spatial Data from SCRD, 2015

0 10 20 30 40
Metres
1:1,500
NAD 1983 UTM Zone 10N

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced, or relied upon by third parties, except as agreed by AECOM and its client, as required by law, or for use by government agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

Temporary Chapman Lake Permit Area

10 November 2016

AECOM

Figure 6

3.2 Construction

Construction of the project is restricted due to weather and snowpack conditions. Typically there is considerable inflow to the lake through June. In order to carry out the construction the lake level must be lowered to install a coffer dam to dewater the outlet channel and allow the excavation necessary to install the pipe. Work must be completed prior to the start of significant fall rain which could have the potential to overtop the coffer dam. Considering these constraints the preferred construction schedule is from July 4 to September 30, 2016. The following is the general order of work within that 3 month period. This schedule is likely to change as the design work is advanced and more details on the preferred construction methods are developed:

- The SCRD would open the existing -3 m outlet in April/May, 2017.
- Site clearing and set up of a construction camp for approximately six people in mid-June.
- Establish a laydown area to store and maintain equipment, fuel, waste management facilities, etc.
- Install the syphon system to bypass water around the existing outlet channel to maintain flow in Chapman Creek by June 15th.
- Once the lake is down to -3 m an initial coffer dam will be established at Sta 0+100 (Drawing C-101). Specific details of the coffer dam will be left up to the successful contractor but it is anticipated that something like a Portadam will be used (see Appendix B) that does not require the use of large volumes of material.
- Once the area is isolated from the lake, work will begin on the dam, and the low level outlet channel, expected to start on July 1, 2017.
- It is expected that the coffer dam will be moved a few times during the course of the project as the water level is lowered in Chapman Lake in order to move it out beyond the intake location to complete the installation of the pipe. The pipe excavation will start at the existing weir and move toward the middle of the lake. In order to install the intake end of the pipe the lake may have to be drawn down below the -8 m level depending on the type of coffer dam used.
- During this past summer a seismic survey was completed to determine the approximate location of the bedrock without completing test drilling or digging test pits. The seismic survey determined that the bed rock is expected to be roughly 0.5 m below the existing soil surface. During construction the soil overburden will be stripped and stockpiled. The stockpiled overburden will be used for pipe bedding and surround. The trench rock will be blasted to a depth upwards of 7 m to install the low level outlet pipe. Blast rock will be used to infill the trench and to armour the -3 m channel leading to the outlet. Drawing C-103 provides details of the trench.
- The majority of the trench excavation for the diversion pipe will consist of bedrock blasting. The rock blasting will be completed in small controlled blasts that comply with the DFO guidelines. The blasted rock will be used for the trench backfill. Screened, clean blast rock will be used to amour the surface of the channel.
- Material removed from the trench will be used to backfill the trench and re-establish the existing channel at a -3 m elevation (relative to full pool level). Excess material from the trench will be spread along the side and top of the existing channel and graded to match the existing land. This will be completed to allow the channel at the -3 m elevation to be used in the future as the primary point of diversion during the summer months. The channel will be connected to the existing weir wall that contains the existing -3 m diversion valve on the north side of the Chapman Lake outlet. This will allow the existing -3 m diversion and channel at the outlet of Chapman Lake to be retained.
- Downstream of the existing weir the plan is to enhance the existing channels to provide defined flow paths during the overflow events and the operation of both the -3 m and -8 m diversion valves. During the overflow events the water will be diverted into a plunge pool. The overflow plunge pool will also be the outlet for the -8 m diversion. The -3 m diversion channel will discharge into the -8 m pool prior to

entering the existing Chapman Creek channel to ensure there is always flow within the plunge pool. This plan is intended to improve the current situation that results in fish being trapped in the pools downstream of the existing weir after overflow events. The plunge pool is the point of discharge for the -8 m diversion pipe that will be used during situations when the water level in Chapman Lake is less than 3 m below the weir elevation.

- The existing weir wall will be strengthened to meet the current dam standards once the rock blasting for the installation of the 900 mm diameter -8 m diversion pipe is completed. The new weir will be constructed with cast-in-place concrete.
- Substantial completion is expected by September 15th, 2017.
- A site restoration plan will be prepared to restore the camp, laydown and excavation areas and the banks of the outlet channel. The restoration plan will include the use of native grass seed and the planting of trees and shrubs as appropriate. A comprehensive restoration plan will be developed as described in Section 7.0.

3.3 Operation

As indicated the SCRD Board has passed a resolution that committed to only drawing water from below the existing operating level (-3.0 m) to avoid stage 4 water restrictions during times of drought. The SCRD's Drought Management Plan has identified four stages of increasing restriction of water use. The first stage automatically goes into effect on May 1. Subsequent restrictions are imposed based on the evaluation of a set of criteria and guidelines used to assess risk of drought or water shortage. In determining increases to restriction to Stages 2, 3 and 4 the SCRD considers the following:

- Time of year and typical seasonal trends;
- Snow pack assessments and snowmelt forecasts;
- Storage volume of water sources and draw down rates;
- Stream flows and monitoring data;
- Weather, recent conditions and short and long term forecasts;
- Water usage, recent consumption and trends; and,
- Water supply system performance.

Withdrawing water below -3.0 m will not occur unless drought conditions have required Stage 3 restrictions and weather forecasts indicate that conditions will persist and the lake will not be recharged by rainfall. Sufficient water will be released through the low level outlet to meet the current requirements to protect fish and to service the community. The current operation requires sufficient flow to be released from Chapman Lake to maintain an instream flow for fish of 0.3 m^3/s below the SCRD intake which can be reduced to 0.2 m^3/s during the summer dry season with an additional amount added to meet the SCRD water demands which typically requires a total flow release from Chapman Lake of approximately 0.44 m^3/s to 0.55 m^3/s.

4. Aboriginal Consultation and Public Participation

4.1 Introduction

The BC Parks Impact Assessment User Guide describes Ministry expectations in terms of Aboriginal consultation and public participation at various levels of review:

Level 2, Detailed Screen

At this level, potential public issues should already have been identified.

Further consultation may be required in certain circumstances. For example:

- if new issues are identified in the Detailed Screen or if previously identified issues require elaboration
- the public may be contacted as a source of more detailed information on protected area values or human uses in the area of the proposed action
- the public may be contacted if any specific issues are found to have significant impacts that may potentially affect interest groups or the general public.

If a proposed action is approved at this stage, or if the action requires further evaluation (through a full impact assessment), the responsible officer should identify any recommendations for public consultation as part of the decision statement for the Detailed Screen.

Level 3, Full Impact Assessment Report

This level of assessment requires considerably more public consultation. At a minimum there will be public notification regarding the proposed action. The public involvement program should be appropriate to the scale and complexity of the assessment. The parameters and objectives of the public involvement program should be defined in the terms of reference for the study (BC Parks Impact Assessment Part 2, User Guide, Appendix 6, 1999)

The BC Parks Tetrahedron Park Management Plan further states:

> …with respect to the SCRD's need to enhance its water system infrastructure/water use of the Chapman/Gray Creek watersheds within the park for future community water supply. A public consultation process to review any options proposed by government that may affect the existing park designation will be implemented… (BC Parks Tetrahedron Park Management Plan 1997)

Clarification of Aboriginal consultation and public participation requirements for the Project was provided in BC Parks Regional Director's correspondence of June 6, 2016 with SCRD Infrastructure Department General Manager. The correspondence considers whether letters of support can be obtained from the shíshálh (Sechelt) Nation and Skwxwú7mesh Úxwumixw (Squamish) Nation to confirm their interests have been addressed, while expressing interest in having the SCRD hold additional meetings with stakeholder groups to address concerns regarding the Project.

Aboriginal consultation and public participation related to the current Project continues the SCRD's extensive Aboriginal and public engagement activities initiated prior to adoption of a Comprehensive Regional Water Plan in 2013.The following SCRD Chapman Lake Water Supply Expansion Project Activity and Issues Tracking Table is based on implementation of the Project's Aboriginal Consultation and Public Participation Plan (March 2016. See Appendix C). Implementation of the Plan included production and distribution of a plain-language Information Package and accompanying map (updated June 2016. Appendix C). Drafts of the Park Use Permit amendment application and supporting environmental assessment report for the Project were also distributed to the shíshálh (Sechelt) Nation and Skwxwú7mesh Úxwumixw (Squamish) Nation for review.

4.2 Activity and Issues Tracking Table

The following provides a summary of Aboriginal Consultation and Public Participation for the SCRD Chapman Lake Water Supply Expansion Project.

Table 3: Summary of Aboriginal Consultation and Public Participation

Date	Activity	Summary / Issues Raised
Aboriginal Consultation - shíshálh Nation (Sechelt Nation)		
February 2016 (multiple dates)	Email correspondence and phone conversations – planning / logistics	Request for meeting with shíshálh Nation to initiate Aboriginal consultation process
15 March, 2016	Email correspondence with shíshálh Nation Rights and Title staff	Detailed background information on the Project including: • Sechelt Indian Band Rights and Title Application Form • Chapman Lake Project – Draft Information Package • Chapman Lake Project – First Nations Territories Map • Draft Aboriginal Consultation and Public Participation Plan • Correspondence with BC Parks re: Park Use Permit application process 3 March 2016 • Chapman Lake Storage Project Impact Assessment Report (Whitehead 1999) • Excerpt from Whitehead Report on Cultural Values (1999) • Bates Report on Low Summer Flows in Chapman Creek (2015) • SCRD Infrastructure Reports to Board re: Preferred Option (September 2016)
18 March, 2016	Meeting with shíshálh Nation Rights and Title staff and consulting aquatic biologist	Introduction to Project and discuss draft public participation and technical information packages and project description • Request that archaeological Preliminary Field Reconnaissance be undertaken to supplement Archaeological Overview Assessment • Appropriate protections and mitigation measures to protect Chapman Creek aquatic resources • Deepening of channel considered short-term solution; interest in longer-term development of engineered lake water storage as part of SCRD Comprehensive Regional Water Plan (CRWP) • Interest in protection of rare plants during construction activities • Discussion of including shíshálh Nation consulting biologist in Park Use Permit amendment and environmental assessment report review • Request for information to refresh Chief and Council's knowledge of CRWP

Date	Activity	Summary / Issues Raised
22 April, 2016	Email correspondence with shíshálh Nation Rights and Title staff	Revised electronic copy of the draft Park Use Permit amendment application incorporating comments and recommendations made by Dave Bates (shíshálh Nation's consulting aquatic biologist)
26 April, 2016	Email correspondence with shíshálh Nation Rights and Title staff	SCRD General Manager provided information on the CRWP as requested
31 May, 2016	Chapman Lake project site visit with shíshálh Nation Rights and Title staff, Director of Lands and Resources and consulting archaeologist, together with SCRD and BC Parks representatives	
3 June 2016	Email correspondence from shíshálh Nation Rights and Title staff to SCRD Infrastructure Department	Request by shíshálh Nation Rights and Title staff for original photos of original water supply project footprint at Chapman Lake
4 July, 2016	Phone call by SCRD Infrastructure Department General Manager with shíshálh Nation Rights and Title staff	Enquiry to confirm the shíshálh Nation Rights and Title staff have sufficient information to complete their report to Chief and Council re: Project recommending support / non-objection
31 August 2016	Email correspondence with shíshálh Nation Rights and Title staff	Request for information on additional environmental field studies; schedule of studies; proposed timing of additional draw-down of Chapman Lake if required during a drought period. Information was provided by the SCRD Infrastructure Department
November 3, 2016	Meeting with shíshálh Nation Rights and Title staff and SCRD Infrastructure Department staff	Follow-up meeting to review the results of additional environmental field programs and letter of support / non-objection for the Project
Aboriginal Consultation – Skwxwú7mesh Úxwumixw Nation (Squamish Nation)		
February 2016 (multiple dates)	Email correspondence and phone conversations – planning / logistics	Request for meeting with Skwxwú7mesh Úxwumixw Nation to initiate Aboriginal consultation process
1 March, 2016	Conference call with Skwxwú7mesh Úxwumixw Nation Chief, Executive Assistant and land use / archaeological consultant	Brief introduction to project. (water supply storage at Chapman Lake lies outside of Skwxwú7mesh Úxwumixw Nation territory; Chapman Lake water system provides water to Sunshine Coast residents east of Roberts Creek within Skwxwú7mesh Úxwumixw Nation territory) Request for more detailed information for review Potential interest in flow rates in relation to Chapman Creek Hatchery
22 March, 2016	Email to Úxwumixw Nation Executive Assistant and consultant	Public participation and technical Information Packages provided to Skwxwú7mesh Úxwumixw Nation for review
29 March, 2016	Follow-up email to Úxwumixw Nation Executive Assistant and consultant requesting meeting to discuss project	Response pending
6 April, 2016	Follow-up email to Úxwumixw Nation Executive Assistant and consultant requesting meeting to discuss project	Response pending

Date	Activity	Summary / Issues Raised
19 April, 2016	Email correspondence from Skwxwú7mesh Úxwumixw Nation consultant	Request for clarification on: • whether there would be reduced flows that would have any negative impact on the Chapman Hatchery downstream of the lake later in the summer • due to climate change concerns, are any plans being made to have water conservation or capture to supplement residential requirements to reduce the need to draw from the lake
22 April, 2016	Email to Skwxwú7mesh Úxwumixw Nation consultant	Response to email correspondence 19 April, providing electronic copies of SCRD park use permit for Chapman Lake (installation of syphon) from BC Parks and Park Use Permit amendment application (deepening of channel; pipe installation and valve system) to BC Parks for review, as well as clarification regarding issues raised. • Indication of Skwxwú7mesh Úxwumixw Nation support or non-objection for the Project requested Response pending
Public Participation		
16 February, 2016	SCRD General Manager interview with CFUN Mountain FM re: Chapman Lake Project	Water management strategy, activities and details of the proposed Chapman Lake water supply expansion project. The interview included water demand strategies and implementation of universal metering; discussion of water restrictions in 2015.
18 March, 2016	Informal meeting in Gibsons with representatives from the Sunshine Coast Conservation Association, Tetrahedron Park Outdoors Club, Tetrahedron Alliance, Tuwanek Ratepayers Association	Introduction to the Project and wide-ranging discussion. Project plain-language Information Package and map distributed, as well as providing requested electronic copy of the environmental assessment produced for the Chapman Lake floating pump option (Whitehead, 1999). Issues raised included: • An interest in diversifying the Sunshine Coast's sources of water supply • The detrimental effects of drawing down Chapman Lake during periods of drought • Imposition of water restrictions earlier to encourage reduced water usage • Whether adequate flow rates were maintained for the Chapman Creek Hatchery • Whether SCRD financial resources should be spent on universal metering program • Tetrahedron Park's three pillars: regional water supply, biodiversity and recreation
30 March 2016	Teleconference discussion with Chapman Creek Hatchery General Manager	Discussion of flow rates in Chapman Creek and ongoing efforts made by the SCRD to maintain flow rates adequate for the hatchery and fish stocks in Chapman Creek
5 April 2016	Teleconference discussion with Ruby Lake Lagoon Nature Reserve Society Executive Director	Based on the Executive Director's training as a limnologist with 45 years of experience, discussion of the "literal fringe" of lakes, suggesting the this area is "dynamic and resilient" with few resident species.
8 April 2016	Teleconference discussion with Vancouver Coastal Health's Drinking Water Officer	Discussion of the importance of the adequate water supply and permitting requirements for expansion of the Sunshine Coast's water supply
13 April 2016	West Howe Sound Community Association Meeting	SCRD Infrastructure presentation; Question and Answer session

Date	Activity	Summary / Issues Raised
24 April 2016	Earth Day event – Roberts Creek	SCRD Booth and discussion with public re: water strategy, activities and Chapman Lake Water Supply Expansion Project
26 April 2016	Sunnycrest Mall	SCRD Booth and discussion
28 April 2016	Trail Bay Mall	SCRD Booth and discussion
29 April 2106	Email correspondence from Tetrahedron Park Outdoors Club member with Chair of Tetrahedron Advisory Council (TAC) re: Project prior to TAC Meeting 9 May 2016	Issues raised included: • Protection of ecological mix • Importance of Tetrahedron Park in protecting biodiversity • Creation of park, recognizing the role of Chapman Lake in providing the Sunshine Coast's water supply, with provision for draw-down during periods of drought • Provision for further modification to manage further water supply requirements if there were no better options • Climate change • SCRD inaction on development of long-term water supply management system / dependency on one creek • SCRD has done no population growth analysis • SCRD has done no aquifer analysis • SCRD has not considered reservoir creation outside of Chapman water system • SCRD has provided no backyard water collection subsidies • SCRD does not implement mandatory prohibition of lawn and driveway watering • SCRD have implemented a universal metering system but there is no redundancy in the system • Increased dependency on Chapman system is short-sighted – an engineering cheap fix
30 April 2016	*Spring in Sechelt* Community Event	SCRD Booth and discussion
3,4,5, May 2016	Chapman Water Treatment Plant	School tours
6 May 2016	Chapman Water Treatment Plant	Public tours
9 May, 2016	Tetrahedron Advisory Council (TAC) Meeting	(See April 29 email correspondence above) SCRD Staff not invited
10 May 2016	Sunnycrest Mall	SCRD Booth and discussion
10 May 2016	Egmont Community Meeting	SCRD Infrastructure presentation; Question and Answer session
11 May 2016	Elphinstone Community Association Meeting	SCRD Infrastructure presentation; Question and Answer session
12 May 2016	Sandy Hook Community Association Meeting	SCRD Infrastructure presentation; Question and Answer session

Date	Activity	Summary / Issues Raised
16, 17, 18, 19, 24, 25 and 26, May 2016	SCRD Community Dialogue Sessions (various locations in the Regional District)	The public's main area of interest was water supply management and the Chapman Lake Water Supply Expansion Project. Key concerns raised: • Inadequate water supply and too much reliance on water demand management (i.e. metering) – balanced by discussion of the SCRD's water supply expansions efforts • Cost of water metering and impact on rates • Water rate structure design, particularly concerns regarding not penalizing young families and food production
9 June, 2016	SCRD Infrastructure Committee	Presentation and public meeting with AECOM Project staff providing SCRD directors and the public an opportunity to ask questions regarding the Project
June 10 2016	Notice of Alternative Approval Process for financing of Chapman Lake Water Supper Expansion Project	Deadline for submission of elector response form July 26, 2016
18 June 2016	Home and Garden Show	SCRD Booth and discussion
21 June 2016	Sechelt Community Association Board	SCRD Infrastructure presentation; Question and Answer session
22 June 2016	Roberts Creek Community Association	SCRD Infrastructure presentation; Question and Answer session
25 June 2016	Children's Festival - Gibsons	SCRD Booth and discussion
June 2016	Notice of Alternative Approval Process	Deadline for submission of elector response form July 26, 2016
1 July 2016	Canada Day - Sechelt	SCRD Booth and discussion
13 July 2016	Additional Chapman Lake Water Supply Expansion Project information uploaded to the SCRD website	SCRD Water Supply Expansion Project Fact Sheet and Frequently Asked Questions document during Alternative Approval Process
10 July 2016	Halfmoon Bay Country Fair	SCRD Booth and discussion
23 July 2016	Sea Cavalcade	SCRD Booth and discussion
28 July 2016	SCRD News Release	"Chapman Lake Supply Expansion Project to Proceed With Elector Approval"
13,14 August 2016	Sunshine Coast Arts Council Fair	SCRD Booth and discussion
26,27 August 2016	Rogue Festival	SCRD Booth and discussion

4.3 Aboriginal Consultation and Public Participation Summary Outcomes

As indicated by the Activity and Issues Tracking Table above, the SCRD has actively engaged with and encouraged public participation by Sunshine Coast residents through a variety of events and forums throughout spring and summer 2016. Supplementing water supply and demand discussions provided during Community Dialogue Sessions in various locations in the region, the SCRD posted information on the Project on its website, including an Information Package and Frequently Asked Questions document. An Alternative Approval Process for financing of the Project was successful in late July.

Further discussions with affected Aboriginal communities (the shíshálh Nation and Squamish Nation) are anticipated pending results of additional environmental studies requested by BC Parks and undertaken in August. Following review of the draft Park Use Permit and amended environmental assessment report the SCRD anticipates receiving First Nations' response in short order.

5. Current Conditions

5.1 Geology

5.1.1 Bedrock Geology

5.1.1.1 Regional Overview

The oldest rocks of the Chapman Lake area belong to the upper Triassic Vancouver group-Karmutsen Formation. This formation is dominated by mafic volcanic flows; associated basaltic breccias and high level mafic dikes and small mafic intrusive pods. The Karmutsen Formation is intruded and partially enveloped by late Jurassic to Cretaceous dioritic intrusive rock, which is mainly composed of quartz diorite and granodiorite.

According to the MINFILE database, the Thornhill Creek limestone occurrence is located within five kilometers of Chapman Lake, on the southeast side of Salmon Inlet. Locally, a mass of white, crystalline limestone is reported to occur. The deposit is situated near the north end of a 6-kilometre long pendant of andesitic to rhyodacitic flows and pyroclastics, greenstone, argillite and schist of the Lower Cretaceous Gambier Group lying in quartz diorite of the Tertiary-Cretaceous Coast Plutonic Complex.

5.1.1.2 Chapman Lake Watershed

Chapman Lake lies within an area of granite rock of the late Jurassic and early Cretaceous ages (156 to 114 million years old). Coastal watersheds underlain by rock types such as quartz diorite tend to be slightly acidic due to the low buffering capacity of these rocks and the natural low pH of rainfall (McKeown et. al., 2002; Triton, 2006).

The dominant soil-types within the Chapman Lake watershed contain large concentrations of organically combined iron and aluminum in their subsoils (Carson, 1999; Whitehead, 1999). In poorly-drained soils on the Tetrahedron Plateau organic matter is not broken down as quickly as in areas of well-drained soils, which means that organic and clay colloids and aluminum and iron compounds are common elements in the water supply and characterize the natural water quality in this area (Triton, 2006).

5.1.2 Generation of Acid Rock Drainage and Metal Leaching

In the natural environment, rocks are broken down into soil through exposure to air and water in a process called weathering. During weathering, minerals react with air and water to release some of their constituents (ions) into the surrounding aqueous environment. In many cases, the primary minerals are transformed into secondary residual minerals during this process. The ions that go into solution may be transported away by runoff, streams, and groundwater and therefore have a large influence on water quality. If a rock is buried beneath other rocks and soil, it naturally weathers very slowly. However, when it is excavated during construction or mining, the weathering process can increase substantially because previously unexposed rocks are broken up and exposed to rain, snow and air at the surface.

5.1.2.1 Acid Rock Drainage

Some rocks contain minerals that can produce acid during weathering. The resulting acidic water is known as "acid rock drainage" or ARD. The most typical and strongest acid-generating mineral is pyrite (FeS_2), which forms sulfuric acid (H_2SO_4) when it reacts with oxygen and water during weathering:

$$FeS_2(s) + 15/4\ O_2 + 7/2\ H_2O = 2\ H_2SO_4 + Fe(OH)_3(s)$$

The oxidation of pyrite is a complex process involving a series of redox reactions, hydrolysis, and complex ion formations. The process also tends to release associated heavy metals into solution. Other sulfides and a few other types of minerals can also form acid, but to a lesser extent. The acid-generation potential (AP) of a rock is the total capacity of that rock to generate acid if all of its acid-generating minerals react to completion during weathering.

Typically, rocks are predicted to be potentially acid generating (PAG) or not potentially acid generating (non-PAG) based on the relative amounts of constituent minerals that can form acid and those that can neutralize acid. The best and most common acid neutralizing mineral is calcite, which is calcium carbonate ($CaCO_3$) (Price 2009):

$$CaCO_3(s) + H_2SO_4 = Ca^{2+} + SO_4^{2-} + H_2O + CO_2\ (g)$$

Other carbonates, including dolomite [$CaMg(CO_3)2$] and ankerite [$Ca(Fe,Mg,Mn)(CO_3)2$] can also neutralize acid to varying extents. In contrast, siderite ($FeCO_3$) is not considered to have neutralization potential, due to its iron content, unless it has magnesium or calcium substituting for some of the iron. Similar to the definition of AP, the acid-neutralization potential (NP) of a rock is its total capacity to neutralize acid if all its carbonate minerals react to completion.

5.1.2.2 Metal Leaching

Elevated ML is most commonly associated with ARD due to the high solubility of many metals under acidic conditions. However, some other constituents, including metalloids that form oxyanions such as arsenic, selenium, and molybdenum, and salts such as sulfate, can be released into the environment even if the water draining the rock has a neutral or basic pH (e.g., Smith 2007).

The task of geochemical characterization at a proposed excavation site is to identify the potential of rocks to produce ARD and/or ML that could affect water quality in surface water and/or groundwater.

5.1.2.3 Sample Collection and Rock Description

One rock sample was collected and submitted to Maxxam Analytics in Burnaby, British Columbia for geochemical analysis. The rock sample was collected from exposed rock at the base of the existing dam on May 31, 2016.

The rock was highly weathered and covered with algae and/or aquatic organisms. It is classified as mudstone, which is evident from its black color and very fine grain size. It appears that the limestone has been partially altered due to contact metamorphism, as indicated by the associated greenish colored rock that is inferred to be of intrusive volcanic origin.

5.1.3 Methodology

The rock sample was submitted to Maxxam Analytics Inc. for the following tests:

5.1.3.1 Whole Rock Analysis

Whole rock analysis is the determination of major element oxides of a rock sample. This will total approximately 100% in non-mineralized samples. The prepared rock sample is mixed with $LiBO_2/Li_2B_4O_7$ flux. Crucibles are fused in a furnace. The cooled bed is dissolved in ACS grade nitric acid and analyzed by ICP and/or ICP-MS. Loss on ignition (LOI) is determined by igniting samples then measuring the weight loss.

5.1.3.2 Total Recoverable Elemental Analysis

To determine “whole rock” concentrations of metals, samples were subjected to bulk geochemical analysis after digestion with aqua regia (HCl + HNO_3). This digestion is routinely used for analysis of trace heavy metals to allow quantification of the maximum potential reservoir of leachable metals. It also allows comparison of concentrations of selected constituents with average crustal abundance data for similar rock types. The digestion does not completely dissolve resistant minerals such as quartz, spinels, zircon, rutile, ilmenite, chromite, or some silicates. Thus, the concentrations of certain major rock-forming constituents including aluminum, calcium, magnesium, potassium, sodium, and iron may be under-reported by this method. The same is true for more weathering-resistant forms of zirconium, chromium, uranium, thorium, and vanadium.

5.1.3.3 Acid Base Accounting

Acid-Base Accounting (ABA) is the series of laboratory tests designed to estimate a rock’s acid potential (AP) and neutralizing potential (NP). The AP of a rock is the total capacity of that rock to generate acid if all of its acid-generating minerals react to completion during weathering. Similar to the definition of AP, the NP of a rock is its total capacity to neutralize acid if all its carbonate minerals react to completion. Both AP and NP are expressed in units of tons of calcium carbonate equivalent per 1,000 tons of material (t $CaCO_3$/kt) to allow direct comparisons. Corrections must be made when the respective minerals are not all pyrite or calcite.

The following tests were included in the ABA analysis:

- Paste pH
- To assess the acid generating status of sample at the time of sampling
- Neutralization Potential

A fizz test is employed to provide a guide to the amount of acid to be initially added to the test. NP is determined by treating a sample of known weight with excess hydrochloric acid at ambient temperatures for approximately 24 hours. Acid is added as required during the acid treatment stage to maintain sufficient acidity for reaction. After treatment, the unconsumed acid is titrated with base to pH 8.3 to allow calculation of the calcium carbonate equivalent of the acid consumed.

Sulphate Sulphur (HCl Extractable)

Sulphate sulphur is extracted from the sample with dilute hydrochloric acid and analyzed using the Konelab. Most sulphate containing minerals are soluble in HCl, but pyritic and organic sulfur species are not. Also, most sulphate minerals including gypsum and anhydrite are non-PAG. However, other minerals such as melanterite ($FeSO_4.7H_2O$) are considered PAG because they will release acid upon dissolution. Mineralogical analysis is used to distinguish between PAG and non-PAG sulphates.

Sulphide Sulphur (HNO_3 extractable)

The residue from the HCl extraction used to determine sulphate sulphur is subsequently extracted using nitric acid. This HNO_3 extract is boiled to dryness and dissolved into HCl to arrive at an extract with the same matrix as the HCl extract (approximately 5% HCl).

Acid Potential

To assess the samples acid-generation capacity. AP is determined from the calculated sulphide sulphur analysis, assuming (1) total conversion of sulphide to sulphate, and (2) production of 4 moles of H+ per mole of pyrite oxidized, in which a conversion factor of 31.25 is used to convert percent contained sulphur to kg $CaCO_3$ equivalent per tonne of material (kg $CaCO_3$/T).

Carbonate Carbon Content

To allow estimate of reactive NP due to presence of carbonate minerals.

Neutralization Potential Ratio (NPR = NP/AP)

Most jurisdictions have a NPR criterion for classifying a sample as non-PAG or PAG. Price (2009) recommends the following classification:

NPR > 2: Sample is considered non-PAG

2 > NPR > 1: Test is inconclusive

1 > NPR: Sample is considered PAG

Net Neutralization Potential (NNP = NP – AP)

A sample is classified as PAG if its acid generation potential exceeds the acid neutralization capacity such that the NNP is a negative number. If a positive NNP value is less than +20 kg $CaCO_3$/T, the test is typically considered inconclusive. Price (2009) does not recommend using NNP in characterizing the future acid producing potential. However, it is potentially useful in mitigation design.

5.1.3.4 Shake Flask Extraction

The shake flask extraction (SFE) is applied to identify parameters potentially prone to leaching in the field.

Samples were shaken for 24 hours at 3:1 water to solids ratio by weight with reverse osmosis deionized (RODI) water. Gentle agitation is provided to ensure continuous exposure of all surfaces and mixing of the rinse solution. Twenty-four hours is a nominal residence time.

5.1.4 Results and Discussion

5.1.4.1 Types and Occurrence of Minerals

Table 4 presents the results of the Whole Rock Analysis of the Chapman Lake rock sample. These amounts represent the relative amounts of major element oxides of a rock sample and normalized to 100%.

The Chapman Lake rock sample is mainly composed of quartz (SiO_2), hematite (Fe_2O_3) and Ca/Mg minerals. The CaO and MgO may be derived from fragments of plagioclase and feldspar. Limestone and/

calcite are also a potential source of CaO and MgO, as these minerals are a common cementing agent in shale and sandstone.

Table 4: Results of Whole Rock Analysis – ICP

Sample ID		Chapman Lake
Depth (m.b.g.s)		0.00
Lithology Description		Mudstone
Weathering		Moderate (II)
Major Element Oxides Composition	**Unit**	**Value**
SiO_2	%	42.8
Al_2O_3	%	13.2
Fe_2O_3	%	11.4
MgO	%	8.91
CaO	%	16.2
Na_2O	%	1.4
K2O	%	1.4
TiO_2	%	1.1
P_2O_5	%	0.1
MnO	%	0.2
Cr_2O_3	%	0.157
Ba	ppm	237.0
Ni	ppm	279.0
Sr	ppm	243
Zr	ppm	75
Y	ppm	15
Nb	ppm	11
Sc	ppm	35
LOI	%	3
Total	%	99.88

The high quartz content (42.8%) is consistent with the mudstone classification. Sedimentary rock usually exhibits a high quartz content because quartz is one of the most abundant minerals in the exposed continental crust. It is an extremely hard, resistant and chemically stable mineral. The low content of potassium (K_2O) indicates that potassium (K)-feldspar has been weathered from the parent rock.

5.1.4.2 Total Recoverable Elemental Analysis

The Total Recoverable Elemental Analysis was conducted to quantify of the maximum potential reservoir of leachable metals. Laboratory concentrations of selected constituents were compared to five times the average crustal abundance data (Price, 1997) for similar rock types (i.e., Shale and Deep-Sea Clay Sediment) to identify metals that are locally elevated.

Table 5 presents the concentrations of a number of constituents from the aqua-regia digestion of the Chapman Lake sample, as well as the average crustal abundances of those constituents in Shale and Deep-Sea Clay. In most cases, the values for both reference data sets were similar, with the exception of silicon. Deep-Sea Clay contains concentrations of silicon (25%) that are approximately 3.5 times higher than those found in Shale (7.3%).

In order to estimate element enrichment in the Chapman Lake sample, a screening criterion was developed by multiplying the crustal abundance values by a factor of five, which is commonly applied in ML/ARD assessments. No elements were found to be present at concentrations above the five times crustal abundance screening criterion for Shale and/or Deep-Sea Clay.

Table 5: Comparison of Total Recoverable Constituents to Crustal Abundance – Chapman Lake

Parameters	Units	Crustal Abundance in Rocks from Price (1997)				Chapman Lake
		Shale[a]	Shale x5 [b]	Deep-sea Clay[a]	Deep-sea Clay x5[b]	
Aluminum (Al)	%	8	40	8.4	42	1.97
Antimony (Sb)	ppm	1.5	7.5	1	5	<0.1
Arsenic (As)	ppm	13	65	1	5	0.6
Barium (Ba)	ppm	580	2900	2300	11500	19
Bismuth (Bi)	ppm	-	-	-	-	<0.1
Boron (B)	ppm	100	500	230	1150	<20
Cadmium (Cd)	ppm	0.3	1.5	0.42	2.1	0.3
Calcium (Ca)	%	2.21	11.05	2.9	14.5	2.24
Chromium (Cr)	ppm	90	450	90	450	276
Cobalt (Co)	ppm	19	95	74	370	25.2
Copper (Cu)	ppm	45	225	250	1250	8
Gallium (Ga)	ppm	19	95	20	100	4
Gold (Au)	ppb	-	-	-	-	1.1
Iron (Fe)	%	4.72	23.6	6.5	32.5	2.27
Lanthenum (La)	ppm	92	460	115	575	<1
Lead (Pb)	ppm	20	100	80	400	3.7
Magnesium (Mg)	%	1.5	7.5	2.1	10.5	1.4
Manganese (Mn)	ppm	850	4250	6700	33500	400
Mercury (Hg)	ppm	0.4	2	-	-	<0.01
Molybdenum (Mo)	ppm	2.6	13	27	135	<0.1
Nickel (Ni)	ppm	68	340	225	1125	120
Phosphorus (P)	%	0.07	0.35	0.15	0.75	0.053
Potassium (K)	%	2.66	13.3	2.5	12.5	0.1
Scandium (Sc)	ppm	13	65	19	95	6.1
Selenium (Se)	ppm	0.6	3	0.17	0.85	<0.5
Silicon (Si)	%	7.3	36.5	25	125	-
Silver (Ag)	ppm	0.07	0.35	0.11	0.55	<0.1
Sodium (Na)	%	0.96	4.8	4	20	0.162
Strontium (Sr)	ppm	300	1500	180	900	60
Sulfur (S)	%	0.24	1.2	0.13	0.65	<0.05
Tellurium (Te)	ppm	-	-	-	-	<0.2
Thallium (Tl)	ppm	1.4	7	0.8	4	<0.1
Thorium (Th)	ppm	12	60	7	35	<0.1
Titanium (Ti)	%	0.46	2.3	0.46	2.3	0.109
Tungsten (W)	ppm	1.8	9	-	-	<0.1

Parameters	Units	Crustal Abundance in Rocks from Price (1997)				Chapman Lake
		Shale[a]	Shale x5 [b]	Deep-sea Clay[a]	Deep-sea Clay x5[b]	
Uranium (U)	ppm	3.7	18.5	1.3	6.5	<0.1
Vanadium (V)	ppm	130	650	120	600	43
Zinc (Zn)	ppm	95	475	165	825	84

Notes:

[a] *From Price (1997), Appendix 3*

[b] *Enrichment criteria based upon crustal abundance data multiplied by a factor of 5.*

Exceeds One Enrichment Criteria

Exceeds Two Enrichment Criteria

Lower limit of detection exceeds criteria from both compilations.

Comparison of the results for the major silicate forming constituents including aluminum, potassium, sodium, and iron show that they are less than their average crustal abundance criteria, suggesting these nutrients may have been leached over time due to natural weathering processes. However, calcium and magnesium are comparable with the Shale and Clay crustal abundance, indicating that the rock sample may contain another calcium and magnesium-bearing mineral (i.e., calcite or dolomite cement).

Although silicon was not analyzed, the high SiO_2 content (42.8%) obtained from Whole Rock Analysis suggests that the composition of Chapman rock sample is more similar with Deep-Sea Clay derived sediments.

5.1.4.3 Acid Base Accounting

The risk of acid generation was determined based upon the NPR and total sulfide-sulphur content following the method described by Price (2009).

The results of ABA testing are presented in Table 6, and indicate that the Chapman Lake sample has an alkaline paste pH value, with no measurable sulfur (<0.02%), and high concentrations of neutralizing material. This resulted in an NPR value that is significantly greater than 2, and the Chapman Lake sample is classified as non-PAG.

Table 6: Acid Base Accounting (ABA) Results - Chapman Lake

Depth (m.bgs)	Lithology Description	Weathering	Paste pH	CO_2	$CaCO_3$ Equiv.	Total S	HCl Extractable Sulphur	HNO_3 Extractable Sulphur	Non Extractable Sulphur (by diff.)	Acid Generation Potential (AP)	Mod. ABA Neutralization Potential (NP)	Net Neutralization Potential NNP=NP-AP	Neutralization Potential Ratio NPR = NP/AP	Acid Generation Status
				wt%	Kg $CaCO_3$/T	wt%	wt%	wt%	wt%	Kg $CaCO_3$/T	Kg $CaCO_3$/T	Kg $CaCO_3$/T		
0.00	Mudstone	Moderate (II)	8.85	0.58	13.20	<0.02	<0.01	<0.01	<0.02	<0.3	25.00	> 24.70	> 83.33	Non-PAG

Notes:

*AP = HNO_3 Extractable Sulphide Sulphur*31.25*

$CaCO_3$ Equivalency = Carbonate Carbon (CO_2)(100/44)*10*

Mod. ABA Neutralization Potential - MEND Acid Rock Drainage Prediction Manual,
MEND Project 1.16.1b (pages 6.2-11 to 17), March 1991.

5.1.4.4 Shake Flask Extraction

The shake flask extraction (SFE) results are presented in Table 7. The results are compared to the Contaminated Sites Regulation (CSR), Schedule 6 water quality criteria for the protection of freshwater aquatic life, and the BC Approved and Working Water Quality Guidelines (BCWQG) for protection of freshwater aquatic life.

The CSR Schedule 6 numerical standards were developed for groundwater and generally assume a tenfold dilution factor to account for groundwater discharge to surface watercourses. BCWQG are the applicable surface water quality guidelines for ambient freshwater.

In general, the Chapman Lake sample produced low concentrations of easily leached constituents when subjected to the SFE analysis, which is consistent with the results of the total elemental analysis. None of the leached constituent concentrations exceeded CSR Schedule 6 Criteria. Cadmium, chromium and copper concentrations slightly exceeded the BCWQGs.

The results of the SFE analysis confirm the results of the ABA testwork in that the SFE leachate pH value is alkaline, and leachate exhibited moderate alkalinity (>20 mg/L). As such, the rock sample indicates there is sufficient acid buffering capacity and the rock is not highly sensitive to acid inputs.

5.1.5 Conclusions

Based on the results of the preliminary geochemical investigation, the following conclusions are drawn:

Based on a review of geologic mapping for the Chapman Lake site, bedrock lithology at all locations is anticipated to consist of late Jurassic to Cretaceous quartz diorite and granodiorite. However, the collected Chapman Lake sample appears to be highly weathered mudstone. The lithology is difficult to identify from the surface sample due to the highly weathered surface. The rock sample analyzed as part of this work was collected from exposed surface rock which may be not representative of subsurface bedrock lithologies present in the area. However, based on the results of the analysis completed on the surface sample collected and the other observations made well completing the field investigations it is expected that acid producing rock being present within the proposed construction area is low for the following reasons:

1. Sulphide minerals were not detected by the whole rock analysis, suggesting a low potential for acid generation.
2. The total metal analysis indicates that no elements are present at concentrations above their respective average crustal abundance screening criteria.
3. The risk of acid generation was determined to be low based on the neutralizing potential ratio (NPR) and total sulfide-sulphur content. The Chapman Lake sample is classified as non-PAG.
4. Shake flask extraction results were consistent with the ABA testwork and whole rock chemistry data as follows:
    1. Leachate pH is alkaline and moderately alkaline, so there is sufficient acid buffering capacity and a low sensitivity to acid inputs.
    2. No leachate constituent concentrations exceeded CSR Schedule 6 Criteria.
    3. Cadmium, chromium and copper marginally exceeded BCWQGs.

.

Table 7: MEND Shake Flash Extraction Results – Chapman Lake

Sample ID	Units	Contaminated Sites Regulation (CSR) Schedule 6 Criteria	British Columbia Water Quality Guidelines (BCWQG)-- Aquatic Life (Aquatic Water)	Chapman Lake	Duplicate	QA/QC
Hardness (as $CaCO_3$)	mg/L	-	-	21.5	22.8	*
pH (Lab)	-	-	-	9.29	9.4	*
Electrical Conductivity (Lab)	µS/cm	-	-	52.7	55.4	*
Total Alkalinity (as CaCO3)	mg/L	-	10 (minimum) [b]	25	26	*
Bicarbonate	mg/L	-	-	30	32	*
Carbonate	mg/L	-	-	<0.5	<0.5	-
Hydroxide (OH)	mg/L	-	-	<0.5	<0.5	-
Sulfate (SO_4)	mg/L	1000	128[a]	<0.5	<0.5	-
Dissolved Metals						
Aluminum (Al)	mg/L	-	-	0.657	0.671	*
Antimony (Sb)	mg/L	0.2	0.02 [c]	0.000051	0.000052	*
Arsenic (As)	mg/L	0.05	0.005	0.000729	0.000792	*
Barium (Ba)	mg/L	10	5 [c]	0.00138	0.00133	*
Beryllium (Be)	mg/L	0.053	0.0053 [c]	<0.000010	<0.000010	-
Bismuth (Bi)	mg/L	-	-	<0.0000050	<0.0000050	-
Boron (B)	mg/L	50	1.2	<0.050	<0.050	-
Cesium (Cs)	mg/L	-	-	<0.000050	<0.000050	-
Cadmium (Cd)	mg/L	0.0001 - 0.0006 [a]	0.00001 - 0.00004 [a,c]	0.000013	0.000016	*
Calcium (Ca)	mg/L	-	-	7.5	7.96	*
Chromium (Cr)	mg/L	0.09	0.001 [c]	0.00179	0.00228	24
Cobalt (Co)	mg/L	0.04	0.11	0.000111	0.000161	*
Copper (Cu)	mg/L	0.02 - 0.09 [a]	0.002 - 0.017 [c]	0.00245	0.00258	*

Sample ID	Units	Contaminated Sites Regulation (CSR) Schedule 6 Criteria	British Columbia Water Quality Guidelines (BCWQG)-- Aquatic Life (Aquatic Water)	Chapman Lake	Duplicate	QA/QC
Iron (Fe)	mg/L	-	1	0.0904	0.119	27
Lanthenum (La)	mg/L	-	-	<0.000050	<0.000050	-
Lead (Pb)	mg/L	0.04 - 0.16 [a]	0.003 - 0.096 [c]	0.000041	0.000049	*
Lithium (Li)	mg/L	-	0.87 [c]	<0.00050	<0.00050	-
Magnesium (Mg)	mg/L	-	-	0.661	0.708	*
Manganese (Mn)	mg/L	-	0.6 - 2.5 [a]	0.00218	0.00289	28
Mercury (Hg)	mg/L	0.001	-	<0.000050	<0.000050	-
Molybdenum (Mo)	mg/L	10	2	0.000103	0.00012	*
Nickel (Ni)	mg/L	0.25 - 1.5 [a]	0.065 [a,c]	0.00172	0.00212	21
Phosphorus (P)	mg/L	-	-	0.0328	0.0337	*
Potassium (K)	mg/L	-	-	0.627	0.66	*
Rubidium (Rb)	mg/L	-	-	0.000548	0.000545	*
Selenium (Se)	mg/L	0.01	0.002	<0.000040	0.000044	-
Silicon (Si)	mg/L	-	-	3.81	3.81	*
Silver (Ag)	mg/L	0.0005 - 0.015 [a]	0.0001 - 0.003 [a]	<0.0000050	<0.0000050	-
Sodium (Na)	mg/L	-	-	1.83	1.94	*
Strontium (Sr)	mg/L	-	-	0.0169	0.0171	*
Sulphur (S)	mg/L	-	-	<10	<10	-
Tellurium (Te)	mg/L	-		<0.000020	<0.000020	-
Thallium (Tl)	mg/L	0.003	0.0003 [c]	0.000002	0.000002	-
Thorium (Th)	mg/L	-	-	<0.0000050	<0.0000050	-
Tin (Sn)	mg/L	-	0.00008 [c]	<0.00020	<0.00020	-
Titanium (Ti)	mg/L	1	-	0.00508	0.00462	*
Tungsten (W)	mg/L	-	-	0.000145	0.000158	*
Uranium (U)	mg/L	3	-	0.000012	0.000013	*

Sample ID	Units	Contaminated Sites Regulation (CSR) Schedule 6 Criteria	British Columbia Water Quality Guidelines (BCWQG)-- Aquatic Life (Aquatic Water)	Chapman Lake	Duplicate	QA/QC
Vanadium (V)	mg/L	-	-	0.00501	0.00501	*
Zinc (Zn)	mg/L	0.075 - 2.4 [a]	0.0075 - 0.056 [a]	0.00033	0.00077	80
Zirconium (Zr)	mg/L	-	-	<0.00010	<0.00010	-

Notes:

[a] *Guideline/standard varies with hardness*

b If alkalinity < 10 mg CaCO3/L (<4 mg dissolved Ca/L), then waterbody is highly sensitive to acid inputs.

c Presented in the working water quality guidelines (BCWQG)

Exceeds BCWQG AW

Exceeds CSR AW

5.2 Aquatic

The Chapman Creek watershed (Watershed Code: 900-120400) is located approximately 5 km east of Sechelt, BC. Chapman Creek flows south from the Tetrahedron Plateau for approximately 24 km and discharges into the Strait of Georgia. Chapman Creek watershed is approximately 73 km^2 in area.

Tetrahedron Provincial Park was established to maintain and enhance the area's water quality and community watersheds for Sunshine Coast residents and preserve its wilderness characteristics by offering limited backcountry recreation opportunities. Tetrahedron Provincial Park is characterized by steep, short mountainous peaks, spongy, water laden meadows and numerous small lakes, including Chapman Lake. Abundant rainfall and snow pack recharges the freshwater supply.

5.2.1 Chapman Lake

Chapman Lake lies at an elevation of 974 m above sea level in steeply sloping terrain; surrounding ridgetops and peaks typically reach over 1,500 m elevation. A bathymetric survey of the lake was completed by Strait Land Surveying Inc. in 2013 and the following data was derived from that survey data. The lake has a surface area of 33.5 ha and a maximum depth of approximately 31 m. It is the largest lake in the Chapman Creek watershed. The catchment area of the lake is 6.58 km^2, and the lake is fed by 2 main streams, both of which enter at the east end of the lake. The lake volume at the high water level is approximately 4.1 million m^3 with an average outflow rate of 0.604 m^3/s. Based on these data, the average retention time of water in the lake is approximately 79 days. The short retention time reflects the high level of precipitation in the watershed. Outflow from the lake is controlled by a concrete dam and valve located on the west side of the lake and operated by the SCRD. During a typical year, water stored behind the dam is allowed to overflow naturally until there is a need to supplement the flows to Chapman Creek, at which time the dam is opened to release stored water from the reservoir. The annual lake level variation is currently between 1.5 m to 3 m.

5.2.2 Chapman Lake Water Quality

Whitehead (1999) conducted a limited assessment of water quality of Chapman Lake. Parameters measured included Secchi disc transparency, temperature and dissolved oxygen. The Secchi disk indicated clear water with a reading at 6.25 metres. Temperature ranged from 16°C at the surface to 7°C at depth with a thermocline evident at a depth of approximately 4 m. During the monitoring program gas bubbles were observed throughout the lake and particularly at the east end in the shallower areas. Based on the smell of hydrogen sulphide it was concluded the gas bubbles were originating from anaerobic decomposition originating in the lake sediments (Whitehead 1999).

Water quality parameters measured during the August 2016 field survey included Secchi disk, temperature and dissolved oxygen depth profiles and laboratory analysis of samples collected at the surface, thermocline and bottom at the deepest points in the lake (Figure 9). Laboratory analysis included physical properties, anions, nutrients, organic carbon, chlorophyll a and total metals. Details of the results of analysis for each of the sample analysis locations are provided in Appendix D. Results of analysis were compared to both the Approved BC Water Quality Guidelines and Canadian Council of Ministers of the Environment (CCME).

Secchi disk readings taken from the deepest part of the lake were measured to be 7.35 m, which was 1.1 m deeper than readings obtained by Whitehead (1999). Dissolved oxygen and temperature depth profiles were taken from 2 locations in the lake as shown on Figure 9. Results of the temperature and dissolved oxygen profiles are depicted in Figure 7 and Figure 10 respectively. Temperatures ranged from 17.9°C at the surface to 3.9°C at depth with the thermocline occurring between the 4 m to 9 m depth. Similar results were obtained in 1999 (Whitehead) although a profile to the bottom was not performed in the original study. Temperature was consistent between the two locations measured in 2016. Dissolved oxygen levels peaked at approximately the 4 m to 6 m depth.

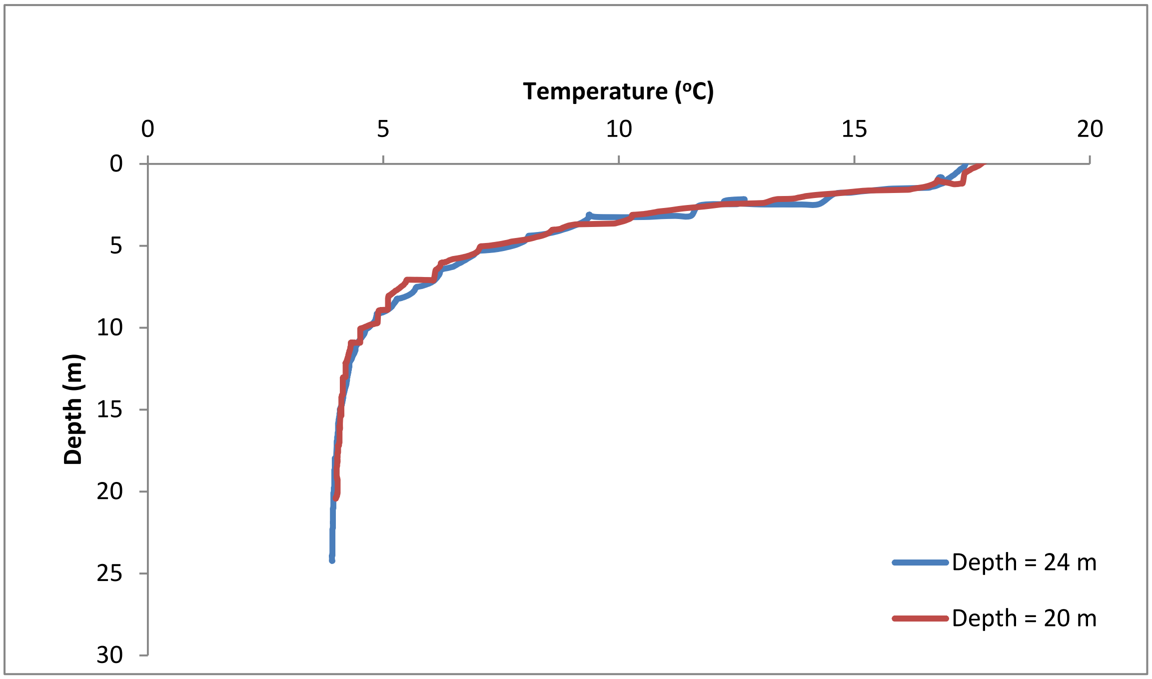


Figure 7: Temperature Depth Profiles in Chapman Lake, 2016

The SCRD collects temperature data of the surface water at the outlet of the lake. Figure 8 provides a plot of the data collected in 2014, 2015 and 2016. Water temperature occasionally exceeds 20° C during the summer months with the exception of the hot summer of 2015 when surface water temperatures were at or above 20° C for almost three weeks.

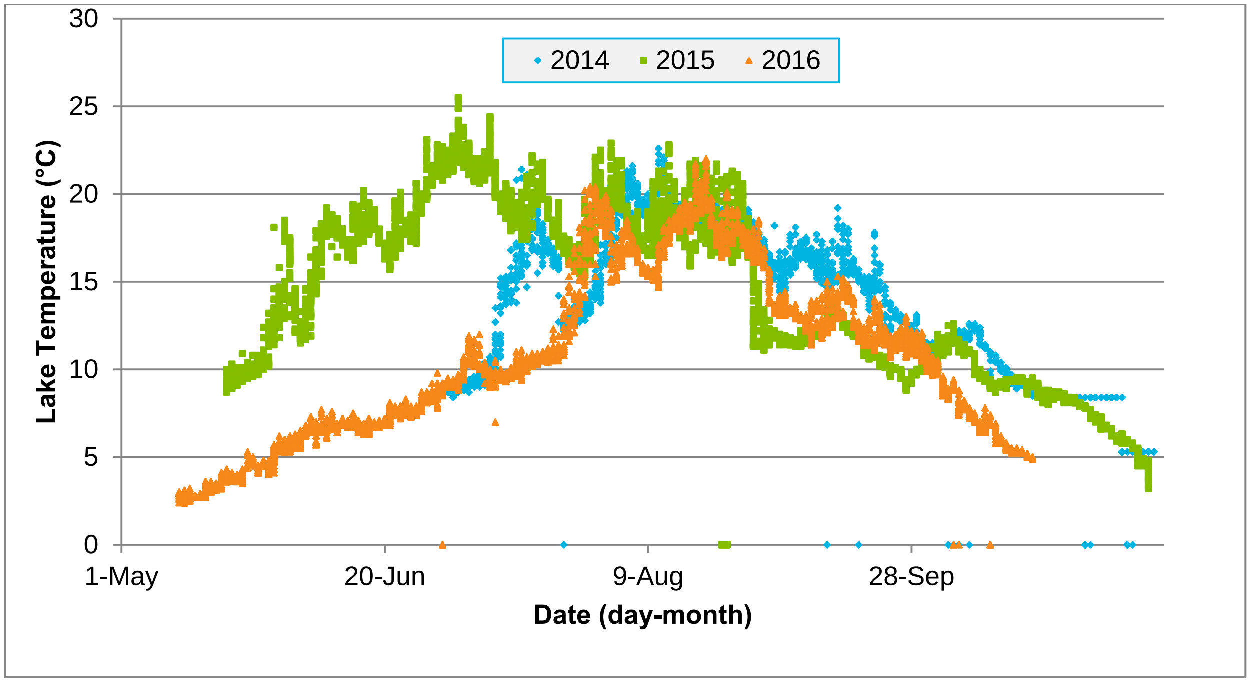
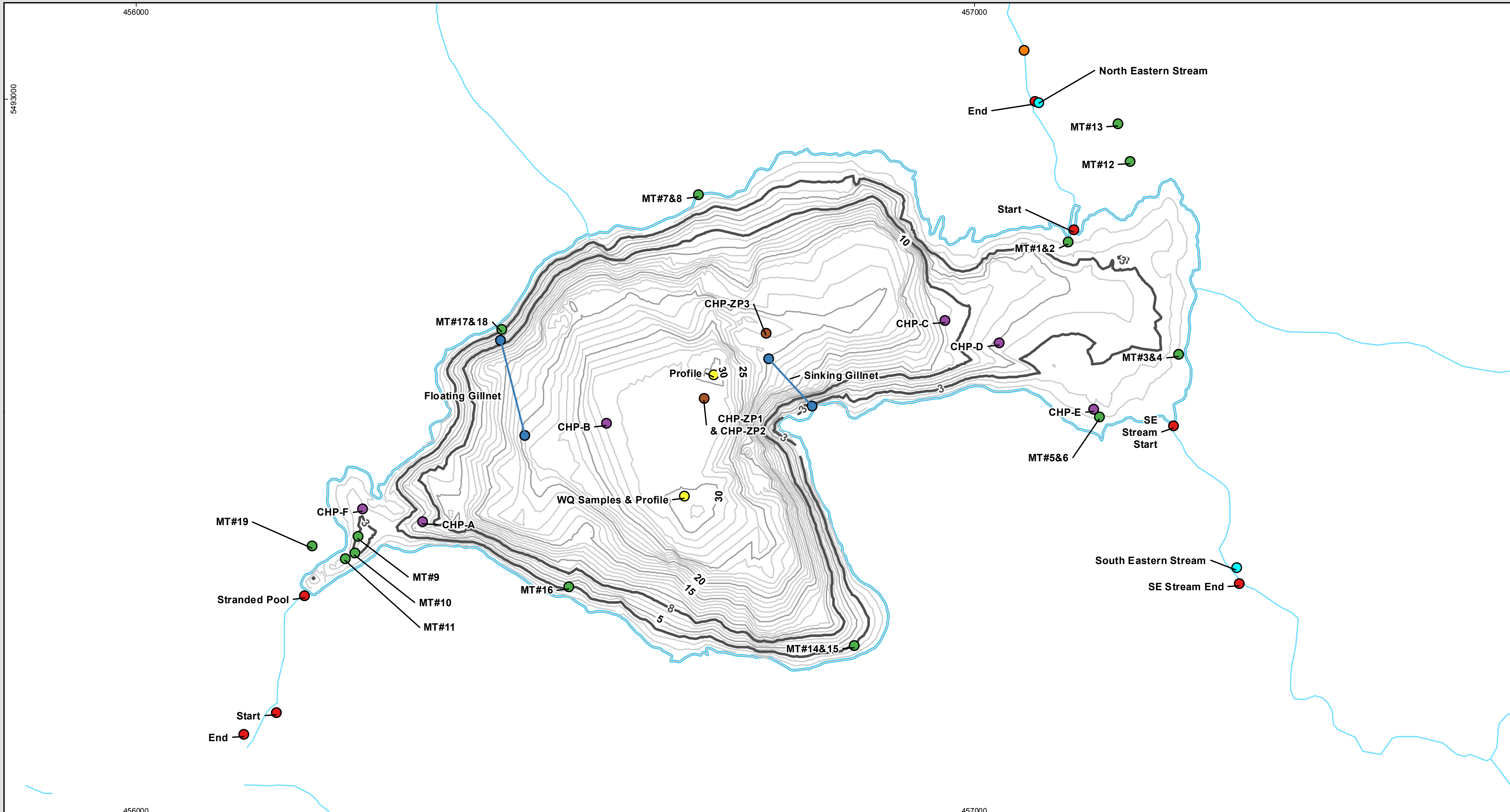


Figure 8: Surface Water Temperature at the Outlet of Chapman Lake, 2014 to 2016



Spatial Data from SCRD, GeoBC, 2015

N
W E
S

0 40 80 120

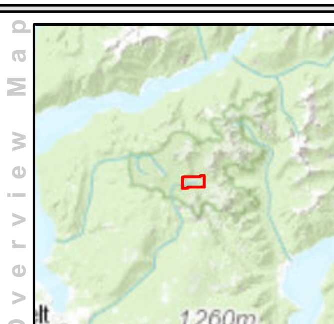
Metres

1:4,500

NAD 1983 UTM Zone 10N

Legend

- Electrofishing
- Fish Habitat Assessment
- Gillnets
- Minnow Traps
- Sediment Sampling
- Debris Jam
- Water Quality
- Zooplankton Tows
- Gill Net Line
- Stream
- Bathymetry Contour at -3 and -8
- Bathymetry Contour (1m Interval)



Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

Field Sampling Locations

10 November 2016

AECOM

Figure 9

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\2016-09-21-FieldData\Figx-2016-09-21-ChapmanLakeFieldData-60485918-003.mxd   Date Revised: November 10, 2016   Reviewed By: AM

Paper Size: 11"x17"   Scale is referenced to the specified paper size.

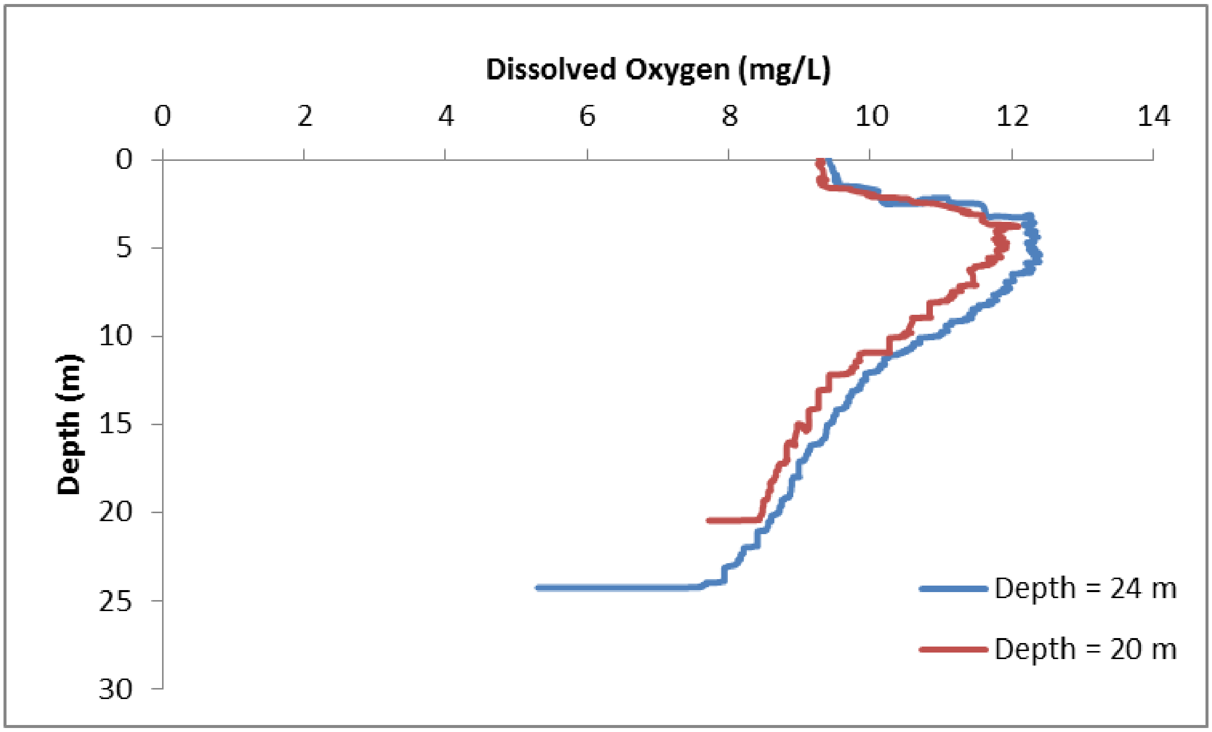


Figure 10: Dissolved Oxygen Depth Profile in Chapman Lake, 2016

Sample analysis indicated that water was generally slightly acidic (mean 6.83), with low buffering capacity and nutrients. Phosphorus levels in the lake were in the ultra-oligotrophic range (CCME 2004). Comparisons of available water quality parameters to guideline values measured one exceedance of total aluminum measured at the bottom depth. Hydrogen sulphide readings at all depths were below detection limits. The study conducted in 1999 (Whitehead) noted the smell of hydrogen sulphide and the visible presence of gas bubbles in the lake. No presence of gas bubbles or releasing of gas bubbles were noted during the 2016 field investigation. Table 8 provides a summary of key water quality parameters taken at the sample site shown on Figure 9. The complete set of parameters and sampling results is provided in Appendix D.

Table 8: Summary of Key Water Quality Parameters in Chapman Lake, 2016

Key Parameter	Units	Surface	Thermocline (6 m)	Bottom
pH	-	6.90	6.78	6.81
Sulphide (as H2S)	mg/L	<0.021	<0.021	<0.021
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	<0.0010	0.0011
Phosphorus (P)-Total	mg/L	0.0020	<0.0020	0.0023
Total Hardness (CaCO3)	mg/L	7.79	6.28	7.73
Total Aluminum (Al)	mg/L	0.0551	0.0875	**0.111**

Bolded values exceeded Water Quality Guidelines, see Appendix D

5.2.3 Sediment Quality

Sediment characterization occurred during the 1998 study by conducting course sediment approximations along transects throughout the lake. Slopes were noted as well as surficial materials classification into mud/silt, sand, gravel and bedrock. A map was produced of the approximate distribution of surficial materials. Materials around the lake range from deep organic forest soils to alluvial sands and gravels and bedrock. Below the high water level, silt was predominant due to the deposition of mineral and organic material from the overlying water column.

During the 2016 study, observational confirmation of the approximate distribution of surficial materials based on the map produced during the previous assessment was completed. Additionally, sediment samples were collected using an Eckman grab sampler at 4 locations, which consisted of 2 shallow depths, mid-depth and deep depth (Figure 9) in 2016. Samples were collected and placed into glass jars and sent for grain size analysis to ALS Laboratories in Burnaby, BC. Samples were kept cold at all times between sample collection and delivery to the lab.

The results of the 2016 laboratory analysis confirms the previous findings in the 1998 study, that silt was the predominant lake material observed at depth. Figure 11 provides the percent composition grain size for each of the sample locations. The dominant grain size at each of the locations was silt.

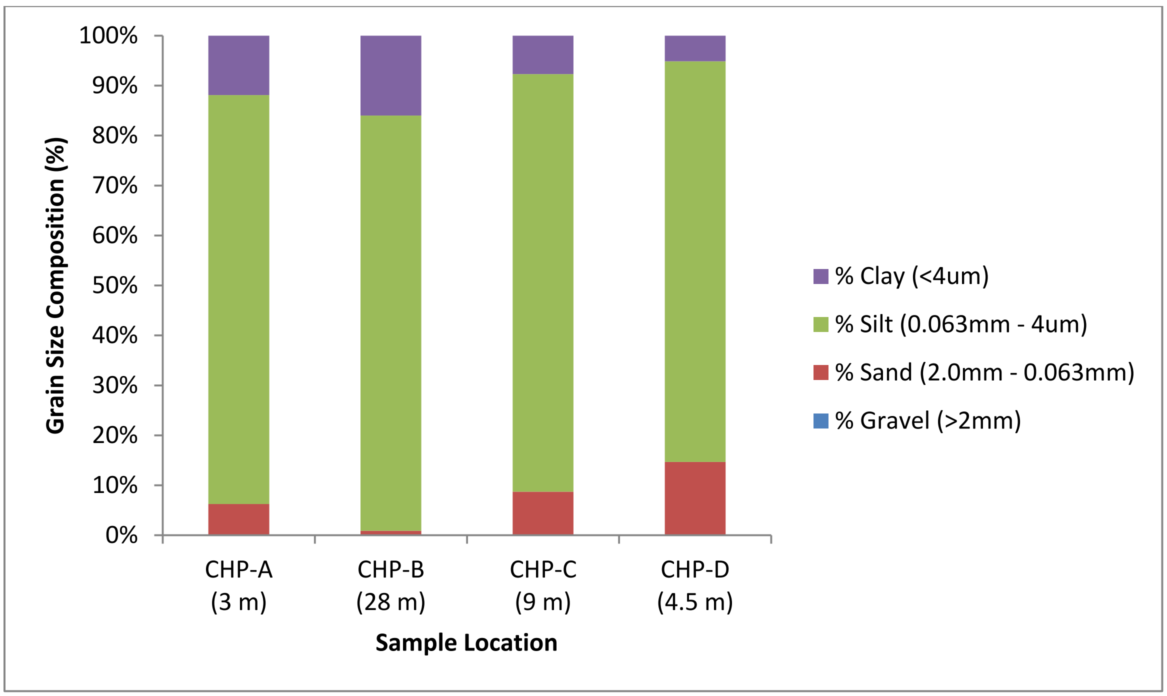


Figure 11: Sediment Grain Size Analysis in Chapman Lake, 2016

5.3 Fisheries Resources

5.3.1 Chapman Lake Fish

The provincial Fish Inventory Summary System[2] database reports that the headwaters section of Chapman Creek supports resident populations of Dolly Varden char (*Salvelinus malma*) and rainbow trout (*O. mykiss*). Coastal cutthroat trout (*O. clarki clarki*) have also been reported in the headwaters of

[2] http://a100.gov.bc.ca/pub/fidq/welcome.do

Chapman Creek. A fish sampling program was undertaken to supplement existing information to support the impact assessment in 1998.

During the 1998 study, gillnetting and minnow trapping methods were used to sample the lake during a 24 hour period. The gill net was set at the surface at a single location near the centre of the lake with minnow traps set along the eastern portion of the lake. Only Dolly Varden char averaging 14 cm long were captured in the lake during this sampling period. The majority of fish were caught between 0.5 m to 1.5 m from the surface. The average length and weight of the 68 gillnet captured fish were 139 mm and 29.3 g respectively (Whitehead 1999).

The 2016 fish sampling program in the study area consisted of minnow trapping gillnetting and electrofishing. Two gillnets were used for sampling, a sinking and floating net. The sinking gill net was set in the same location as the 1998 assessment. Minnow traps were set throughout the lake along the shallows, in areas with appropriate fish habitat (e.g. trees, boulders). Electrofishing was conducted in the lake outlet stream below the dam and at the two larger inlet streams along the eastern portion of the lake. The sampling effort for each method is provided in Table 9, Table 10 and Table 11 with the sampling locations shown on Figure 9. Five fish were selected to represent the range of sizes caught and were submitted to the laboratory for analysis of mercury concentrations.

Table 9: Minnow Trapping Effort in Chapman Lake, 2016

MT Ref	Deployment	Retrieval	Total Soak Time (hh:mm)
1	8/23/2016 16:30	8/24/2016 9:35	17:05
2	8/23/2016 16:30	8/24/2016 9:35	17:05
3	8/23/2016 16:45	8/24/2016 9:20	16:35
4	8/23/2016 16:45	8/24/2016 9:20	16:35
5	8/23/2016 16:50	8/24/2016 9:15	16:25
6	8/23/2016 16:50	8/24/2016 9:15	16:25
7	8/23/2016 17:00	8/24/2016 9:10	16:10
8	8/23/2016 17:00	8/24/2016 9:10	16:10
9	8/23/2016 17:20	8/25/2016 12:30	43:10
10	8/23/2016 17:20	8/25/2016 12:30	43:10
11	8/23/2016 17:20	8/25/2016 12:30	43:10
12	8/24/2016 15:50	8/25/2016 11:25	19:35
13	8/24/2016 15:50	8/25/2016 11:25	19:35
14	8/24/2016 16:05	8/25/2016 11:45	19:40
15	8/24/2016 16:05	8/25/2016 11:45	19:40
16	8/24/2016 16:10	8/25/2016 11:50	19:40
17	8/24/2016 16:15	8/25/2016 12:00	19:45
18	8/24/2016 16:15	8/25/2016 12:00	19:45
19	8/24/2016 10:00	8/25/2016 12:30	26:30

Table 10: Electrofishing Total Effort in Streams along Chapman Lake, 2016

Location	Total Electrofishing Effort (seconds)
Downstream of dam	448
Stranded pools downstream of dam	60
South east stream	426
North east stream	408

Table 11: Gillnetting Total Effort

Net Type	Deployment	Retrieval	Total Soak Time (hh:mm)
Sinking Net	8/24/2016 15:10	8/25/2016 10:00	18:50
Floating Net	8/24/2016 15:40	8/25/2016 8:50	17:10

A total of 16 fish were captured by minnow traps; 14 captured by electrofishing; and, 87 were captured in the gill nets. Appendix E provides details of the fish captured for each of the sampling methods, including length, weight, species and condition factor. Weight, length and stomach contents were recorded for 50 fish captured in the gill nets that were representative of the size and location of the fish caught, the rest were counted only. All fish captured were identified as Dolly Varden. Photos of fish captured are provided in Photographs 12 through 14.

5.3.1.1 Fish Size

The average fish length captured in and around Chapman Lake was 118 mm (fork length), which was 20 mm smaller than the average length reported in the 1998 study. The average length of fish captured in the lake in gill nets was 144 mm; average capture length in the north eastern stream during electrofishing was 67 mm; and, fish captured in minnow traps in channels off the lake was 59 mm. Length-frequency histograms were produced for fish in streams and in the lake and results are provided in Figure 12. Length frequency trends and capture locations indicate that younger fish remain in the streams and don't move to the lake until they reach a larger size.

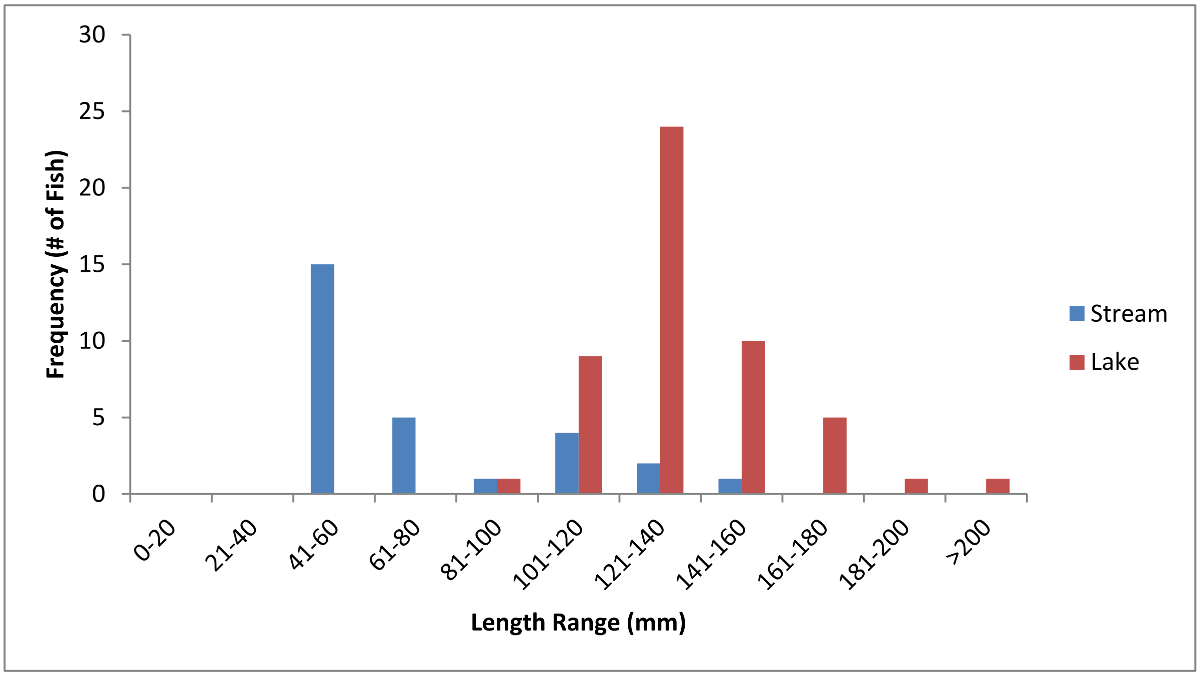


Figure 12: Length Frequency Histogram of Fish Captured in Chapman Lake and Inlet Streams, 2016

Weight-length regressions for fish were calculated as:

$$\ln(W) = a + b\ x\ (\ln(L))$$

where W = weight (g) and L = fork length (mm), a = the intercept of the regression, and b = the slope of the regression.

Both weight and length were transformed using natural logarithms to normalize the distributions and produce homogenous variances. The slope of the regression (b) provides information on fish growth. If b = 3 the growth is isometric, which means the shape of the fish does not change with growth. The results of the length-weight regression analysis are provided in Figure 13. The slope for fish in Chapman Lake was 3.07 indicating the fish growth is isometric, a typical growth pattern for healthy salmonids.

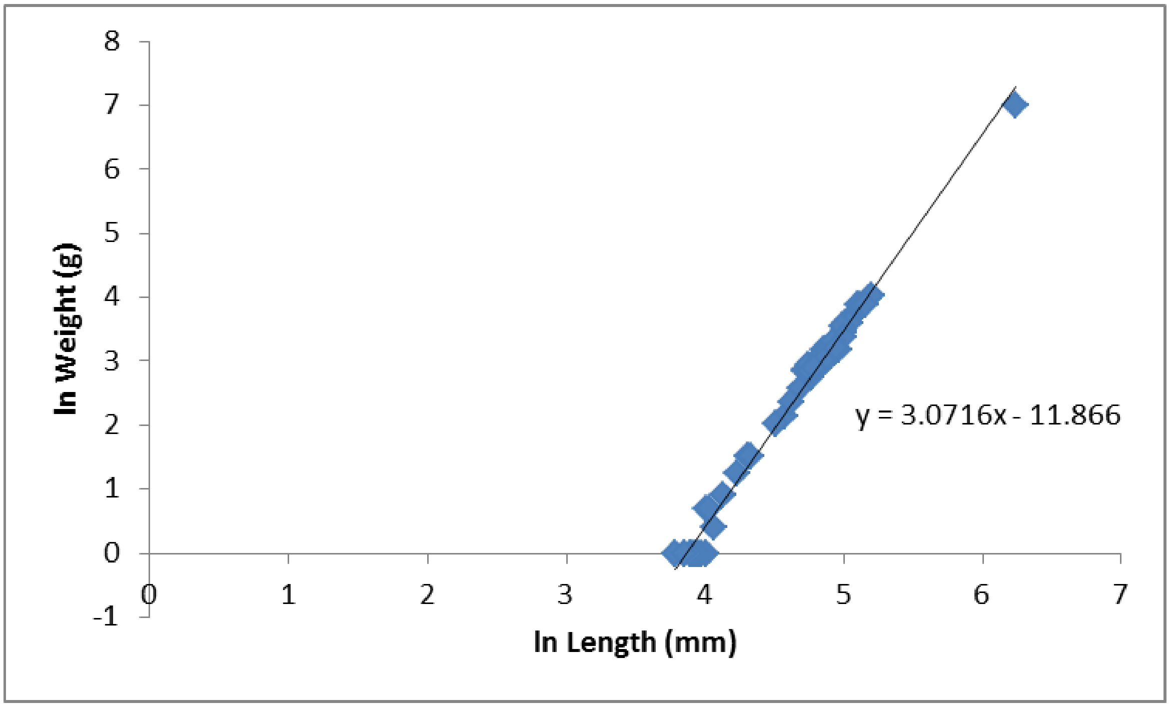


Figure 13: Length Weight Regression Analysis of Fish Captured in Chapman Lake, 2016

5.3.1.2 Fish Condition

A Fulton condition factor (K) was calculated for each fish as:

$$K = \left(\frac{W}{L^3}\right) \times 100{,}000$$

where W = weight (g) and L = fork length (mm).

A summary of condition factors (K) statistics for each of the fish captured is presented in Appendix E. The condition factor represents an index of the "fatness" of the fish as measured by the weight of the fish relative to its length. Thus, the heavier a fish is for a given length the higher the condition factor. The average condition factor (0.99) for all captured fish was close to 1, which is an indication that the fish are in relatively good condition. Values below 1 suggest poor nutrition or other factors are limiting the health of fish.

5.3.1.3 Fish Age

Fish aging structures were obtained from a varied size class from the gill net captured Dolly Varden fish in Chapman Lake. Fish otoliths were removed from 20 fish and sent for fish aging analysis to a fish aging professional. A size analysis was completed prior to otolith removal to ensure a representative size class of fish was being analyzed. Details of the lengths, weights, sex and age of the selected gill net fish are provided below in Table 12 and the age frequency plot is provided in Figure 14. Results indicated that the average age of fish analyzed were 4+ years. Based on the age class of the analyzed otoliths in comparison with the overall captured fish length range, Table 13 below provides an approximate age-length classification.

Table 12: Gill Net Captured Dolly Varden Age Analysis Details

Fish Reference	Length (mm)	Weight (g)	Sex	Age
1	164	48.5	Male;	3+
2	166	48.5	Male	3+
5	126	20.5	Female	3+
16	123	19	Male	3+
17	132	24	Male	3+
20	126	20	Male	3+
21	128	24	Female	3+
25	126	22	Female	3+
28	128	21.5	Male	3+
3	140	28	Female	4+
11	127	19.5	Male	4+
13	120	17.5	Female	4+
14	130	24	Female	4+
15	141	23.5	Female	4+
19	127	21	Female	4+
23	125	20.5	Male	4+
27	182	56	Male	5+
29	170	47.5	Female	5+
30	156	36	Male	5+
10	510	1095.5	Male	8+

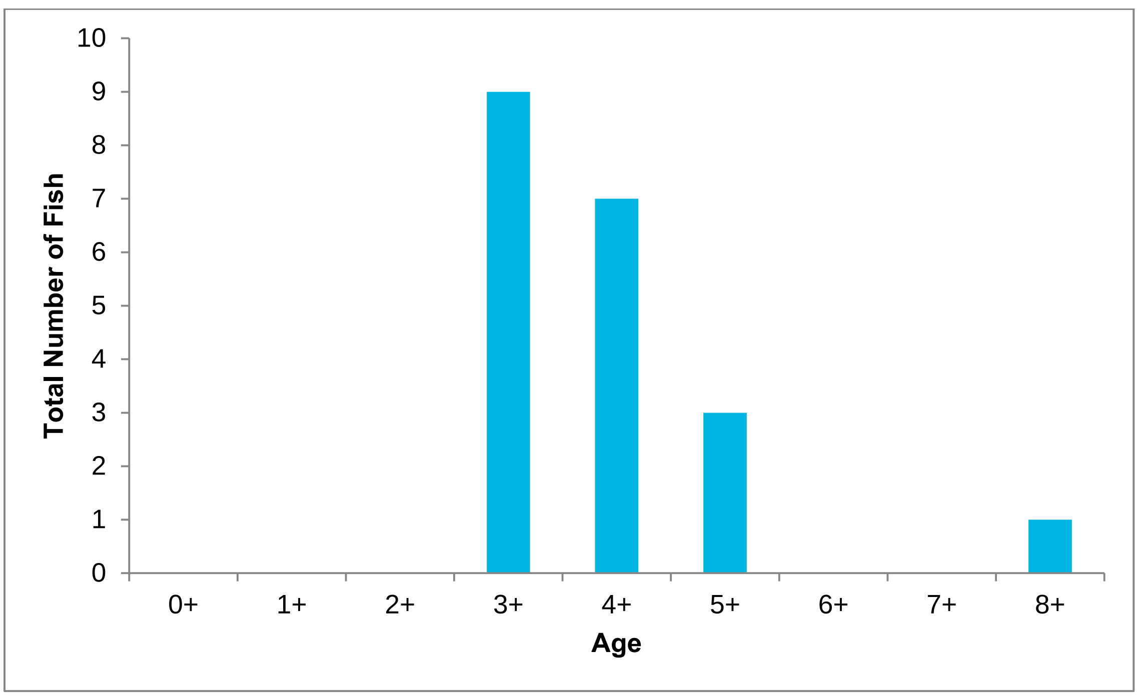


Figure 14: Plot of the Total Number of Fish Analyzed in each Age Class

Table 13: Estimated Age-Length Classification of Chapman Lake Dolly Varden

Age	Length Range (mm)
1	40-80
2	90-120
3-4	120-160
5	160-180
8	500

The estimated age and length suggest that there is a positive correlation between the size of a fish and age. To further support observations, an age to weight analysis was completed. Figure 15 below provides the log normalized weights plotted against age showing a positive trend. Further analysis was completed by comparing the condition factor of fish with age. The condition factor is a measure of the degree of well-being of a fish and primarily reflects the state of sexual maturity and degree of nourishment. Based on the population of fish analyzed, there is a decreasing trend in the condition of fish in Chapman Lake as they age.

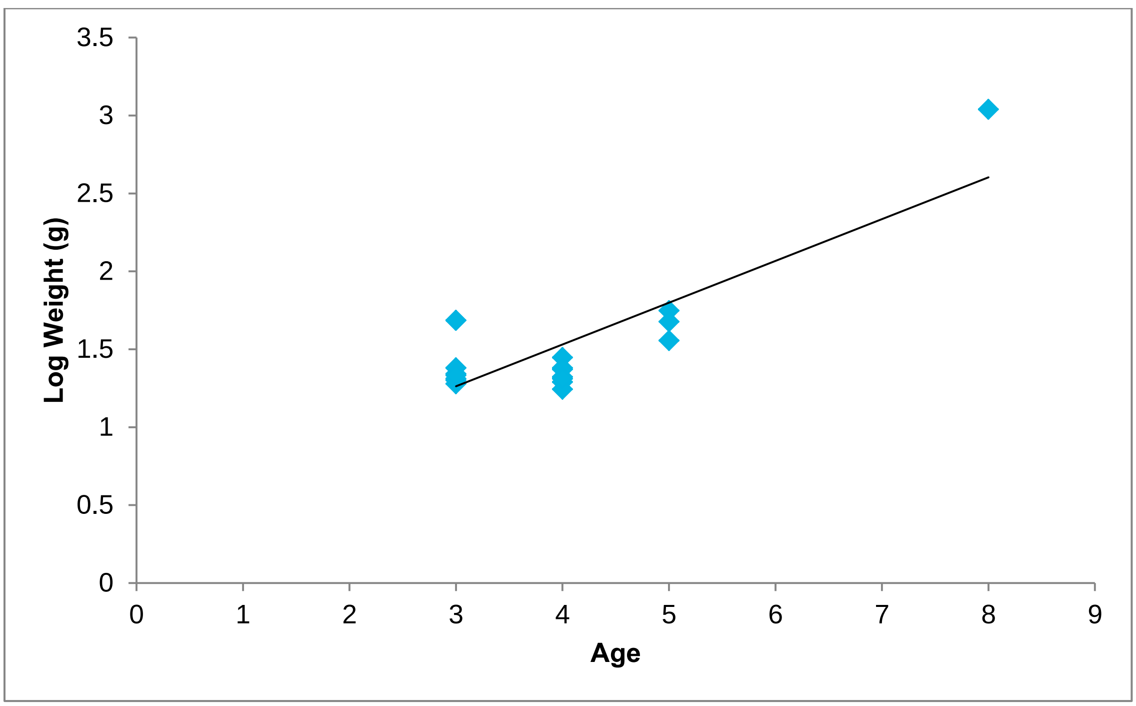


Figure 15: Weigh to Age Relationship of Dolly Varden Captured in Chapman Lake

5.3.1.4 Mercury in Fish Tissue

Mercury occurs naturally at low concentrations in air, water, soil, sediments, plants and animal tissues. The majority of mercury occurs in the environment in the inorganic form, with approximately 1% available in the organic form, methyl mercury. Methyl mercury enters the aquatic food chain when benthic organisms living in the sediment absorb methyl mercury into their tissues and then are consumed by organisms of higher trophic levels (Langston 1986), or when low levels of methyl mercury in the water column are absorbed across gill membranes or skin (Francesconi and Lenanton 1992). This organic form of mercury is considered to be the most toxic and can become concentrated in fish tissue as a result of bioaccumulation through diet. The formation and operation of reservoirs have been known to cause elevated levels of mercury into the food web through the release of methl mercury from the breakdown of submerged vegetation.

The 2016 fish sampling included analysis of the mercury concentration in fish tissue to establish a baseline for comparison to fish sampled at a future date. A range of size classes were selected for analysis and the whole fish was used. Results of total mercury samples with the associated physical fish parameters are provided in Table 14**.**

Table 14: Fish Tissue Total Mercury Results, 2016

Fish Reference	Length (mm)	Weight (g)	Age	Total Mercury (mg/kg wwt)
1	164	48.5	3+	0.068
2	166	48.5	3+	0.056
3	140	28	4+	0.089
10	510	1095.5	8+	0.184
19	127	21	4+	0.029

The results are provided as the concentration in wet weight of the tissue (wwt). Typically, mercury in fish tissue is primarily in the form of methyl mercury. The reported values of total mercury were compared against CCME and BC Tissue Residue Guidelines to Protect Wildlife from Mercury Toxicity, which is 0.033 mg/kg (MeHg, wwt). All but one of the fish had total mercury values that were higher than the stated criteria.

Figure 16 shows the relationship between mercury concentration and fish age. While the graph does indicate a trend of increasing concentration with age, had the oldest fish been removed from the analysis there would be no significant relationship. There was no evidence during the 2016 field study to indicate that the elevated levels of mercury in the Dolly Varden of Chapman Lake was anything but natural.

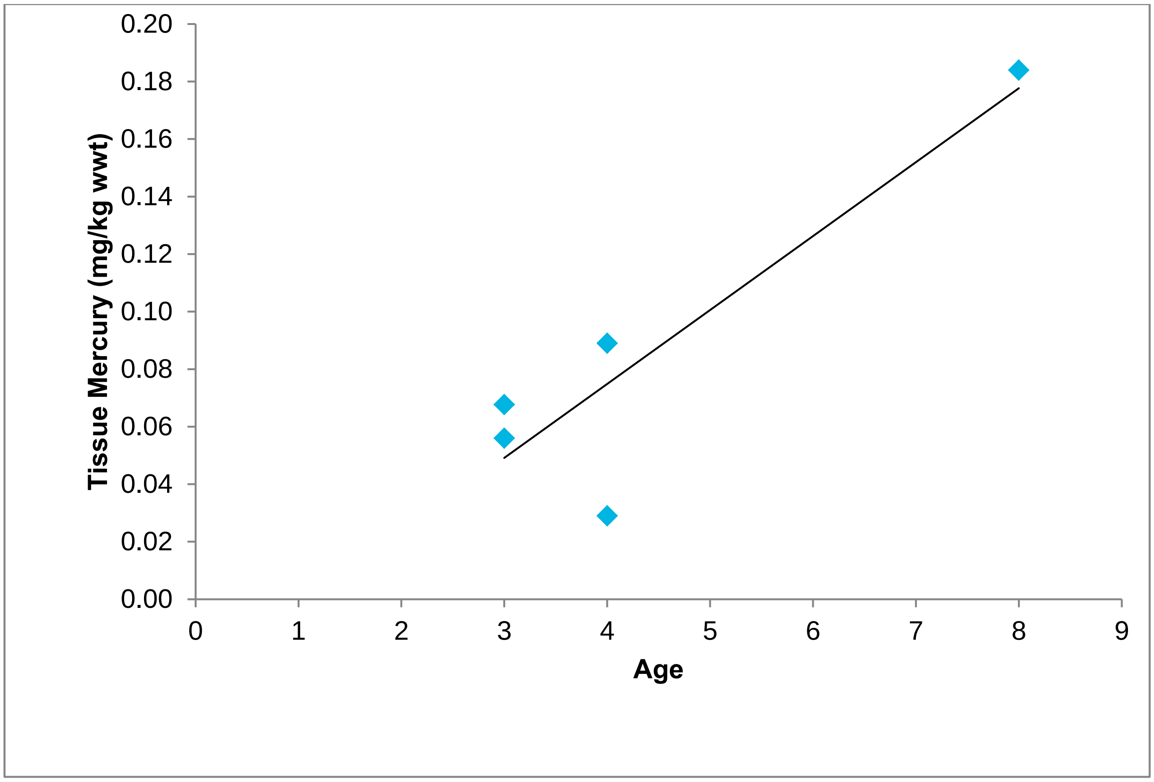


Figure 16: Dolly Varden Tissue Mercury Concentration in Relation to Age in Chapman Lake

5.3.2 Chapman Lake Benthic Invertebrates

Benthic macroinvertebrate sampling during 1998 field study was limited to identification of species from sediment samples collected along transects and incidental observations of other species. Benthic macroinvertebrates were identified from sediment samples collected at 3 m and 5 m depth using an Eckman dredge, along 9 transects. The main types of invertebrates collected were caddis fly larvae cases, bloodworms and other unidentified worms. The benthic macroinvertebrate abundance levels in Chapman Lake were considered low and similarly the density of benthic macroinvertebrate levels were low. During the 2016 field program, a total of 6 macroinvertebrate samples were collected at various locations at shallow, mid and deep locations in the lake (Figure 9). An Eckman grab sampler was used to collect a 500 ml of bottom substrate. Sample results suggest that the total abundance of organisms were correlated with depth with higher abundance in samples from shallower sites. Figure 17 and Figure 18 provide the abundance and biomass of the macroinvertebrates in each sample. The most dominant order present at each of the sample locations were Diptera (Figure 19). Diptera were also found in the stomach contents of the fish captured in the gillnets. Consistent with abundance and biomass, species richness was higher in the shallow samples (Figure 20).

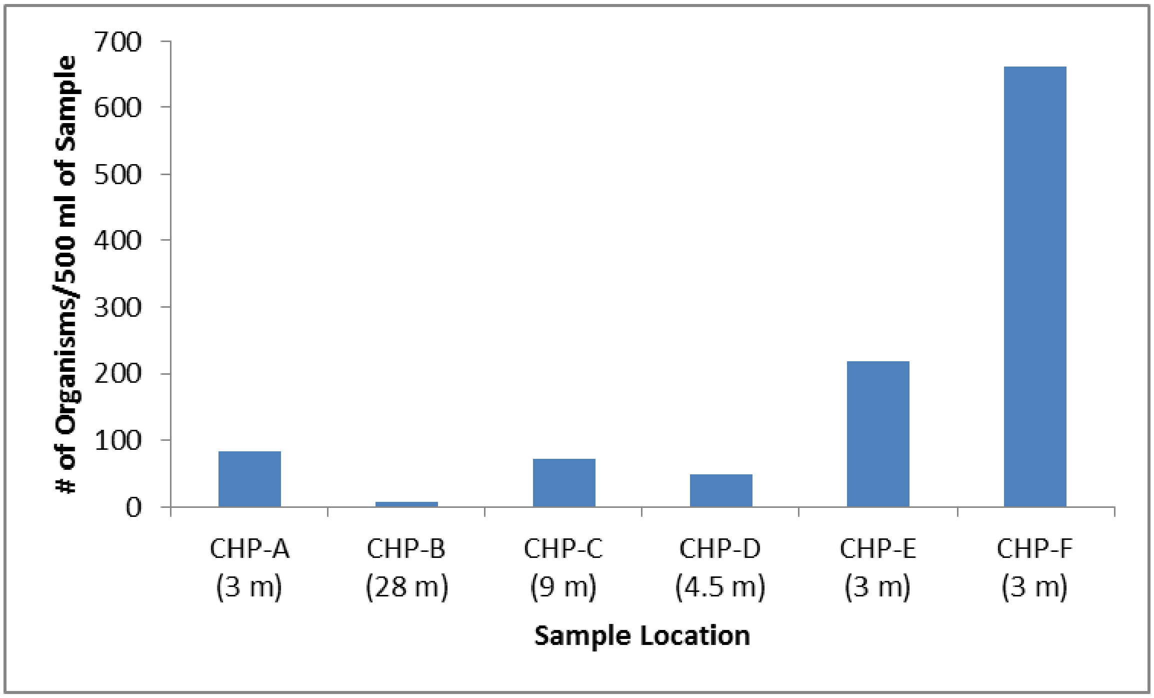


Figure 17: Total Abundance of Benthic Macro Invertebrates in Chapman Lake Samples, 2016

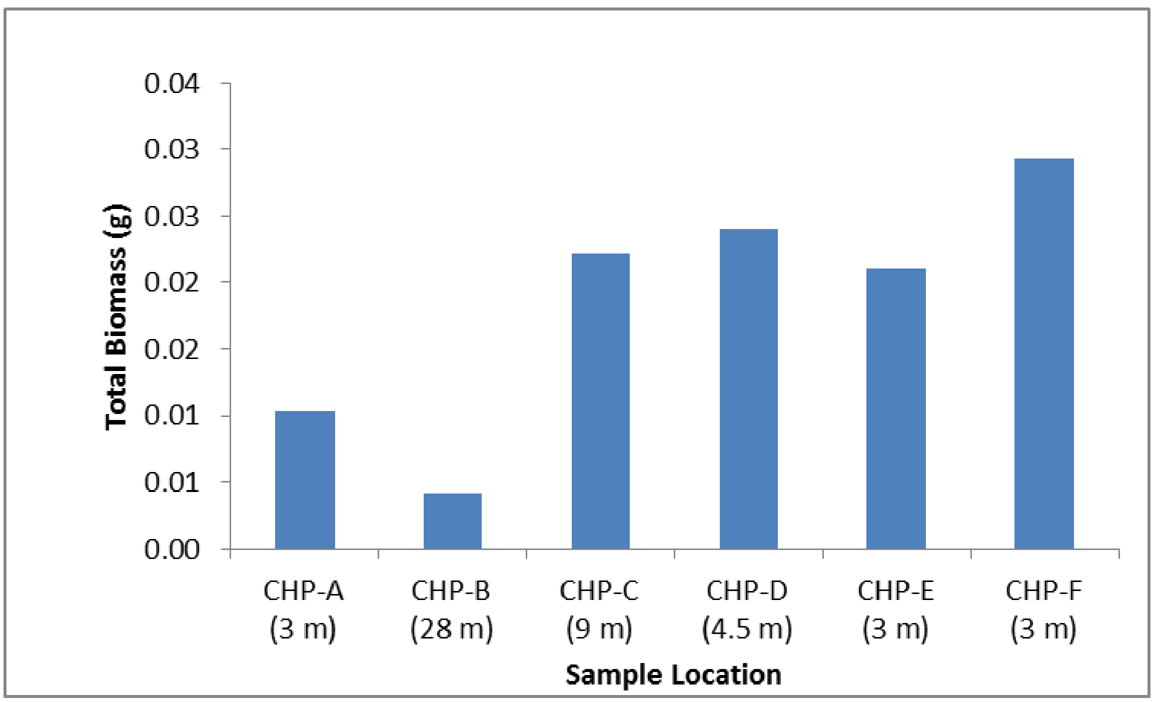


Figure 18: Total Biomass of Benthic Macro invertebrates in Chapman Lake Samples, 2016

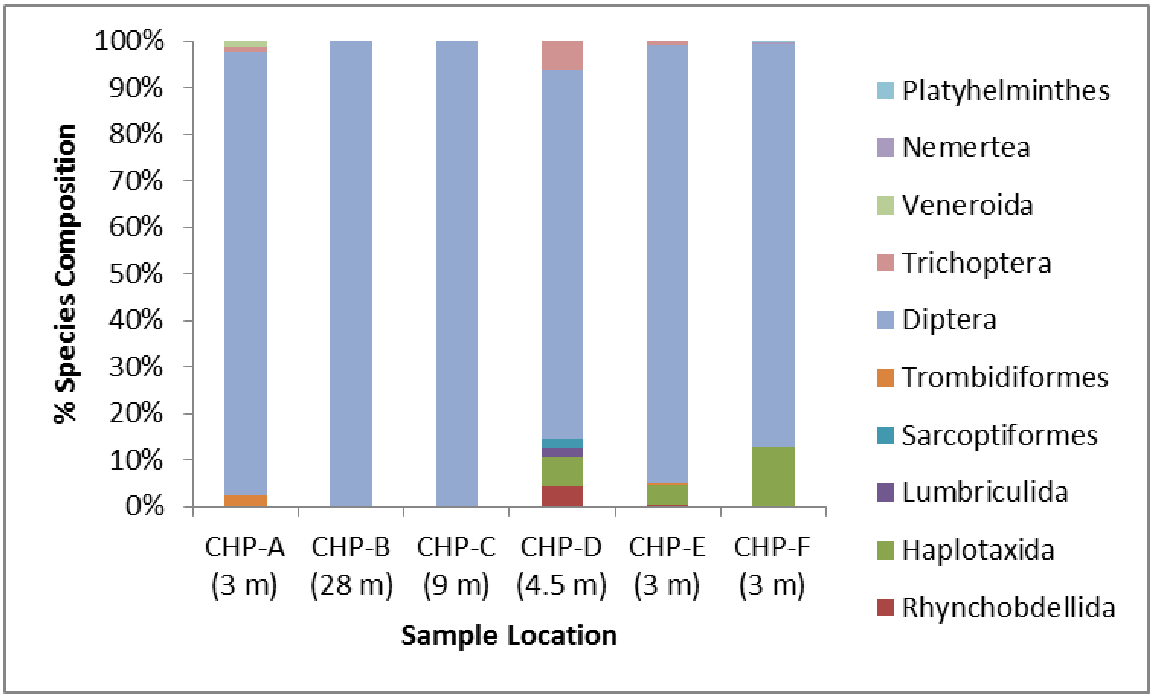


Figure 19: Benthic Macro Invertebrate Sample Species Composition in Chapman Lake, 2016

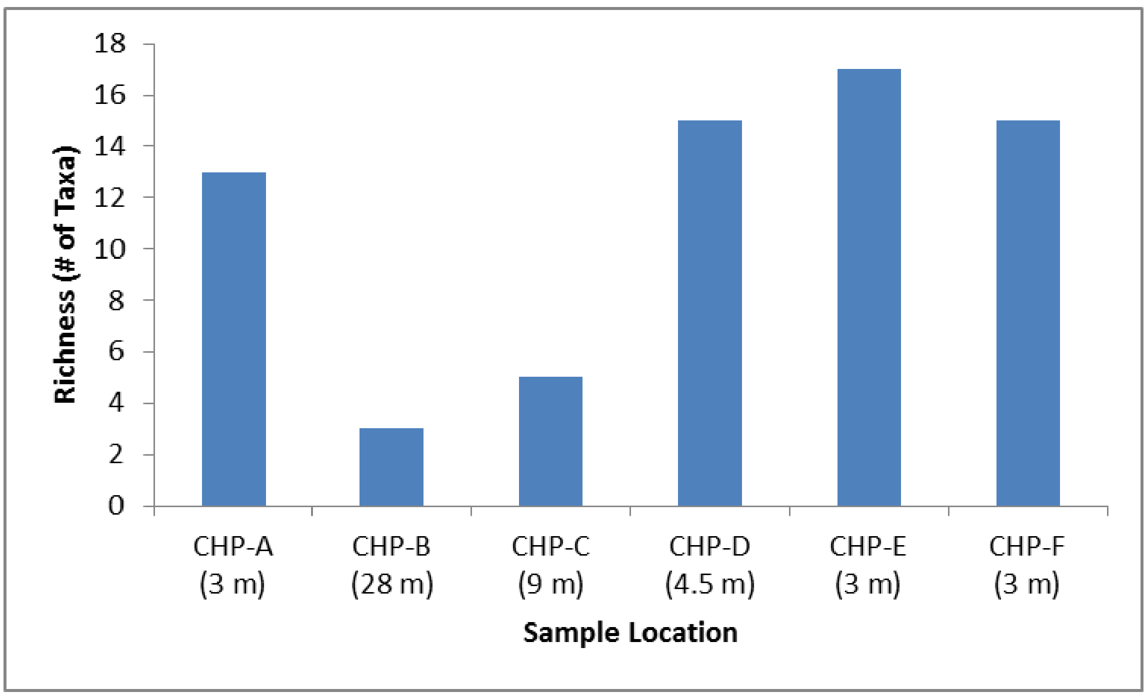


Figure 20: Benthic Macro Invertebrate Samples Species Richness in Chapman Lake, 2016

5.3.3 Chapman Lake Zooplankton

Sampling of zooplankton in Chapman Lake was carried out in 2016 to provide a baseline measure of food resources for comparison to future sampling results. Zooplankton was sampled using a vertical zooplankton tow at the deeper areas of the lake. Density of zooplankton (number of individuals/L) was calculated for each sample by dividing the total number of individuals of each species in a sample by the total volume sampled. Sample volume consisted of a calculation of the area of the sample net opening by the distance the net was towed. The volume of water filtered was calculated using the equation:

$$V = \pi r^2 d$$

Where r was the radius of the net mouth (0.1475 m) and d was the depth of net sampler. Volumes were converted from cubic metres to litres for abundance calculations.

The total abundance of zooplankton per litre of water for each site is provided in Figure 21. The samples CHP-ZP1 and CHP-ZP2 were taken from the same deep lake location (20 m) and CHP-ZP3 was taken at the mid-range depth (14 m). The largest number of zooplankton was captured from the 14 m depth location. Taxonomic richness at all sample locations was 10 taxa. The total taxa is the count of all unique taxa that was not represented by a lower taxonomic level in the sample.

Each sample consistently contained a relatively similar composition of 3 major groups of taxa which included cladocera, copepod and rotifera. Figure 22 shows the percent composition of the three major taxa groups at each sample location.

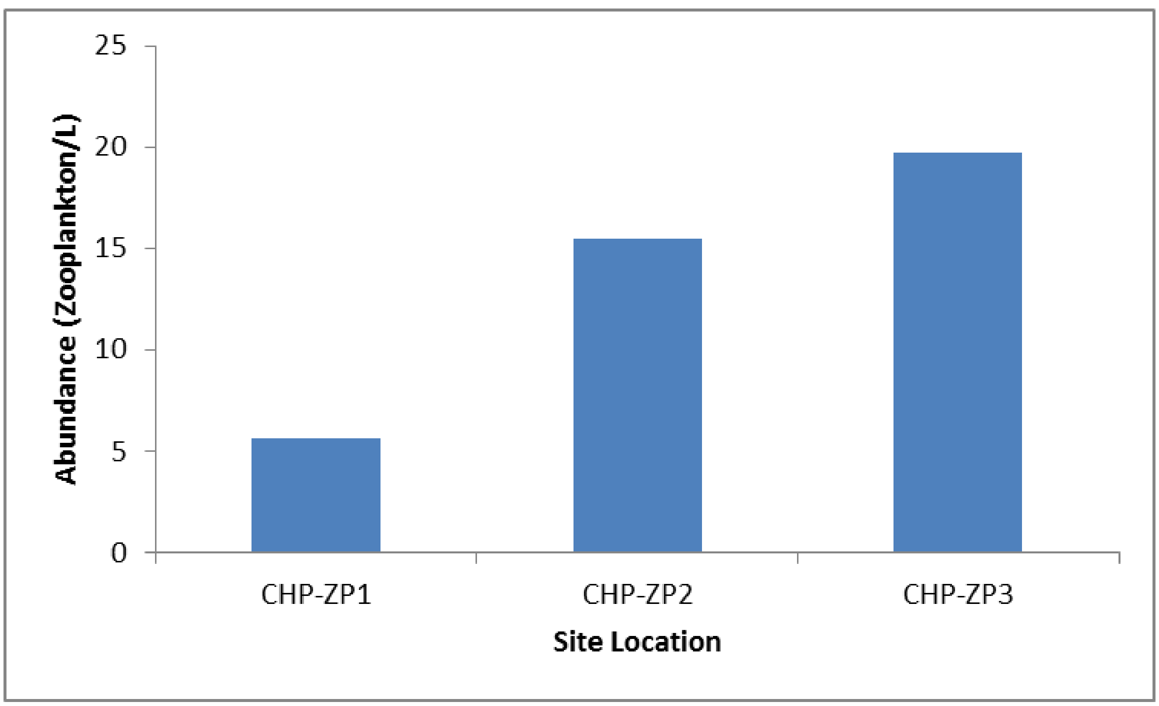


Figure 21: Zooplankton Sample Total Abundance in Chapman Lake, 2016

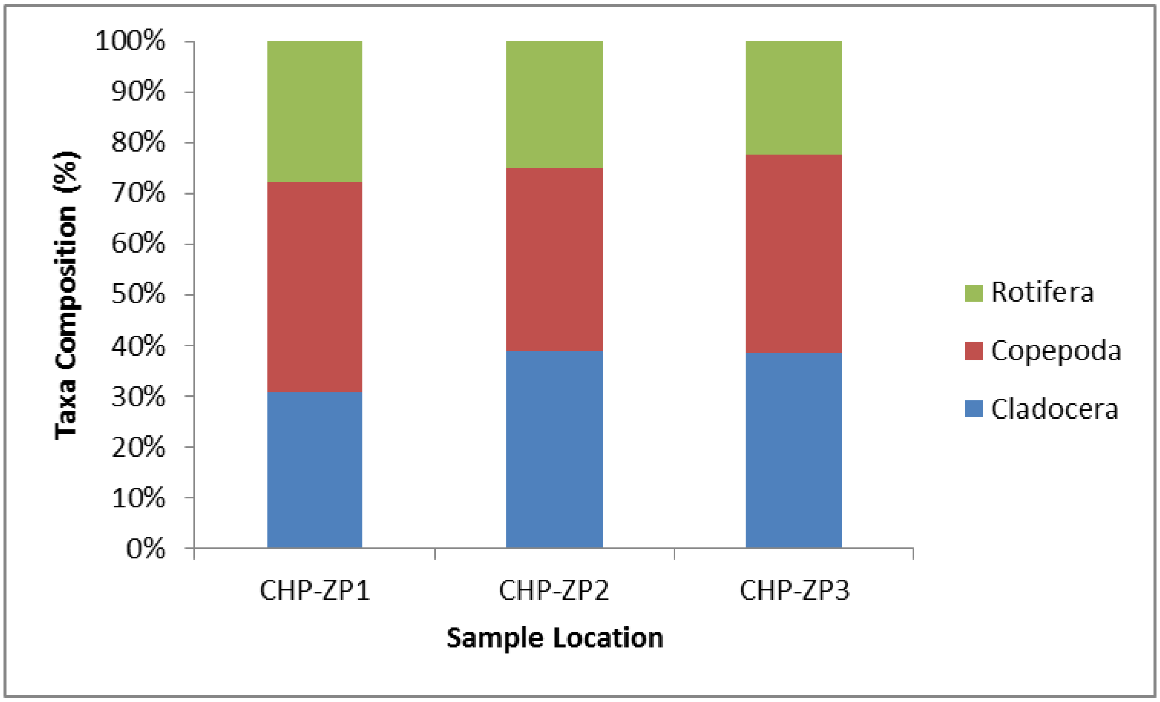


Figure 22: Zooplankton Sample Species Composition in Chapman Lake, 2016

5.3.4 Tributary Stream Fish Habitat Characteristics

Fish habitat assessments were completed for each of the streams that outlet into Chapman Lake at the eastern portion of the lake, as part of the 2016 study. Figure 9 provides the location where the habitat assessments were completed. Appendix F provides a summary of the RISC stream habitat cards that were completed including the physical characteristics of the stream and assessment of the quality of habitat for fish. Table 15 below provides habitat quality definitions and indicators.

Table 15: Definition and Indicators of Fish Habitat Types

Criteria	Habitat Ranking		
	High	**Moderate**	**Low**
Definition	Habitat that is critical in sustaining a subsistence, commercial, or recreational fishery, or any species at risk (i.e., aquatic red- and blue-listed species, those designated by COSEWIC, or those listed under SARA), or because of its relative rareness, productivity, and/or sensitivity[1]	Habitat that is used by fish for feeding, growth, and migration but not deemed critical. This category of habitat usually contains a large amount of similar habitat that is readily available to the stock.	Habitat that has low productive capacity and contributes marginally to fish production.
Indicators[2]	The presence of high-value spawning or rearing habitat (e.g., locations with an abundance of suitably sized spawning gravels, deep pools, undercut banks, or stable debris, which are critical to the population present), or the presence of any SARA-listed species, its residence, or critical habitat.[3]	Important migration corridors. The presence of suitable spawning habitat. Habitat with moderate rearing potential for the fish species present.	The absence of suitable spawning habitat, and habitat with low rearing potential (e.g., locations with an absence of deep pools, undercut banks, or stable debris, and with little to no substrate of spawning gravels suitably sized for fish species present).

[1] *See http://www.cosewic.gc.ca/.*

[2] *The indicators provided here are highly generalized and may require regional interpretation. For further information on conducting a habitat assessment, see: Fisheries and Oceans Canada's Working Near Water in BC and Yukon website (http://www.pac.dfo-mpo.gc.ca/habitat/index-eng.htm) and the BC Ministry of Environment's Fish and Fish Habitats website (http://www.env.gov.bc.ca/wld/fishhabitats/index.html).*

[3] *The* Species at Risk Act *prohibits the harming, harassing, capturing, taking, or killing of a species at risk or the destruction of its residence, or critical habitat as defined by act. For more information about SARA-listed species and their habitat, see: http://www.sararegistry.gc.ca*

One site (north eastern stream) was classified as having high quality fish habitat with suitable habitat for all stages of fish life cycles (spawning, rearing, overwintering, migration, and spawning/holding). The south eastern stream was rated as moderate, with no spawning or staging and holding areas. In general, the south eastern stream had a higher gradient (SE stream 4%, NE Stream 2%), greater channel width (SE stream 7.2 m bankfull, NE stream 6.9 m bankfull) and residual pool depth (SE stream= 16 cm, NE stream=5 cm) in comparison to the north eastern stream. The north eastern stream had a higher proportion of small cobbles and gravels with the south eastern stream having a higher proportion of larger cobbles and boulders. Figure 23 provides the quantitative estimate of the stream sediment composition and Photos 7 through 11 provide additional documentation of the two streams.

Following the ratings provided in Table 15 the north east stream habitat rating is high as it appears to be the stream that supports most of the spawning and rearing for Chapman Lake DV. There is approximately 240 m of good spawning and rearing habitat that is currently accessible in this tributary. Currently a log jam limits upstream migration but within 100 m upstream of the logjam the stream gradient appears to increase significantly and the stream substrate is dominated by boulders and bedrock. Approximately 225 m of the south east tributary is accessible would be rated as low to moderate based on observations that included the dominance of cobble/boulder substrate with limited spawning substrate, no DV were captured

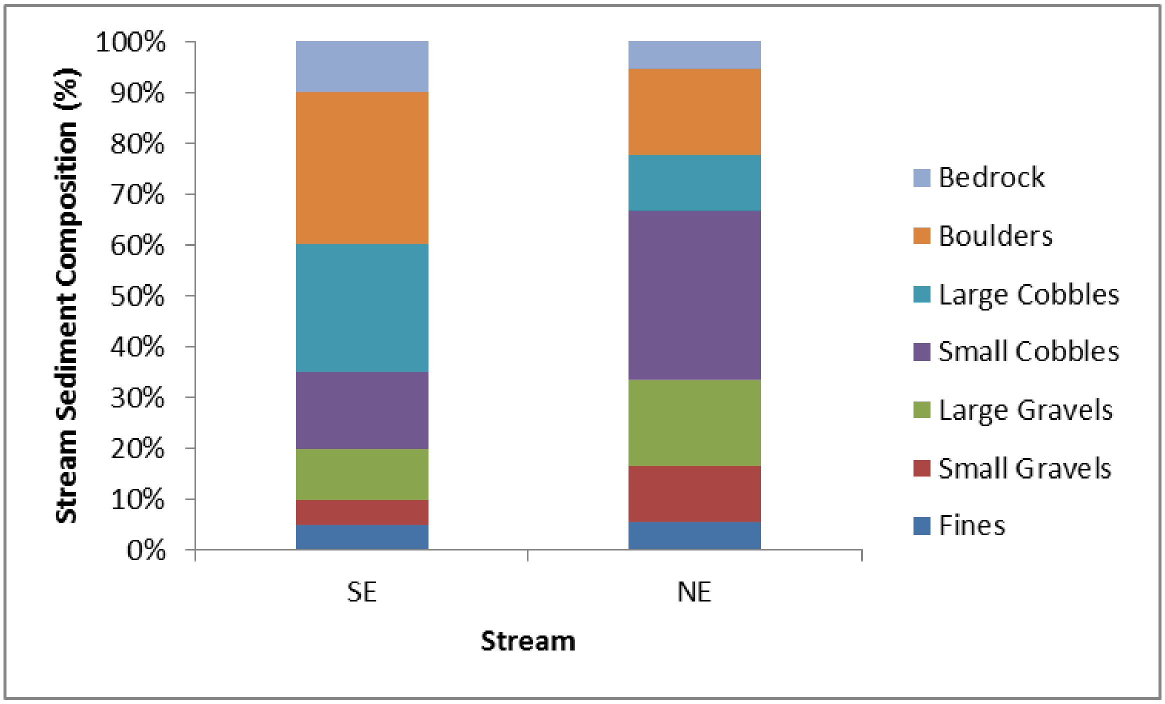


Figure 23: Quantitative Estimate of Eastern Inlet and Stream Sediment Composition, 2016

5.3.5 Aquatic Vegetation

Aquatic vegetation assessments conducted during the 2016 study were intended to confirm findings of the 1998 study and primarily was observational. The assessment focussed on the eastern portion or the lake, as a higher proportion was concentrated in this area. Samples of the dominant plant types were collected and identified by an AECOM plant specialist. Aquatic vegetation was considered anything below the high water mark of the lake, submergent vegetation.

During the 1998 field investigation, characterization of the horizontal and vertical distribution of aquatic plant species were completed using transects surveys at various locations around the lake. Studies also assessed submergent vegetation below the high water level of the lake. The study was conducted later in the summer where the lake levels were approximately 3 m below normal high water levels. The dominant species of aquatic vegetation noted in 1998 was bristle-like quillwort (*Isoetes echinospora*), which was found growing on suitable substrates throughout the lake. An extensive strand of this species was present at the east end of the lake. Narrow-leafed bur-reed (*Sparganium sp*., possibly *S. angustifolium*) and pondweed (*Potamogeton sp*., possibly *P. gramineus*) were observed on the exposed lake bed or infrequently in shallow water at the east end of the lake.

During the 2016 study, two bands of aquatic vegetation were noted to occur above the study water level and a separate type below the water line. The dominant plant species was identified as western quillwort (*Isoetes occidentalis*) and narrow-leaved bur-reed (*Sparganium angustifolium*). The narrow leaved bur-reed was found closer to the shoreline, near the terrestrial and aquatic interface. Western quillwort was present near the water edge or submerged in the shallows.

Similar aquatic vegetation species observations were made between the 1998 and 2016 assessments. Differences were noted in the species of quillwort plant identified. In 1999 the quillwort *Isoetes echinospora* was noted; however, *Isoetes occidentalis* was identified during the 2016 survey. Identification of the plant species in 2016 followed the Illustrated Flora of British Columbia identification guidebook (2000) and the key characteristic in the determination of species was observation of rigid and stiff leaves of *Isoetes occidentalis*. Typically, *Isoete echinospora* have leaves that are characterized as being flaccid, which was not observed. Distribution of the aquatic vegetation was similar to that observed in 1999 (Whitehead). The majority of the aquatic vegetation was observed along the shallows, primarily at the eastern and western inlets and outlet areas of the lake. Minimal aquatic vegetation was observed along the southern perimeter of the lake, as it was characterized as having greater sediment size and steeper slopes.

5.3.6 Chapman Creek

Fisheries information was gathered using the FISS database for Chapman Creek and Chapman Lake (FISS 2016). Fish species found in Chapman Creek include five species of anadromous fish: coho (*Oncorhynchus kisutch*), Chinook (*O. tshawytscha*), chum (*O. keta*), pink (*O. gorbuscha*), steelhead (*O. mykiss*) and coastal cutthroat. These fish can access the first 6.8 km of Chapman Creek up to an impassable series of two waterfalls. In 2015 and 2016 the SCRD commissioned FSCI Biological Consultants to conduct a study of low summer flows in Chapman Creek. The purpose of the study was to determine the limitations imposed on salmonid populations in the lower sections of Chapman Creek during late summer flow conditions. FSCI's report on the findings in 2015 and 2016 is provided in Appendix G and summarized below.

FSCI assessed habitat conditions through a range of flows from 0.1 m^3/s to 2.2 m^3/s. The report looked at the amount and quality of habitat available for rearing juveniles and migrating adults, including the determination of restrictions to upstream migration. The assessment concluded that a flow of 0.2 m^3/s was adequate to support rearing juveniles and upstream migration for adult salmon based on 2016 conditions. However, a site in the lowest section of Chapman Creek (Reach 1) was identified where migration could be restricted at low flows by the deposition of a gravel bar creating an area of shallow riffles. This gravel bar was created when the creek channel was confined by the construction of the Highway 101 Bridge. The configuration of the gravel bar changes from year to year during high flows and was expected to vary from year to year depending on movement of gravels during high flow events. The timing of the low water conditions will normally only affect the migration of pink and chinook salmon. Chinook and pink salmon have been introduced to the system and appear to be sustained through hatchery production. The more important local species, chum and coho typically do not start to migrate into the creek until later in the fall, end of September at the earliest when water levels are typically increasing with the onset of fall weather. The FSCI report recommends that local stakeholders (i.e. Sunshine Coast Salmonid Enhancement Society, Fisheries and Oceans Canada, Ministry of Transportation, SCRD) prepare a plan to facilitate getting salmon around this section if monitoring indicates that it is restricting upstream migration during late summer low flow.

5.4 Vegetation

5.4.1 Methods

5.4.1.1 Desktop Review

AECOM conducted a desktop review of information from the following sources to acquire information on the biophysical environment in the Study Area:

- Impact Assessment Report – Sunshine Coast's Proposed Water Storage Project (Floating Pump Station) on Chapman Lake, In Tetrahedron Provincial Park (1999)

- Terrestrial Ecosystem Mapping (TEM) data prepared by Timberline Natural Resource Group Ltd. For International Forest Products Ltd. (2008)
- Management Plan for Tetrahedron Provincial Park (1997)
- BC Parks Management Plan – Background Document, Tetrahedron Provincial Park prepared by Doug Leavers Consulting (1996)
- iMapBC: a spatial information tool that provides public access to land, resource and geographic information stored in the Land Resource Data Warehouse (LRDW)
- Ecological Reports Catalogue (EcoCat): a database of digital reports and publications, and their associated files including maps, datasets, and published inventory information. EcoCat contains reports for a variety of disciplines, including terrestrial species and habitats, floodplain mapping, ground water, and vegetation
- BC Conservation Data Centre (BC CDC): a database that includes information on plants, animals, and ecosystems at risk in BC
- BC Species and Ecosystem Explorer: for authoritative conservation information on species and ecosystems at risk, plants, animals, and ecological communities in BC
- Peer-reviewed websites such as E-Fauna and E-Flora BC
- Published literature on general ecology and population dynamics of relevant species.

5.4.1.2 Fieldwork

Fieldwork for this project was completed to achieve a comprehensive understanding of the ecosystems that surround Chapman Lake, document the quality and types of wildlife habitat that these ecosystems support and to opportunistically record any wildlife or wildlife sign as well as any rare or endangered plants.

On the week of August 22nd 2016 fieldwork for the study area was completed over a 3 day period. Access to Chapman Lake was by helicopter and a crew of two terrestrial ecologists completed 11 plots (5 full plots & 6 visual plots). A reconnaissance of the study area was also carried out by helicopter and areas between plots were traversed by foot or by boat. The photographs 15 to 26 in the Photo Log are a selection of photographs taken during the terrestrial fieldwork representing the highlights of the field study.

5.4.1.3 Terrestrial Ecosystem Mapping

Terrestrial Ecosystem Mapping (TEM) was chosen as the basis for the terrestrial baseline for this project as it is the standard for ecosystem classification in BC. The TEM for this report is based on the Biogeoclimatic Ecosystem Classification (BEC) system and describes the diversity, relative abundance, and distribution of vegetation communities and structural stages for lands where vegetation may be affected by the Project. AECOM acquired the Chapman Landscape Unit TEM completed by Timberline Resource Ltd. 2008 from the BC government; unfortunately the mapping was not completed for Tetrahedron Provincial Park surrounding Chapman Lake. It was determined that TEM would be undertaken by AECOM for the area surrounding Chapman Lake within 500 meters. The legend used for the 2008 Chapman Landscape Unit TEM, was adopted for the purpose of this TEM.

Up to three site series were noted for each TEM polygon. The percentage of each site series is indicated by deciles ranging from 1 to 10 (1=10%; 10=100%). Decile 1 is greater or equal to Decile 2, which must be greater or equal to Decile 3. If the first two deciles total 10 then the third decile is left blank (e.g., 7-3). Each decile represents either a vegetation community; described in either the *Field Guide for Site Identification and Interpretation for the Vancouver Forest Region (Figure 1)* or the *Wetlands of British*

Columbia: A Guide to Identification or a non-vegetation unit code defined in the Standard for Terrestrial Ecosystem Mapping in British Columbia Guide.

			Soil Nutrient Regime				
		Actual	**Very Poor**	**Poor**	**Medium**	**Rich**	**Very Rich**
	Actual	**Relative**	**A**	**B**	**C**	**D**	**E**
Soil Moisture Regime	SD	0					
	SD	1		**02**			
	F	2		**Zonal**			
	F	3		**01**		**03**	
	F	4					
	M	5		**04**		**05**	
	VM	6		**06**		**07**	
	W	7		**08**		**09**	

Figure 24: Mountain Hemlock windward moist maritime Edatopic Grid

5.4.2 Vegetation Overview

Chapman Lake and the surrounding forest are within the Mountain Hemlock moist maritime windward variant (MHmm1) Biogeoclimatic Ecosystem Classification (BEC) zone, subzone and variant. Forest cover around Chapman Lake and the upper Chapman Creek watershed consists of mountain hemlock (*Tsuga mertensiana*), yellow cedar (*Xanthocyparis nootkatensis*) and Pacific silver fir (*Abies amabilis*), while lower elevations in Tetrahedron Provincial Park contain western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*; Triton 2006).The canopy formed by the tree cover varies from relatively open to dense. Throughout the park, semi-open meadows, marsh complexes, and areas of dense shrub [e.g., blueberry (*Vaccinium* sp.)] are also found (Whitehead 1999).

The mid and lower reaches of the Chapman Creek watershed, outside the park boundaries, fall within the Coastal Western Hemlock very wet maritime submontane (CWHvm1) biogeoclimatic zone, subzone and variant, and are characterized by forests dominated by Douglas fir (*Pseudotsuga menziesii var. menziesii*), western hemlock, western redcedar and a variety of understory shrub species. Widespread logging and associated disturbance and revegetation have resulted in a change in forest composition from old-growth conifer forests to communities with a higher proportion of broadleaved trees. Much of the riparian zone in the mid and lower reaches of Chapman Creek now consists of alder stands (Whitehead 1999). The park is situated within the Southern Pacific Ranges ecosection and Coastal Western Hemlock/Mountain Hemlock biogeoclimatic zones. The park contains one of the oldest undisturbed forests in Canada with stands containing trees over 1,000 years. Semi-open meadows, marsh complexes and dense understorey (e.g. blueberry) are characteristic of the park, which also contains ten lakes (MELP 1997).

5.4.3 Riparian Vegetation

Riparian vegetation surveys were completed in 1998 (Whitehead 1999) as part of impact assessment from the 5 m lake depth to 5 m above the high water level. The riparian area is largely forested to the high water level with several smaller areas where shrubs and/or herbaceous species predominate. The four habitat types identified include forest, shrubland, wet meadow and wetland/aquatic. Forest vegetation consisted of mountain hemlock and amabilis fir with some yellow cedar. The shrub layer was dominated by Alaskan blueberry (*Vaccinium alaskaense*) and oval-leaved blueberry (*Vaccinium ovalifolium*) with the herb layer consisting of moss. Meadow and wetland areas contained a graduation from one to the other with an increase in soil moisture. Meadow areas tended to be moist due to subsurface drainage from hillslope areas. Vegetation growth within the lake that was less than 2 m in depth was considered part of the wetland habitat.

The riparian vegetation survey was updated in 2016 finding similar results to the 1998 study. The meadows and wetlands referenced in the 1998 study are now referred to as fens and marshes.

5.4.4 Sensitive Species

A list of plant species potentially within the study area was compiled using the BC Conservation Data Centre database. The same search categories as above were used to compile the information. Table 16 provides a summary of the resulting species, including the BC designation and Species at Risk statuses. A total of seven sensitive BC species were identified, with no SARA listed species results. During the fieldwork no rare plant species were identified.

Table 16: Sensitive Plant Species in the Sunshine Coast Forest District

Common Name	Scientific Name	Species Type	BC Status	SARA Status
Elegant Jacob's-ladder	*Polemonium elegans*	Dicot	Blue	
Kamchatka spike-rush	*Eleocharis kamtschatica*	Monocot	Blue	
Poison oak	*Toxicodendron diversilobum*	Dicot	Blue	
Roell's brotherella	*Brotherella roellii*	Nonvascular plant	Red	
Slimleaf onion	*Allium amplectens*	Monocot	Blue	
Small spike-rush	*Eleocharis parvula*	Monocot	Blue	
Snow bramble	*Rubus nivalis*	Dicot	Blue	

A search was also conducted in the BC Conservation Data Centre database for terrestrial ecological communities in the area surrounding Chapman Lake. Criteria used to focus the search results was applied using the regional and forest districts for the Sunshine Coase filters. In addition, the biogeoclimatic zone of Coastal Western Hemlock, subzone very wet maritime and montane (CHWvm2) variant and Mountain Hemlock windward Moist Maritime (MHmm1) filters were applied. Table 17 provides the results of the ecological community database search of the area, which includes BC sensitive species status.

Table 17: Sensitive Ecological Community Plant Species in the Sunshine Coast, Mountain Hemlock Windward Moist Maritime Biogeoclimatic Zone, Subzone and Variant (MHmm1)

Common Name	Scientific Name	Site Serries Number	Vegetation Community Code	BC Status	Endemic
Mountain Hemlock - Amabilis fir/ Blueberry	*Tsuga mertensiana - Abies amabilis/ Vaccinium alaskaense*	01	MB	Yellow	
Mountain Hemlock - Amabilis fir/ Mountain-heather	*Tsuga mertensiana - Abies amabilis/ Phyllodoce empetriformis*	02	MM	Yellow	
amabilis fir - mountain hemlock / oak fern	*Abies amabilis - Tsuga mertensiana / Gymnocarpium dryopteris*	03	MO	Yellow	
Sitka sedge / peat-mosses Fen	*Carex sitchensis / Sphagnum* spp.	-	TS	Red	Yes
Sitka willow / Sitka sedge	*Salix sitchensis / Carex sitchensis*	-	HM	Blue	Yes
mountain hemlock - amabilis fir / five-leaved bramble	*Tsuga mertensiana - Abies amabilis / Rubus pedatus*	04	AB	Yellow	
amabilis fir - mountain hemlock / rosy twistedstalk	*Abies amabilis - Tsuga mertensiana / Streptopus lanceolatus*	05	MT	Yellow	
mountain hemlock - yellow-cedar / deer fern	*Tsuga mertensiana - Xanthocyparis nootkatensis / Blechnum spicant*	06	MD	Yellow	
yellow-cedar - mountain hemlock / Indian hellebore	*Xanthocyparis nootkatensis - Tsuga mertensiana / Veratrum viride*	07	YH	Yellow	
mountain hemlock - yellow-cedar / common red peat-moss	*Tsuga mertensiana - Xanthocyparis nootkatensis / Sphagnum capillifolium*	08	YS	Yellow	
yellow-cedar - mountain hemlock / skunk cabbage	*Xanthocyparis nootkatensis - Tsuga mertensiana / Lysichiton americanus*	09	YC	Yellow	Yes

5.4.5 TEM Results

A total of 80 TEM polygons (Appendix H) have been delineated using 11 identified site series (Table 18 & Appendix H). The most common site series is Mountain Hemlock - Amabilis fir/ Blueberry , which is found in 48 polygons covering 141.33 ha, and is the dominant site series in 32 polygons (Appendix H, Table 4) (Photograph 23). The HmBa-Blueberry site series occurs on middle to upper positions on gentle slopes with deep, medium textured soils, and is considered submesic to mesic upland habitat (Appendix H, Table 4). The structural stage for the site series ranges from a shrub/herb structure (structural stage 3) to mature old-growth forest (structural stage 7).

Table 18 provides the TEM of the construction area while the TEM of the entire lake study area is provided in Appendix H (see Figure 25).

The second most common site series is Sitka sedge / peat-mosses Fen, which is found in 26 polygons and is the dominant site series in 21 polygons (Appendix H; Table 18) (Photograph 21). The Sitka sedge / peat-mosses Fen site association occurs on gentle to level slopes with poor drainage typically adjacent to watercourses especially near the eastern end of Chapman Lake (Table 18), (Figure 5-19), Sitka sedge / peat-mosses Fenis a wetlands, and is therefore considerably wetter than Mountain Hemlock - Amabilis fir/ Blueberry. Within the Study Area three site series have been classified as wetlands, including forested (HmYc-common red peat-moss, YcHm-Skunk cabbage) and non-forested Fen (Sitka sedge / peat-mosses) and Marshes (Sitka willow / Sitka sedge; Photograph 20) as well as open water (Appendix H, Table 18). Wetlands are found in 34 polygons and are the dominant site series in 25 polygons (H, Table 18). The most common wetland site series is the Sitka sedge / peat-mosses Fen. These sites occur in poorly drained organic soils and on gradual slopes with relatively slow moving seepage.

Eight polygons (72, 73, 74, 76, 77, 78, 79 and 80) containing upland forests and wetlands intersect the proposed project site. Site series include Sitka sedge / peat-mosses Fen, Mountain Hemlock - Amabilis fir/ Blueberry, amabilis fir - mountain hemlock / oak fern and mountain hemlock - yellow-cedar / deer fern (Table 18). The wetlands cover approximately 49.6 ha of the project site (Appendix H), but are only dominant in 26 polygons.

Table 18: TEM Site Series Information

Common Name	Scientific Name	Site Serries Number	Vegetation Community Code	Area
Mountain Hemlock - Amabilis fir/ Blueberry	*Tsuga mertensiana - Abies amabilis/ Vaccinium alaskaense*	01	MB	141.33
Mountain Hemlock - Amabilis fir/ Mountain-heather	*Tsuga mertensiana - Abies amabilis/ Phyllodoce empetriformis*	02	MM	4.93
amabilis fir - mountain hemlock / oak fern	*Abies amabilis - Tsuga mertensiana / Gymnocarpium dryopteris*	03	MO	3.65
Sitka sedge / peat-mosses Fen	*Carex sitchensis / Sphagnum* spp.	-	TS	45.27
Beaked sedge – Water sedge Marsh	*Carex utriculata – Carex aquatilis*	-	HM	0.92
mountain hemlock - amabilis fir / five-leaved bramble	*Tsuga mertensiana - Abies amabilis / Rubus pedatus*	04	AB	6.89
amabilis fir - mountain hemlock / rosy twistedstalk	*Abies amabilis - Tsuga mertensiana / Streptopus lanceolatus*	05	MT	19.44
mountain hemlock - yellow-cedar / deer fern	*Tsuga mertensiana - Xanthocyparis nootkatensis / Blechnum spicant*	06	MD	3.28
yellow-cedar - mountain hemlock / Indian hellebore	*Xanthocyparis nootkatensis - Tsuga mertensiana / Veratrum viride*	07	YH	8.80
mountain hemlock - yellow-cedar / common red peat-moss	*Tsuga mertensiana - Xanthocyparis nootkatensis / Sphagnum capillifolium*	08	YS	1.31
yellow-cedar - mountain hemlock / skunk cabbage	*Xanthocyparis nootkatensis - Tsuga mertensiana / Lysichiton americanus*	09	YC	0.31
Total				243.66

Table 19: Non-vegetated TEM Areas

Common Name	TEM Code	Area
Open Water	OW	3.08
River	RI	0.33
Talus	TA	4.20

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\Vegetation\2016-09-19-TEMArea\Figx-2016-09-19-TEMAreaV2-60485918-002.mxd Date Revised: October 26, 2016 Reviewed By: AM
Paper Size: 11"x17" Scale is referenced to the specified paper size.

Basemapping from Google Earth,
Spatial Data from SCRD, GeoBC, 2015

N
W E
S

0 10 20 30
Metres
1:1,000

NAD 1983 UTM Zone 10N

Legend

TEM Area

Buffer Boundary of Study Area (500m)

Ecosystem Label

6YH3b (Primary - Decile, Site Series Name, Structural Stage)
3MT3b (Secondary - Decile, Site Series Name, Structural Stage)
1MT7b (Teritary - Decile, Site Series Name, Structural Stage)

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Overview Map

Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

TEM Area

26 October 2016

AECOM

Figure 25

5.5 Wildlife Resources

The Chapman Creek watershed supports populations of Roosevelt elk (*Cervus canadensis roosevelti*), Columbian black-tailed deer (*Odocoileus hemionus columbianus*), black bear (*Ursus americanus*), cougar (*Puma concolor*) and other furbearing animals. Mink (*Neovison vison*), marten (*Martes americana*), ermine (*Mustela erminea*), river otter (*Lontra canadensis*), and bobcat (*Lynx rufus*) have historically been trapped in Tetrahedron Provincial Park; all of which are dependent upon old-growth forest stands for vole and other small rodent food sources. Mountain goat (*Oreamnos americanus*) and coyote (*Canis latrans*) have also been reported in Tetrahedron Provincial Park (MELP 1997, DLC 1996, Whitehead 1999).

Many species of birds have been recorded throughout the area, including peregrine falcon (*Falco peregrinus*), rosy finches (*Leucosticte tephrocotis*), rock ptarmigan (*Lagopus muta*), grouse, ravens (*Corvus corax*), raptors, songbirds, grouse, eagles, and cavity nesting birds such as nuthatches, three-toed woodpeckers, and red-breasted sapsuckers (*Sphyrapicus ruber*), and duck species (MELP 1997, DLC 1996). Marbled murrelet (*Brachyramphus marmoratus*), a red-listed species, is known to exclusively nest in old growth forest have been recorded in Tetrahedron Provincial Park. This is a small seabird that spends the majority of its adult life on the open ocean. When it comes time to nest marbled murrelets space out and nest on branches of old growth and mature conifers as far as 60 km or more inland (Blood 1998).

Amphibians are common along the lake's border in adjacent wetlands and vernal pools. Reptiles and amphibians recorded in Tetrahedron Park or observed in the Chapman Lake Study Area include Pacific treefrog (*Pseudacris regilla,* Photograph 17), Western toad (*Anaxyrus boreas*), long-toed salamander (*Ambystoma macrodactylum*), northwestern salamander (*Ambystoma gracile*), and garter snake (*Thamnophis sp*.) (Whitehead 1999).

During site investigations, the following wildlife and evidence of wildlife were observed:

- Elk; elk tracks
- Bear scat and tracks (Photograph 19)
- Red fox traks (Photograph 18)
- Bald eagle (*Haliaeetus leucocephalus*)
- American dipper (*Cinclus mexicanus*)
- Belted kingfisher (*Megaceryle alcyon*)
- Rufous hummingbird (*Selasphorus rufus*)
- Steller's jays (*Cyanocitta stelleri)*
- Common raven
- Shorebirds and swallows
- Egg masses, tadpoles, larvae and adults of long-toed salamander, northwestern salamander, and northern Pacific treefrog in wetland
- Water beetles, caddisflies, and water striders in wetland pools

5.5.1 Sensitive Wildlife Species

Species with special conservation status with the potential to occur in the Study Area are listed in Table 20. They were identified based on a review of available information from the area, species range and habitat requirements. These species are listed under SARA, COSEWIC, are provincially listed or a combination of the three.

Table 20: Listed Species potentially within the Chapman Lake Study Area

Scientific Name	English Name	Status				
		Provincial	BC List	COSEWIC	SARA	Global
Ascaphus truei	Coastal Tailed Frog	S3S4 (2010)	Blue	SC (2011)	1-SC (2003)	G4 (2016)
Brachyramphus marmoratus	Marbled Murrelet	S3B,S3N (2015)	Blue	T (2012)	1-T (2003)	G3 (2013)
Cervus elaphus roosevelti	Roosevelt Elk	S3S4 (2010)	Blue			G5T4 (2016)
Chrysemys picta pop. 1	Painted Turtle - Pacific Coast Population	S2 (2012)	Red	E (2006)	1-E (2007)	G5T2 (2007)
Contopus cooperi	Olive-sided Flycatcher	S3S4B (2015)	Blue	T (2007)	1-T (2010)	G4 (2008)
Cypseloides niger	Black Swift	S2S3B (2015)	Blue	E (2015)		G4 (2015)
Epargyreus clarus	Silver-spotted Skipper	S3 (2013)	Blue			G5 (2009)
Galba bulimoides	Prairie Fossaria	S3? (2015)	Blue			G5 (1999)
Gulo gulo luscus	Wolverine, luscus subspecies	S3 (2010)	Blue	SC (2014)		G4T4 (1996)
Hesperia colorado oregonia	Western Branded Skipper, oregonia subspecies	S1 (2013)	Red	E (2013)		G5T2 (2016)
Hirundo rustica	Barn Swallow	S3S4B (2015)	Blue	T (2011)		G5 (2014)
Megascops kennicottii kennicottii	Western Screech-Owl, kennicottii subspecies	S3 (2009)	Blue	T (2012)	1-SC (2005)	G5T4 (2003)
Myotis keenii	Keen's Myotis	S3? (2015)	Blue	DD (2003)	3 (2005)	G3 (2014)
Ophiogomphus occidentis	Sinuous Snaketail	S3 (2015)	Blue			G5 (2015)
Oreamnos americanus	Mountain Goat	S3 (2015)	Blue			G5 (1996)
Parnassius clodius claudianus	Clodius Parnassian, claudianus subspecies	S3S4 (2013)	Blue			G5TNR
Pekania pennanti	Fisher	S3 (2015)	Blue			G5 (2005)
Physella propinqua	Rocky Mountain Physa	S3S4 (2015)	Blue			G5Q (2015)
Physella virginea	Sunset Physa	S3S5 (2015)	Blue			G5Q (2015)
Planorbula campestris	Meadow Rams-horn	S3S4 (2015)	Blue			G4G5 (2015)
Rana aurora	Northern Red-legged Frog	S3S4 (2010)	Blue	SC (2015)	1-SC (2005)	G4 (2015)
Salvelinus confluentus - coastal lineage	Bull Trout - Coastal Lineage	S3 (2011)	Blue	SC (2012)		G4T3T4 (2011)
Sphaerium striatinum	Striated Fingernailclam	S3S4 (2015)	Blue			G5 (2015)

Scientific Name	English Name	Status				
		Provincial	BC List	COSEWIC	SARA	Global
Ursus arctos	Grizzly Bear	S3? (2015)	Blue	SC (2002)		G4 (2000)

Provincial and Global Status Rank Numbering

1 = critically imperiled

2 = imperiled

3 = special concern, vulnerable to extirpation or extinction

4 = apparently secure

5 = demonstrably widespread, abundant, and secure.

S#S# or G#G# = Range Rank; A numeric range rank (e.g., S2S3, G3G4) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).

B = Breeding; Conservation status refers to the breeding population of the species in the province.

N = Nonbreeding; Conservation status refers to the non-breeding population of the species in the province.

T = Infraspecific Taxon (trinomial); The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole (e.g., a G1T2 cannot occur).

BC List

Red: Indigenous species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in BC. Species are considered to be at risk and require further investigation.

Blue: Indigenous species or subspecies considered to be of Special Concern (formerly Vulnerable) in BC. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events.

Yellow: Species that are apparently secure and not at risk of extinction. Yellow-listed species may include red- or blue-listed subspecies.

COSEWIC/SARA Status

E = Endangered: A species facing imminent extirpation or extinction.

T = Threatened: A species that is likely to become endangered if limiting factors are not reversed.

SC = Special Concern: A species of special concern because of characteristics that make it is particularly sensitive to human activities or natural events.

NAR = Not at Risk: A species that has been evaluated and found to be not at risk.

Sources: *BCMOE (2016)*

Notes: *Values that are not applicable are left blank (e.g., federal status of species that have not been assessed by SARA or COSEWIC).*

5.6 Socio-Cultural Studies

The only site specific study carried out in this category was a preliminary field reconnaissance survey to identify the potential for archaeological artifacts to be present in the construction area. The field survey took place on May 31, 2016 by an archaeologist from In Situ Consulting. The archaeologists that carried out the survey did not observe any evidence to indicate that archaeological artifacts are present in the project area, however, the survey was limited to observation of surface conditions. The archaeologist has recommended that excavations be archaeologically monitored and during the initial drawdown of the lake to levels below -3 m an archeologist should investigate the exposed shoreline for artifacts (i.e. toward the end of the construction period when water levels will be at or close to -8 m).

6. Project Effects Assessment and Proposed Mitigation Measures

6.1 Assessment Methodology

The purpose of this section is to identify and assess residual environmental effects related to project activities. Residual effects are those effects remaining after the application of mitigation measures a potential environmental effect related to the project. BC Parks created guidance documents for preparing impact assessment reports for projects within a park (BC Parks 1999) which included a methodology for assessing project impacts. This process suggests rating project effects using the following attributes: direction, magnitude, geographic extent or scope, duration, frequency and confidence of the residual effect on a valued component. Table 21 provides a brief description of each attribute and a general description of the associated ratings. Note that the ratings may be refined for some of the valued components which will be describe in further detail in the appropriate section.

Table 21: Residual Effect Assessment Attributes and Rating

Attributes	Rating		
	Low	**Medium/Moderate**	**High**
Magnitude (the severity of the effect compared to thresholds, or in the context of the affected population)	Effect is apparent, although with little to no difference from baseline conditions	Effect clearly different from baseline conditions, but remains below defined threshold	Effect exceeds threshold (i.e., exceeding water quality criteria)
Geographic Extent (the physical area where the effect occurs)	Effect is apparent only within the Project Site	Effect is evident throughout the local study area	Effect extends beyond the local study area
Duration	Effects short term, evident within only a limited portion of project phases, generally within 1 year	Effects are intermediate term, evident throughout all project phases, generally within 1 to 10 years	Effects long term and persist beyond the life of the project or longer than 10 years
Frequency	Effects are expected to occur only once or sporadically through the life of the project	Effects are expected to occur sporadically through the life of the project.	Effects are expected to occur sporadically or are continuous through the life of the project.
Confidence	Conclusion is uncertain		Conclusion is certain as the VC and the effect are well understood
Direction (note this uses different ratings)	**Positive**	**Neutral**	**Negative**

The assessment ratings are used, in combination with professional judgement, to make a determination of the overall impact of the project on the various environmental components.

6.2 Valued Components

Typically an environmental assessment focuses on key components within or associated with the project and the project setting. Based on the information provided in the Section 5, Current Conditions, we have identified valued environmental and social components in or associated with Chapman Lake and Tetrahedron Park that will be used to assess the effects of the Project. These valued components were selected through informal discussions with stakeholders including the shíshálh Nation, SCRD Staff, professional experience of the authors of this report and previous studies on Chapman Lake. The following table lists the valued components selected for assessment and a matrix showing how they interact with the project.

Table 22: VC's Selected for Assessment

Component	Latin Name	Status	Reason for Inclusion
Water Quality	-	Good Quality	The lake is an important component of the Chapman Creek Water Supply for the Sunshine Coast
Dolly Varden Char	*Salvelinus malma*	Blue Listed	Chapman Lake supports a monoculture of this fish which is unique
Western Toad	*Anaxyrus boreas*	Blue Listed	At risk amphibian likely to be found within the Study Area
Roosevelt Elk	*Cervus Canadensis*	Unlisted	Large ungulate known to be in the study area
Sitka sedge / peat-mosses (Fen)	*Carex sitchensis / Sphagnum* spp.	Red Listed	Red Listed Fen known to be in the study area
Snow bramble	*Rubus nivalis*	Blue Listed	Blue listed plant species known to be on the sunshine coast, potentially in the study area.
Socio-cultural values	-	-	The project area is an important component of the wilderness experience provided by Tetrahedron Park

6.3 Soils and Vegetation

6.3.1 Project Effects and Mitigation

6.3.1.1 Construction

Disturbance during construction will include removal of vegetation, compaction of soils, and excavation of a 5-m deep trench. Efforts will be made to contain the areas impacted by construction to one continuous area rather than creating several smaller areas. The construction is expected to take 3 months. Also, the current plan anticipates a work camp to be assembled at the site. To minimize disturbance to soils and vegetation the camp and laydown will be confined to areas used during the original dam construction in 1978.

Construction will require:

- Regular helicopter flights to the work area and associated noise the establishment of a work camp
- Laydown area for equipment and supplies including on-site fuel containment

- Use of fuels and lubricants for machinery required for works
- Excavation and blasting to create a trench to install a deep water withdrawal pipe
- Disposal of excess overburden and rock removed from the trench drilling through bedrock to install the low level outlet.

Potential effects on terrestrial habitat could result from direct disturbance of vegetation, exposure or compaction of soils, accidental spill of fuels or changes to the hydraulic regime of adjacent wetlands. Most direct disturbance will occur during the construction phase and will be low magnitude, limited extent, low duration and low frequency.

The project requires a laydown site to accommodate for the equipment and supplies necessary for the excavation of the pipe location and the construction of the dam. The laydown site has the potential to cause direct disturbance of vegetation and has been located within the original works area of the 1978 construction site. This area is outside of the wetlands adjacent to the dam and it will allow for the least amount of disturbance while allowing sufficient room to complete the works safely. Other direct disturbance to vegetation could be caused by helicopter rotorwash, additional workspace or clearance of danger trees around the site.

Exposure or compaction of soils may occur from the operation of heavy equipment required to excavate the pipe and build the dam. When soils are exposed it can cause erosion and sediment that can reduce the soil capability, remove nutrients and disturb areas where deposition of sediments occurs. Soil compaction can reduce the porosity of soils thereby causing harm to existing vegetation and reducing the ability for new vegetation to grow.

Accidental leaks and spills can occur from the equipment onsite. Every effort will be made to prevent and contain any leaks or spills; however, it is possible that they could occur. Petroleum products can kill vegetation as well as contaminating the soil.

Hydraulic changes to the wetlands can be caused by any excavation or compaction of soils within or adjacent to any of the wetlands. Changes to the hydrologic conditions may cause the wetland to drain more quickly or more slowly. These situations may cause a change in the vegetation over the short and long term towards a different wetland class or a forested site.

The majority of the identified effects will be repaired through site remediation and restoration works resulting in a medium residual effect. A monitoring plan will be implemented to assure remediation is successful.

6.3.1.2 Operation

Disturbance during operations will be limited to a drawdown of lake surface water below -3 m only to avoid Stage 4 water use restrictions. Other disturbances will be no different than the current operation and maintenance activities that the SCRD undertakes each year at Chapman Lake. This includes visits to check and maintain the infrastructure which occurs a few times a year.

With receding water levels, segments of the shoreline may be exposed which can increase erosion and sedimentation. Adjacent wetlands may experience additional hydrologic draw-downs during drought conditions that would cause the lake to be drawn below the historic norm of -3 meters. Given that these events are relatively infrequent and of short duration, long term effects are not expected.

6.3.1.3 Mitigation

Mitigation measures would include:

- Conducting pre-construction surveys for any rare plants and plant communities and relocate the plants to suitable habitat nearby either permanently or to for use in site rehabilitation after construction
- Application of appropriate erosion and sediment control measures, particularly in area where vegetation is removed and soils disturbed. A plan detailing these measures will be prepared as per Section 5.0.
- Emergency response plans in the event of accidental release of deleterious materials (i.e. sediment, fuel) as identified in Section 7.0.
- Remediate areas used for construction camp and laydown including de-compacting soils, seeding and other plantings to re-establish vegetation and pre-existing habitat values. A full remediation plan will be developed prior to start of construction.
- While all the overburden and any excess rock is expected to be used to reconfigure and stabilise the excavated channel, if there are any excess materials they will be placed within the camp/laydown area and planted with native vegetation. A reclamation plan for overburden and/or rock disposal area would be developed.

6.3.2 Summary of Residual Effects

Table 23 presents the residual effects on vegetation and soils VCs for construction and operation of the proposed project. The effects identified are all low in magnitude and have a limited geographic extent either within the project area or within Chapman Lake and the associated riparian vegetation. The duration and frequency are also considered Low. Our confidence is high given that these types of effects have been well documented on other similar projects and standard mitigation measures can be used to minimize the effects.

6.3.2.1 Soils

Potential residual effects on soils during construction are expected to be a minor amount of compaction and erosion within the project site caused by heavy equipment. After remediation of the project site and given that the work area was already cleared for the original dam construction, the residual effect is expected to have little difference from baseline conditions resulting in a low magnitude. The geographic extent will be within the project footprint and the duration of construction is expected to be 3 months resulting in a low geographic extent and a low duration. The frequency is also low given only one construction period will be necessary to complete the project. Our confidence is high given that many construction projects have been completed using the mitigation measures proposed resulting in minimal effects to soils.

Potential residual effects on soils during operation are expected to be a limited extent of erosion within the Chapman Lake area due to increased drawdown of the lake in years of drought. Soils during operation will again have a residual effect that is expected to have little difference from baseline conditions resulting in a low magnitude. The geographic extent will be within the Chapman Lake area and the duration of drawdown is expected to be less than a few weeks resulting in a low geographic extent and a low duration. The frequency is also low given the drought conditions required for stage 4 restrictions currently happens very infrequently but is expected to gradually become more frequent as climate change alters the summer hydrology. Our confidence is high given that many construction projects have been completed using the mitigation measures proposed resulting in minimal effects to soils.

6.3.2.2 Snowberry

Potential residual effects on snowberry during construction and operation are expected to be nil. Given that the project site has been assessed once and an additional pre-construction rare plant survey will be completed, the residual effect is expected to be none.

6.3.2.3 Sitka sedge/peat mosses (Fen)

Potential residual effects on Sitka sedge / peat-mosses (Fen) during construction are expected to be nil. Given that the project site has been located outside of the mapped wetlands, the residual effect is expected to be none.

Potential residual effects on Sitka sedge / peat-mosses (Fen) during operation are expected to be a limited hydrologic drawdown within the Chapman Lake area due to increased drawdown of the lake in years of drought. These Fens during operation will have a residual effect that is expected to have little difference from baseline conditions resulting in a low magnitude. The geographic extent will be within the Chapman Lake area and the duration of drawdown is expected to be less than a few weeks resulting in a low geographic extent and a low duration. The frequency is also low given the drought conditions requiring stage 4 restrictions have only occurred twice historically. Confidence is moderate given that there is some uncertainty around the amount of hydrologic drawdown the wetlands will experience and how much is a natural product of drought conditions and how much would be due to reduced water levels in the lake.

Table 23: Vegetation and Soils Residual Effect Assessment Attributes & Rating

Valued Component	Phase	Magnitude	Geographic Extent	Duration	Frequency	Confidence	Direction
Soils	Construction	Low	Low	Low	Low	High	Negative
	Operation	Low	Moderate	Low	Low	High	Negative
Snowberry (*Rubus nivalis*)	Construction	N/A	N/A	N/A	N/A	N/A	Neutral
	Operation	N/A	N/A	N/A	N/A	N/A	Neutral
Sitka sedge / peat-mosses (Fen)	Construction	NA	NA	NA	NA	NA	Neutral
	Operation	Low	Moderate	Low	Low	Moderate	Negative

6.4 Wildlife

6.4.1 Construction

Disturbance during construction will include noise from construction, blasting, and helicopters, human/wildlife interaction and removal of wildlife habitat. Efforts will be made to contain the areas impacted by construction to one continuous area rather than creating several smaller areas. The construction is expected to take 3 months, during which time wildlife will likely avoid the work area. Also, the current plan anticipates a work camp to be assembled at the site. To minimize disturbance to wildlife habitat the camp and laydown areas will be confined to areas used during the original dam construction in 1978 and avoid the nearby wetlands.

Construction will require:

- Regular helicopter flights to the work area and noise associated with the construction.
- Laydown area for equipment and supplies including on-site fuel containment.
- Excavation and blasting to create a trench to install a deep water withdrawal pipe .

Potential effects on wildlife habitat and wildlife could result from direct disturbance of wildlife, wildlife habitat or exclusion from habitat areas during site preparation, excavation and construction of the dam. Most direct disturbance will result in the temporary avoidance of wildlife from the project site. The effects to wildlife habitat will be repaired through site remediation and restoration works resulting in a medium residual effect. A monitoring plan will be implemented to assure remediation is successful.

6.4.2 Operation

Deer, bear and other mammals use the lakeshore for drinking water. With receding water levels, segments of the shoreline may be soft, which can interfere with an animal's ability to approach the water. Also, animals crossing the shore to drink may be exposed to increased predation as the water line recedes from the cover provided by riparian vegetation. Whitehead (1999) identified areas around the lake where the substrate is firm, as well as small watercourses and ponds, where animals can access water without undue risk of predation or becoming hampered by soft ground. The potential effects on terrestrial wildlife from additional drawdown of the lake were not considered significant by Whitehead (1999).

Disturbance of terrestrial species and habitat during the operational phase is not considered significant. Drawdown below -3 m will only occur to avoid Stage 4 water use restrictions. Disturbance to wildlife during operation will be limited to human visits to check and maintain the infrastructure which takes place a few times a year. Essentially this aspect will be no different than the current operational and maintenance activities that the SCRD undertakes each year at Chapman Lake. There is no residual effect anticipated due to the infrequent drawdown of the lake below the -3 m level.

During construction and operation the flow from Chapman Lake into Chapman Creek will be monitored and due to the increased drawdown the creek will be able to maintain a minimum flow during drought conditions years. Maintaining a minimum flow within Chapman Creek during drought years is expected to enhance wildlife habitat and access to water downstream resulting in a neutral or positive effect.

6.4.3 Mitigation

Mitigation measures would include:

- Setting up the camp so that wildlife is excluded from entering the camp area.
- Limiting the work area by flagging machine only areas where equipment does not need to go.
- Pre-construction site survey for amphibians, i.e. eggs or tadpoles in ponded water or along the edge of the lake in the vicinity of proposed construction and relocation of any that are found.
- Site hygiene including secure bins for garbage, no garbage left around the site, regular removal of garbage to reduce the risk of human and black bear interaction.
- Application of appropriate erosion and sediment control measures, particularly in area where vegetation is removed and soils disturbed. A plan detailing these measures will be prepared as per Section 5.

- Emergency response plans in the event of accidental release of deleterious materials (i.e. sediment, fuel) as identified in Section 1.
- Remediate areas used for construction camp and laydown including de-compacting soils, seeding and other plantings to re-establish vegetation and pre-existing wildlife habitat values. A full remediation plan will be developed prior to start of construction.
- Develop a reclamation plan for overburden and/or rock disposal area.
- Pre-construction nest searches for migratory birds will be completed if clearing is to be carried out during the nesting window.

6.4.4 Summary of Residual Effects

Table 24 presents the residual effects on wildlife VCs for construction and operation of the proposed project. The effects identified are all low in magnitude and have a limited geographic extent either within the project area or within Chapman Lake and the associated riparian vegetation. The duration and frequency area also considered Low. Our confidence is high given that these types of effects have been well documented on other similar projects.

6.4.4.1 Roosevelt Elk

Potential residual effects on Roosevelt Elk during construction are expected to be a minor amount of disturbance and exclusion within and around the project site caused by heavy equipment and people. After remediation of the project site and given that the work area was already cleared for the original dam construction, the residual effect is expected to have little difference from baseline conditions resulting in a low magnitude. The geographic extent will be within and adjacent to the project footprint and the duration of construction is expected to be 3 months resulting in a moderate geographic extent and a low duration. The frequency is also low given only one construction period will be necessary to complete the project. Our confidence is high given that many construction projects have been completed using the mitigation measures proposed resulting in minimal effects to ungulates.

Potential residual effects on Roosevelt Elk during operation are expected to be a limited extent of exclusion from the lakeshore within the Chapman Lake area due to increased drawdown of the lake in years of drought. Roosevelt Elk during operation will again have a residual effect that is expected to have little difference from baseline conditions resulting in a low magnitude. The geographic extent will be within the Chapman Lake area and the duration of drawdown is expected to only last for a few weeks resulting in a moderate geographic extent and a low duration. The frequency is also low given the drought conditions required for stage 4 restrictions currently happens very infrequently but is expected to gradually become more frequent as climate change alters the summer hydrology. Our confidence is high given that many construction projects have been completed using the mitigation measures proposed resulting in minimal effects to ungulates.

6.4.4.2 Western Toad

Potential residual effects on Western Toad during construction are expected to be a minor amount of disturbance and exclusion within and around the project site caused by heavy equipment and people. After remediation of the project site and given that the work area was already cleared for the original dam construction and the project site is located outside of the wetlands the residual effect is expected to have little difference from baseline conditions resulting in a low magnitude. The geographic extent will be within and adjacent to the project footprint and the duration of construction is expected to be 3 months resulting in a moderate geographic extent and a low duration. The frequency is also low given only one construction period will be necessary to complete the project. Our confidence is high given that many construction projects have been completed using the mitigation measures proposed resulting in minimal effects to amphibians.

Potential residual effects on western toad during operation are expected to be minimal, as wetlands may experience periodic reduction in water levels as a result of lake draw down in years of drought. The residual effect on western toad during operation in the near term is expected to be little difference from baseline conditions resulting in a low magnitude. Over the longer term draw down could reach 8 m causing more substantive reduction in water levels in wetlands. However, in both cases the reduced water levels are expected to occur late in the summer once a majority of tadpoles have gone through metamorphosis and no longer dependent on ponded water. The geographic extent will be within the Chapman Lake area and the duration of drawdown is expected to last only a few weeks resulting in a moderate geographic extent and a low duration. The frequency is also low given the drought conditions required for stage 4 restrictions currently happens very infrequently but is expected to gradually become more frequent as climate change alters the summer hydrology. Our confidence is moderate as specific changes to wetlands are not quantified but timing of amphibian life stages is known.

6.4.4.3 Coastal Tailed Frog

Potential residual effects on Coastal Tailed Frog during construction and operation are expected to be neutral or positive due to increased ability to manage the flow of Chapman Creek. Residual effects are not expected for Coastal Tailed Frog.

6.4.4.4 Migratory Birds

Potential residual effects on Migratory Birds during construction are expected to be a minor amount of disturbance and exclusion within and around the project site caused by heavy equipment and people. After remediation of the project site and given that the work area was already cleared for the original dam construction and the project site is located outside of the wetlands the residual effect is expected to have little difference from baseline conditions resulting in a low magnitude. The geographic extent will be within and adjacent to the project footprint and the duration of construction is expected to be 3 months resulting in a moderate geographic extent and a low duration. The frequency is also low given only one construction period will be necessary to complete the project. Our confidence is high given that many construction projects have been completed using the mitigation measures proposed resulting in minimal effects to migratory birds.

No residual effects on Migratory birds are expected during operation.

Table 24: Vegetation and Soils Residual Effect Assessment Attributes and Rating

Valued Component	Phase	Magnitude	Geographic Extent	Duration	Frequency	Confidence	Direction
Roosevelt Elk (Cervus Canadensis)	Construction	Low	Medium	Low	Low	High	Negative
	Operation	Low	Medium	Low	Low	High	Negative
Western Toad (Anaxyrus boreas)	Construction	Low	Medium	Low	Low	Moderate	Negative
	Operation	Low	Medium	Low	Low	Moderate	Negative
Coastal Tailed Frog (Ascaphus truei)	Construction	Low	Medium	Low	Low	High	Positive/ Neutral
	Operation	Low	Medium	Low	Low	High	Positive/ Neutral
Migratory Birds	Construction	Low	Low	Low	Low	High	Negative
	Operation	NA	NA	NA	NA	NA	NA

6.5 Aquatic Resources

6.5.1 Water Quality

6.5.1.1 Construction

The construction phase of the project has the potential to affect water quality and resources in Chapman Lake and downstream. Potential sources of adverse effects on water quality during construction include:

- Accidental release of fuels, lubricants and other substances used in construction.
- Erosion of soils and release of sediments to the lake or downstream into Chapman Creek.
- Contamination by human and other wastes.
- Blasting and waste rock.

The volumes of fuels, lubricants and other substances can be expected to be relatively small. Precautions will be taken during construction to avoid spills. However, small spills and leaks of hydrocarbons (fuel, grease and oils) or other substances from construction equipment are possible. Fuels, lubricants and other substances used in construction will be stored well away from the water, at least 30 m from the high water line. A Spill Prevention Plan will include details on refueling and maintenance of equipment that will reduce the potential for oils and greases from entering the lake. Guidance is provided in A field Guide to Fuel Handling, Transportation and Storage (BC MWLAP 2002).

The potential for spills to enter the lake waters and streams will be mitigated by providing the on-site workers with appropriate training in the handling and storage of deleterious substances and in spill response. The Spill Prevention Plan will also include specifications for spill cleanup equipment that will be on site during construction and procedures for handling and reporting spills.

To control adverse effects of resuspension of sediment, construction activities will be completed by excavating and installing the intake pipe in the dry. Only at the end of the pipe installation will any work be carried out that could cause sedimentation and degraded water quality. A water management plan will be developed to handle any water that seeps into the construction area and how any sedimentation will be contained during the final installation of the pipe. To assess the effectiveness of this plan and its associated mitigation measures, routine monitoring of water quality in the lake and in Chapman Creek will be carried out. Evidence of degraded water quality will require a review of the mitigation measures and the environmental monitor shall make recommendations for the application of additional measures.

In general the risk to water quality during construction will be low provided that adequate preventive measures are implemented. If mitigation measures are not fully effective, elevated sediment levels released into Chapman Creek should have minimal impact on drinking water as there are numerous pools in the creek that will allow sediments to drop out of suspension during the approximately 17 km course from Chapman Lake to the intake at the water treatment plant.

Residual effects from construction are most likely to come from unforeseen or uncontrolled events such as the work site being inundated due to heavy rain but these will be short term events and conditions are expected to return to normal soon after the event is over resulting in a medium impact.

6.5.1.2 Operation

The operation of the low level outlet will allow the SCRD to draw the lake level down below the -3 m level during periods of drought. The timing of additional drawdown would likely be during late summer and early fall. Opus DaytonKnight (2013) predicted that by 2036 if the SCRD initiated intensive demand side management, including water metering, the existing Chapman Creek storage would be robust enough to handle drought conditions expected to occur as infrequently as once every 15 years and to meet the 1:25 drought conditions an additional 350,000 m^3 of water would be required which amounts to a total drawdown of 4.5 m. Climate change studies do suggest that future conditions will be drier and warmer during the summer which will likely increase the frequency of drought conditions and potentially the need to draw down the lake to -8 m to meet water supply during drought could be 1:25. However, in the near term it appears that a drawn down will be limited to -4 m to – 5 m.

The potential effects of drawdown below -3.0 m on water quality include:

- Increased sedimentation from shoreline erosion, either by wave action or rilling and other effects from rain
- Changes in lake dynamics that causes changes to temperature regimes and/or dissolved oxygen
- Drying of the lake shore in the drawdown area

The current maximum allowed drawdown of 3.0 m exposes approximately 7.3 ha of lake shore. The exposed area will increase to 14 ha at a full drawdown of 8 m. Exposure of this additional area of the lake bed to air and sun effects include partial to complete drying and warming of the sediment surface; physical-chemical reactions in the surface layer; biotic community effects; and, lateral flow of pore water from the upper sediment layer toward the contiguous retreating water. Also the increased area will expose a larger area to erosional effects of rainfall related erosion resulting in increased sedimentation and turbidity in the lake. However, this would be offset by the reduced length of shoreline. At -3 m the shoreline is 2,787 m while at -8 m 2,145 m of shoreline is in direct contact with the lake and exposed to wave erosion. The extent of this effect is unknown but past experience has shown no significant concern with high levels of turbidity in the water leaving Chapman Lake when the water levels were close to -3.0 m.

Concern has been expressed about increased drawdown in the reservoir creating conditions that increase the mercury levels in the fish populations. BC Hydro has been studying this phenomenon in Carpenter Lake, a reservoir on the Bridge River hydroelectric system since the early 2000's. A recent report by Azimuth Consulting (2015) discussed the sources of methyl mercury in reservoirs and how these processes might be working in the Carpenter Lake reservoir. However, Carpenter Lake is a much different situation than Chapman Lake. Carpenter Lake is much bigger and operation of the reservoir can result in up to a 24 m drawdown on an annual basis. The total dewatered area can be up to 2,384 ha. Many areas are dewatered for 41 to 70 days, long enough for vegetation to become established each year and hundreds of hectares with vegetation growth are subsequently flooded and the plant matter decomposes. Also, large areas of sediment are exposed to oxygen and sunlight resulting in chemical changes in the sediment. These processes are proposed as mechanisms for increased methyl mercury in reservoirs. Chapman Lake is much smaller with a maximum are of exposure being 14 ha and the period of exposure being relatively short. Also exposure is most likely to occur at the end of the growing season which limits the opportunity for growth of terrestrial plants in areas that will subsequently be submerged. While not necessarily a measure of methyl mercury available in the food chain, the analysis of water samples from Chapman Lake reported total mercury levels below the detection level of 0.000005 mg/L (less than 0.005 parts per billion; Appendix D). Given the significant differences between Carpenter Lake and Chapman Lake, particularly size and operation, it is not expected that mercury levels in the environment will increase in Chapman Lake during the operational phase of this project.

Concern has also been expressed that an 8 m drawdown could cause instability of the deltas created at the mouths of the major tributaries that flow into Chapman Lake. The two major tributaries are located at the east end of the lake. The bathymetry of that area shows the lake to be generally shallow and the creek deltas are not located on steeply sloping shorelines as is seen at other locations around the lake. Instability of the shoreline in this area that could cause a major movement of lake sediments resulting in a significant release of turbidity is unlikely.

Overall, the potential impact to water quality during times of drawdown between -3.0 m and -8.0 m is not expected to be significant. The frequency of having to draw the lake levels to -8 m is expected to be low in the near term and unknown in the long term as it will depend on what steps the SCRD will take to augment the water supply to meet future growth in the region. Also, the conditions that are expected to cause elevated levels of total suspended solids would likely be associated with large storm events with heavy rain and wind. The lake is known to refill quickly under significant rain events and the rising lake levels would serve to mitigate the shoreline erosion. In 2015 the lake went from a level of -2.9 m to full in 4.5 days with a rain fall of 199 mm.

6.5.1.3 Summary of Residual Effects

The main water quality concern during construction is the accidental release of deleterious substances such as fuel and inundation of the work area causing a period of sedimentation, i.e. high concentration of total suspended solids. The potential for spills can be minimized through supplies of proper containment materials on site and effective spill response training. During operation the only likely water quality concern will be increased concentrations of total suspended solids. It is expected that any change from baseline water quality conditions would be of limited duration.

The following (Table 25) summarizes the effects of the residual effects on quality:

- **Magnitude:** The expected degree of magnitude is low if proper mitigation measures are implemented during construction and maximum drawdown occurs infrequently.
- **Geographic extent:** Changes to quality of water in Chapman Lake that could affect freshwater drinking water quality, or other beneficial uses of the water will be monitored; however, it is anticipated that effects would be confined to the lake. The geographic extent rating would be considered moderate as it could spread throughout the lake.
- **Duration:** Is rated as low. Construction is restricted to a 3 month period and if there are sediment events during operation, they would also be limited to the period of drawdown
- **Frequency:** over the short term a full draw down of 8 m is expected to be a rare event.
- **Confidence:** is moderate

Table 25: Water Quality Residual Effect Assessment Attributes & Rating

Valued Component	Phase	Magnitude	Geographic Extent	Duration	Frequency	Confidence	Direction
Water Quality	Construction	Low	Moderate	Low	Low	Moderate	Negative
	Operation	Low	Moderate	Low	Low	Moderate	Negative

6.5.1.4 Proposed Monitoring and Follow up

Water quality data should be collected during construction to monitor the possible release of contaminants into the lake and into the creek from construction activities. Also, any time the lake is lowered substantially below -3 m a water sampling program should be initiated to confirm the conditions of the lake, including an oxygen and temperature profile, and collection of water samples to compare to the results of the water collected in 2016.

6.5.2 Fish and Fish Habitat

6.5.2.1 Construction

The following issues are expected during the construction phase of the project

- Trapping/stranding fish in the outlet channel when it is dewatered to install the new pipe
- Construction activities such as blasting
- Temporary loss or alteration of habitat when the lake is drawn down to -8 m or more to install the pipe through alteration of lake limnology or restricting fish access to tributary streams

The work area around the dam and the intake channel will be isolated from the lake and it is likely that fish will become trapped in the work area and steps will have to be taken to salvage them to avoid or minimize any harm. Once the water level in the channel is reduced to a wadeable depth, a crew qualified in fish salvages, i.e. use of electrofishers, seine nets and other methods, will collect any fish in the channel and move them into the lake. The fish salvage would have to be repeated if lake levels overtop the coffer dam and the area is re-drained. The fish salvage is an effective mitigation measure for minimizing harm to fish and during the construction phase.

Blasting is expected to be a significant component of trench construction and work below the dam. Fisheries and Oceans Canada provides guidance for blasting around fish bearing waters to avoid causing serious harm to fish. Following these guidelines and working in the dry are effective mitigation measures to avoid harm to fish when blasting.

Riparian and in water habitat in the area surrounding the dam and the outlet channel will be temporarily affected by the construction works. A restoration plan will be developed to ensure any altered fish habitat is restored to pre-construction conditions.

In order to install the low level outlet pipe it will be necessary to draw the lake down to approximately -8 m depending on the type coffer dam used. Aquatic life is constrained by physical and chemical factors of the water column. Typically, biota does not occupy the entire lake volume, but select areas of favourable temperature and oxygen levels. If the lake is drawn down below the -3 m level, the volume and depth of the water will decrease potentially leading to destratification of the water column. However, at full drawn down to -8 m the maximum depth in the lake will still be 22 m which would still support stratification of the waterbody. Also, the rate of drawdown is not expected to be rapid enough to breakdown the stratification. Therefore, it is expected that a cool deeper volume of water will persist even during draw down and will continue to provide a temperature refugia for fish if surface layers become too warm.

The maximum draw down for construction is expected to occur at the end of August or early September and the water level will not stay at that level very long as the onset of fall rains will fill the lake in a few weeks, therefore it is not expected that the smaller volume of water present at -8 m will affect the overall productivity of the lake.

This draw down for construction could also restrict access to the creeks that the Dolly Varden used for spawning. This impact is not expected to impact the Dolly Varden population in the lake. During the 2016 observations of the main creeks at the east end of the lake, it did not appear that a draw down to -8 m would cause a complete blockage as the lake shore gradient in that area is relatively flat. Also, Dolly Varden are likely to spawn later in the fall when the lake is refilling. The 2016 field sampling did not determine the timing of Dolly Varden spawning in Chapman Lake and the fish collected did not appear to be close to reaching spawning condition. The Washington Department of Fish and Wildlife[3] report that Dolly Varden typically spawn when water temperatures drop to 4° to 5° C. According to the data in Figure 8 the surface water temperatures of Chapman Lake don't reach that level until the end of September. Since construction is expected to be complete by mid-September, the lake should be full or filling and any potential barriers to spawning streams would be minimal or similar to current conditions.

6.5.2.2 Operation

The additional infrastructure has the potential to harm fish and fish habitat specifically:

- Increased sedimentation from shoreline erosion degrading habitat
- Decrease in fish habitat through alteration of lake dynamics
- Access to spawning habitat when the lake is drawn down to -8 m
- Potential injury to fish leaving the lake and going over an 8 m dam.
- The intake of the pipe could draw fish into the pipe.

During draw down a greater surface area of the lake littoral area would be exposed to weathering and sediment transport to the water column in Chapman Lake. Increased sediment transport could increase suspended particulate matter in a water body which could decrease the amount of light through the water and increase bacteria growth. High turbidity also reduces light penetration and impairs photosynthesis of submerged vegetation and algae. In the water quality section these affects were expected to be minor as the potential drawdown over the near term is expected to be in the -4 to -5 m range and it is not until late 2020s or 2030s that the demand and increasing drought conditions related to climate change will require drawdowns approaching -8 m. Also, it is expected that the time the lake is below -3 m will be short with precipitation events re-filling the lake in the fall.

The operational draw down effects on spawning fish will differ slightly from the conditions described for the construction phase. During operations the drawdown will only occur during drought conditions, something that will be experienced throughout the watershed. This lack of water may naturally affect access and spawning in the tributary streams by creating such low flow conditions in the creeks that rearing and spawning habitat is severely restricted. There are also a number of smaller groundwater fed streams that outlet to the lake that appear to support some spawning and were observed to support rearing young-of-year fish in 2016. These areas may be affected by the full drawdown by isolating or drying these areas adjacent to the lake. There are multiple age classes of Dolly Varden in the lake and if

[3] http://wdfw.wa.gov/fishing/char/

spawning is restricted in one year due to drought, there will be a cohort of spawners, available to spawn the next year. Also, temperature data suggests that Dolly Varden may not spawn until later in September or October when water levels should be recovering.

The outlet area will be reconfigured to accommodate the -8 m pipe. This will allow modification to the existing dam so that fish that pass over the dam do not get trapped in a moderate sized pool at the base of the dam which becomes cut off from the main channel when water is released from the low level outlet only. In 2016 a number of Dolly Varden were captured in this pool which was completely isolated from the main channel. The current layout (Drawing C-101) is to channel fish passing over the dam to the channel that will carry the water from the -3 m outlet and direct the flow into the main -8 m outlet channel where they will always have access to downstream passage.

The channel immediately downstream of the dam will have to be deepened to accommodate the -8 m outlet which will create an 8 m drop from dam crest to the channel below. The channel will be blasted out of the bedrock to provide a 2 m deep plunge pool. The 8 m drop that fish leaving Chapman Lake will experience is not likely to cause serious harm. Reviews of the effects fish passage at hydro dams on fish by Larinier (2001) reported that dams less than 10 m are considered safe for fish to pass over the provided there is sufficient depth of water at the base. A report by Amaral *et al.* (2014) reported survival of fish passing over dam spillways between 12 and 20 m high was between 98 and 99%. The 8 m drop out of Chapman Lake into the creek is not expected to result in harm to fish.

The new pipe will be fitted with an intake consisting of two 1.9 m diameter openings as described in Drawing C-103. The intake will be fitted with a trash screen with 25 mm openings, intended to prevent sticks and debris from entering the diversion pipe, while minimizing the chance of being plugged by debris. This screen does not meet the criteria in the guidelines issued by Fisheries and Oceans Canada for protecting fish from damage at water intakes. However, fish are not expected to be impacted by this intake. The guidelines are designed to protect juvenile fish. During the 2016 sampling, fish captured in the lake (gill netting and minnow trapping) were between 110 and 190 mm (average = 140 mm), no young of the year were captured in the lake. The smallest fish in the lake are typically over 100 mm in size with significantly better swimming ability than the smaller fish which could become entrained in the pipe or impinged on the trash screen. A study by Mesa *et al* (2004) reported that the upper end sustainable swimming speed for bull trout char in the 110 to 190 mm size range was from 48 to 55 cm/s (~0.5 m/s). Bull trout have similar swimming capabilities as Dolly Varden and are often found in similar habitats. The inlet velocity is expected to be 0.14 m/s, resulting in a maximum inlet velocity roughly 3.5 times less than the swimming speed of the fish potentially present at the inlet.

Fish are unlikely to become entrained into the low level pipe, however, if they are the fish should not be injured by passage through the pipe and into the creek. There will be no significant pressure changes in the pipe and the butterfly valve in a 900 mm pipe should also allow for safe passage of fish. Overall the likelihood of fish becoming entrained in the outlet pipe is low and if they are fish are unlikely to be injured. Fish have been moving downstream and out of Chapman Lake under natural conditions and are unable to return due to water falls present in the canyon immediately below the outlet. The project should not result in any change in the populations of Dolly Varden in Chapman Lake or downstream in Chapman Creek.

6.5.2.3 Summary of Residual Effects

Fish and fish habitat residual effects from the Project are expected to be low in magnitude, restricted to the localized area, a single event of short term duration and reversible. An overall characterization of the residual effects is summarized below and in Table 26.

- **Magnitude**: Is rated as low. While the lake drawdown to -8 m could affect the spawning success of Dolly Varden by restricting access to spawning streams this is only expected to happen infrequently and it will only affect a portion of the population leaving sufficient numbers to spawn the next year. This effect is the same for construction and operation and is not expected to affect the overall viability of the Dolly Varden population in the lake.

- **Geographic extent:** Effects related to fish and fish habitat would occur in and around Chapman Lake with no effects to fish habitat observed expected downstream in Chapman Creek. The geographic extent rating would be considered low.
- **Duration:** Project effects will occur over the life of the project however, there is uncertainty as to how long the project will run as new water supply options will have to be developed to meet future water demand and may reduce the use of this project. Construction effects are only short term and therefore low and the operational effect will occur in any year there is a drought the frequency of draw down affect is expected to be spread out over several years giving duration a medium rating.
- **Frequency:** Frequency of effects is expected to be low as full drawdown conditions are only expected to happen infrequently and should only occur at the end of the summer or early fall with reservoir re-filling starting immediately.
- **Confidence:** Moderate due to the uncertainty of the frequency of drought conditions that will require the lake to be drawn down the 8 m.
- **Direction:** Overall the direction is neutral to negative however, there is a positive component as the pool that fish currently get trapped in when water stops spilling over the dam will be adjusted so fish do not get trapped.

Table 26: Fish Residual Effect Assessment Attributes & Rating

Valued Component	Phase	Magnitude	Geographic Extent	Duration	Frequency	Confidence	Direction
Doll Varden (Salvelinus malma)	Construction	Low	Low	Low	Low	Moderate	Negative
	Operation	Low	Low	Medium	Low	Moderate	Negative

The additional drawdown of Chapman Lake to provide water during times of drought is expected to have a low impact on aquatic resources of the lake due to the temporary and infrequent nature of the drawdown. Also, effects on the spawning population in a drought year may not be solely attributed to lake drawdown as drought conditions would also cause low flows in the creeks used for spawning. Any effect on the Dolly Varden population in a drought year would be offset by spawning the following year.

6.5.2.4 Proposed Monitoring and Follow up

The effects on fish and fish habitat from the project activities that could occur include increased sedimentation from shoreline erosion, decrease in fish habitat .

The follow up monitoring should include comparisons of fish habitat characteristics with background level collected during baseline studies conducted in Chapman Lake in 1998 and 2016 studies. Background information includes:

- Water quality
- Sediment composition
- Benthic invertebrate composition and density
- Zooplankton composition

- Aquatic vegetation location and composition
- Inlet stream fish access and usability.

Indicators of effects of the project on fish and fish habitat include presence and distribution of fish; quality and quantity of habitat for all sensitive parts of lifecycles; and, primary and secondary productivity of watercourses (e.g. benthic invertebrate community). These indicators can be measured and can be used to assess effects on the productive capacity of fish habitat. The following effects would be assessed:

- Changes in habitat quality and quantity.
- Disruption in fish movements.
- Change in the density of Dolly Varden in the project area.

The construction year provides an opportunity to confirm the findings of this study as the lake will have to be drawn down to -8 m. A study during construction should include assessment of fish and fish habitat around the lake and in the tributary streams, including access to those streams. Mitigation measures will be implemented to minimize the impacts to fish and fish habitat during construction. Disturbed areas would be restored to pre-construction conditions and follow a restoration plan that will be created for this project. A qualified professional will be on site to ensure construction occurs according to the construction environmental management plan and that the area is restored according to the restoration plan, created for the project.

6.6 Socio-Cultural Effects

6.6.1 Park Use

Special regulations have been applied to Tetrahedron Park because the park encompasses the headwaters of Chapman and Gray Creeks that are part of the community water supply. Park use has been limited to hiking, cross country skiing and overnight use of cabins, specifically overnight stays are only allowed in the cabins, no mechanized vehicles are permitted. According to the Tetrahdron Outdoor Club web site[4] , the majority of overnight visits to the park occur in the winter from cross country skiing. The following provides a discussion of the potential effects this project may have on park use.

6.6.1.1 Park Access

There will be no changes to park access during construction or operation. Helicopters will be used to move people and equipment to the site. The proposed works during construction would not obstruct the existing hiking trails.

6.6.1.2 Aesthetics and Visual Values

Chapman Lake is not highly visible from the surrounding terrain and trails due to its position at the foot of steep slopes. Chapman Lake is a visual feature of the area but can only be appreciated from a close distance directly from the shore or from the air.

Construction will affect the visual quality for some hikers passing the construction site. While park use is focused primarily during the winter months, the few users that might pass by Chapman Lake during construction may find the construction camp and excavation work intrusive. Providing information signs

[4] www.tetoutdoor.ca/

at trail heads and on the BC Parks and Tetrhedron Outdoor Club websites could be used to let potential users know that construction activity is taking place at the west end of the lake.

6.6.1.3 Air Quality

During the construction phase helicopters and various types of equipment used for excavating the channel will be emitting exhaust. All equipment should be in good working order and well maintained to minimize the impact to air quality. The construction site is in a mountainous area and air emissions are likely to disperse quickly, however, no air quality modelling has been carried out. The potential sources of impacts to air quality are considered minor due to the small scale and

The operation phase is not expected to have any effect on air quality. Large reservoirs with wide expanses of exposed soil during draw down are known to be sources of dust. The area that will be exposed at a full draw down of 8 m will be 14 ha and likely not sufficient area to generate large amounts of dust. Also because the lake is in a confined valley surrounded by tall mountains there isn't a long fetch that would create the conditions that would mobilize dust I significant quantities. Also, the lake sediments contain a high organic content that tends to hold the sediments together and limits the fraction that is small enough to become airborne during periods of wind (Whitehead 1999).

6.6.1.4 Noise

The use of helicopters and earth moving equipment, generators and blasting will be primary sources of noise during construction. Noise can disturb park users and affect wildlife. During construction helicopters will be used to transport people, equipment and supplies to the work site. Several trips per day will likely be required during the initial start-up and then intermittently during the construction phase. During construction noise would also be generated through use of an excavator, generators, power tools and other incidental construction activities. Recreational use of the trail near the project site is reported to take place mostly during the winter (Whitehead 1999); however, there is known summer use of trails around Chapman Lake.

The potential effect to the area from construction noise will be to area wildlife and human park users. The greatest wildlife impacts will be to those species sensitive to noise, such as nesting birds during breeding season. Mitigation measures for helicopter use includes the development of a standard flight path that can be used to efficiently fly between the pick-up and drop off spots but also minimize flying close to park trails and any sensitive environmental features such as active raptor nests. Additional mitigation measures to limit impact on park users could include scheduling the noisiest activities (i.e. blasting and helicopter use) to mid-day hours. Noise associated with ground based activities isn't likely to travel far from the site due to the surrounding forest and mitigation measures such as ensuring equipment and noise mufflers are in good working order should limit the impact.

There is no additional noise impact associated with the operation of this gravity fed system. The valve controls will be operated remotely by the SCRD and helicopter visits to the site will be similar to the frequency of visits to the site for the existing facility.

6.6.2 Cultural Values

As indicated in Section 5.6, there is no evidence of archaeological values in the construction area but this finding was based on observation of ground conditions. While impacts to archaeological resources are expected to be low or non-existent, it is recommended that archaeological monitoring be carried out when excavating soils. A chance find procedure will be drawn up as part of the Environmental Management Plan.

6.6.3 Summary of Residual Effects

The construction phase has the highest potential to disrupt park use with the use of helicopters, earth moving equipment, generators and blasting all having the potential to disrupt the recreational enjoyment of a wilderness area. This will last for 3 months over the summer but once constructed the mechanics of withdrawing the extra water from Chapman Lake will have little effect on park use. The drawdown of the lake to -8 m would likely be judged by park users as an impact to the visual quality of Chapman Lake. This aesthetic impact will be infrequent and during the late summer and early fall period, a time when park use is low. A process of informing park users of the condition of the lake if it is being drawn down may help mitigate the impact.

At this time it is unknown but judged to be unlikely that there are any archaeological sites present in the project area.

The residual socio-cultural impacts are considered to be a low magnitude and geographically confined to the project area. The duration for both construction or operational impacts are expected to be short, confined to the last weeks of summer and early fall. The construction effects will occur once and the operation effects could occur multiple times but on an infrequent basis, current analysis suggests full drawdown of 8 m maybe on the order of 1 in 25 years.

Table 27: Socio-cultural Residual Effect Assessment Attributes & Rating

Valued Component	Phase	Magnitude	Geographic Extent	Duration	Frequency	Confidence	Direction
Socio-cultural	Construction	Low	Low	Low	Low	Moderate	Negative
	Operation	Low	Low	Low	Low	Moderate	Negative

7. Environmental Management Plan

Prior to start of construction a detailed Environmental Management Plan (EMP) will be prepared and provided to BC Parks, Ministry of Forests Lands and Natural Resources Operations and the shíshálh Nation for review and approval. The plan will identify the mitigation strategies to offset each of the construction impacts identified in this report and will define the role of an environmental monitor and the frequency of monitoring during the construction phase. The following provides high level content to be included in the Construction EMP. A final, detailed EMP will be developed once specific construction details are known (likely when a construction contractor is selected):

- Environmental monitor(s) and frequency of monitoring including roles and responsibilities
- Daily monitoring form to be completed by the monitors
- Reporting requirements
- Details on how the mitigation measures will be implemented including:
  - Sediment and erosion control
  - Management of human waste
  - Noise management program
  - Management of visual aesthetics
  - Water quality monitoring
  - Protection of riparian vegetation
  - Wildlife management
  - Chance find procedures for archaeological resources
  - Site restoration plan based on the ecological conditions and the current vegetation found in the areas that will be disturbed
- Provision for pre-construction site visit to identify the presence of any rare or endangered plant species in the area to be used for the worker camp and equipment and supplies storage.
- Survey of nesting birds in the construction area and raptor nests along the flight path of the helicopter
- Development of a helicopter flight path for flying into and out of Chapman Lake to avoid sensitive areas.
- Provisions for an approved archaeologist to examine the lake shore once the lake is at its lowest level during the construction phase
- The initial assessment of rock in the vicinity of the dam suggests that ML/ARD potential is low, however, this is based on geochemical analysis of rocks on the surface. The bedrock below the surface could have different geochemical properties. Based on the conclusions from the geochemical analysis and the assessed potential for ML/ARD presented in Section 5.1, the following recommendations are offered:
  - The geology, mineralization and weathering of blasted bedrock should be logged by a trained geologist to confirm that the geology (and inferred geochemical behaviour) presented in this report is representative of the rock excavated during construction at the Chapman Lake site. Blast rock should be inspected before it is repurposed as aggregate or distributed around the site.
  - Further investigation of the geology of the rock should be conducted in advance of construction if the bedrock that will be excavated can be exposed prior to blasting. Any additional sampling will be determined by the geologist based on comparison of the new rock with the sample that has been analyzed. ML/ARD sampling guidelines provided in Price

(2009) and BC MoT (2013) should be followed. These guidelines suggest collection and laboratory analysis of at least one rock sample per 1,000 m^3 of excavated rock for each rock type present, Current estimates suggest that up to 5,000 m3 of rock may have to be excavated for the trench. In the unlikely event that mineralized bedrock is encountered, special management may be required

An operation phase EMP will also be developed and will include:

- Monitoring of shoreline conditions during drawdown including erosion and aquatic vegetation.
- Evaluation of the stream access and wetland conditions when lake levels are low.
- Establish a monitoring program in Chapman Lake including temperature, oxygen levels, and turbidity/light intensity and water quality sampling. The program would be conducted under normal conditions and under extreme drawdown conditions. The use of data loggers deployed at different depths could be used to reduce the need for regular visits to the lake.
- Monitoring and assessment of the effectiveness of the site restoration works. An "as-built" planting layout will be prepared after the remediation works are complete showing the location and numbers/types of plants which will be used as the basis for post construction monitoring. Monitoring should take place at a time of year when any areas of poor plant survival can be identified and new plantings made in the growing season of that year.

8. Summary

A summary of the project construction and operation, identification of mitigation measures and determination of residual impacts of the project were completed in order to assess the impacts for the project. The assessment focused on seven environmental and social aspects associated with the construction and operation of the new system. Table 28 provides a summary of the findings. The construction phase will employ standard construction techniques for which there are established mitigation measures that are effective for containing and managing the effects of earth moving, blasting and other general requirements (fuel handling, waste management, etc.). The application of the mitigation measures will be presented in detail in a construction EMP. Because this work is being carried out in a park environment the residual effects of some construction activities have been rated moderate but the effects are only present during construction and most will revert to pre-construction conditions once construction is finished. The construction site will be remediated directly after construction which will require monitoring to track the effectiveness of the works and if necessary identify any additional work that might be required to achieve proper restoration. Residual impacts of the operation of the proposed system on the assessment components were determined to be negligible to low resulting in an overall assessment that operational impacts will be insignificant. However, monitoring of the effects on Chapman Lake was recommended to confirm the effects of an increased drawdown of the lake during drought conditions.

Table 28: Project Effects, Proposed Mitigation Residual Effect and Assessment of the Proposed SCRD Water Project

Component	Mitigation Measures	Residual Effect	Magnitude	Geographic Extent	Temporal Bound	Overall Impact
Geophysical: Blasting	Blasting plan to be developed by a certified blaster Limit blasting overpressures to a maximum of 133 dB (follow DFO guidelines http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html)	Construction: Vibration and Noise	L	L	L	Low
		Operation: No residual effect	-	-	-	-
Air Quality	Use well maintained equipment Apply dust suppression when required On site fuel containers to be have proper caps and to be covered Minimize helicopter flights to the area	Construction: Degraded air quality from heavy equipment, helicopter use and dust	L	M	L	Low
	Monitor effects during drawdown	Operation: Increase of dust from lake drying	L	L	L	Negligible
Noise	Typical mitigation measures may not be practical due to the need to complete the work within a defined period. Use proper and well maintained equipment Minimize flights required to the area Work outside of sensitive breeding windows Avoid areas with species sensitive to noise Early and late day work to be avoided Some mitigation measures may not be practical	Construction: noise from blasting, helicopter and construction equipment	M	M	L	Moderate
		Operation: No residual effect	-	-	-	-

Component	Mitigation Measures	Residual Effect	Magnitude	Geographic Extent	Temporal Bound	Overall Impact
Terrestrial Resources	Develop a vegetation remediation plan Proper camp design and set up Erosion and sediment control plan Fence off the work and laydown areas Ensure appropriate construction timing to avoid wildlife breeding season or conduct appropriate surveys prior to clearing (i.e. birds and amphibians) Proper management of potential wildlife attractants	Construction: Temporary loss of vegetation/wildlife habitat and change in biodiversity, camp wildlife attractant, disruption of wildlife,. Draw down effects on wildlife such as amphibians	L	M	L	Moderate
		Operation: Potential effect on amphibians from lowered water levels in wetlands	L	M	L	Low
Aquatic Resources	Emergency spill response plan/spill cleanup equipment and properly trained staff Installation of sediment and erosion control measures Installation of intake pipe in the dry Salvage fish from any areas where water is cut-off from the lake and will be dewatered	Construction: Release of sediment or other deleterious substances, resuspension of sediment, contamination with wastes. Potential restriction of access to spawning areas	M	L	L	Low
	Water demand reduction programs (e.g. metering) Infrequent drawdown below -3 m Maintain current water release requirements to maintain fish habitat in the lower reaches of Chapman Creek	Operation: Instability of shoreline or creek mouths causing sedimentation and erosion, Changes in lake dynamics including temperature profiles Drying of exposed shoreline below -3 m and associated changes to lake side and aquatic vegetation. Temporary restriction of access to spawning areas for Dolly Varden	M	L	L	Low

Component	Mitigation Measures	Residual Effect	Magnitude	Geographic Extent	Temporal Bound	Overall Impact
Socio-Community: Recreation	See air quality and noise for mitigation Installation of information signage Screening of construction areas Minimize duration of construction	Construction: Reduced quality of recreational experience due to equipment noise and other activities related to construction	L	L	L	Low
	Infrequent drawdown of lake below -3 m	Operation: Altered viewscapes leading to diminished quality of recreational experience	L	L	L	Low
Heritage Resources	Confine work areas to sites disturbed during the original dam and channel construction in 1978 Monitor for artifacts of archaeological significance during excavation Conduct archaeological survey of shoreline when draw down for construction is at its lowest level	So far no direct evidence of archaeological resources being present	-	-	-	-

9. References

Amaral, S. C. Fay, and G. Hecker. 2014. *Estimating Total Passage Survival For Fish Migrating Downstream At Hydropower Projects.* Alden Research Ltd.

Azimuth Consulting. 2015. BRGMON-12: *Possible Effects of WORKS1 Vegetation Program on Mercury Concentrations in Carpenter Reservoir.* prep. for St'at'imc Eco-Resources as part of BC Hydro'w Bridge River Water Use Plan

BC MoT (British Columbia Ministry of Transportation). 2013. *Technical Circular T-04/13: Evaluating the Potential for Acid Rock Drainage and Metal Leaching at Quarries*, Rock Cut Sites and From Stockpiled Rock or Talus Materials Used by the MOTI. September 15, 2013. 6pp.

BC Parks 1997. *Management Plan for Tetrahedron Provincial Park*.

Canadian Council of Ministers of the Environment (CCME). 2004. *Canadian Water Quality Guidelines for the Protection of Aquatic Life. Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems.* http://ceqg-rcqe.ccme.ca/download/en/205/.

Chapman, A.R. and D.E. Reksten. 1991. *Chapman Creek Hydrology, data summary and analysis.* Ministry of Environment, May 1991.

Carson, B. 1999. Cumulative Summary Report – *Watershed Monitoring Program for Chapman and Grey Creeks* (1995 through 1999). Forest Renewal BC, April 1999.

EBA Engineering Consultants Ltd. 2000. *Watershed Assessment (CWAP) for Chapman Creek and Grey Creek, Sechelt, BC*. Prepared for International Forest Products Ltd., August 2000.

Francesconi, K.A. and R.C.J. Lenanton. 1992. *Mercury contamination in a semi-enclosed marine embayment: organic and inorganic mercury content of biota, and factors influencing mercury levels in fish.* Marine Environmental Research, 33:189-212.

Global Village Research Consultants. 1998. *Chapman Lake Impact Assessment Project. Memo*. Provided in Whitehead 1999 (See reference below).

Hodgins, D.O. 2015. *Drought Analysis and Implications for Salt Spring Island, British Columbia*.

IWMP. 1998. *Chapman and Gray Creeks Integrated Watershed Management Plan*.

Langston, WJ. 1986. *Metals in sediments and benthic organisms in the Mersey Estuary*. Estuarine, Coastal and Shelf Science 23:22, 239-261.

Larinier. 2001. *Environmental Issues, Dams and Fish Migration. In Dams, Fish and Fisheries Opportunities, Challenges and Conflict Resolution* ed. by G. Marmulla, FAO Fisheries Technical Paper 419.

McKeown, D., J. Leney and J. Lim. 2002. *Assessment of Stream Acidity in Chapman and Grey Creeks and the Effects of Industrial Emissions from the Howe Sound Pulp and Paper Mill*, Port Mellon, BC. September 2002.

MELP (Ministry of Environment, Lands and Parks). 1997. *Management Plan for Tetrahedron Provincial Park. BC Parks Department South Coast Regional Planning Services*. January 1997.

MFLNRO (Ministry of Forests, Lands and Natural Resource Operations). 2005. Coast Forest Region website: http://www.for.gov.bc.ca/rco/.

Ministry of Environment. 2016. *Dealing with Drought: A Handbook for Water Suppliers in British Columbia.* Sourced from www2.gov.bc.ca/gov/content/environment/air-land-water/water/drought-flooding-dikes-dams/drought-information

MOE (Ministry of Environment). 2016b. *Fisheries Information Summary System (FISS*). Fisheries Inventories Data Query Tool. http://www.env.gov.bc.ca/fish/fiss/.

Ministry of Environment, *Lands and Parks and Ministry of Forests. 2000*. Illustrated Flora of British Columbia. Volume 5: Dicotyledons and Pteridophytes. https://www.for.gov.bc.ca/hfd/pubs/docs/mr/Mr104.pdf.

MSRM (Ministry of Sustainable Resource Management). 2002. *Sunshine Coast Landscape Unit Planning. Chapman Landscape Unit Plan*. Prepared by S. Gordon and S. Waghorn. November 25, 2002. Available at: https://www.for.gov.bc.ca/tasb/slrp/srmp/coast/sunshine_coast/reports/chapmanlu_final.pdf. Accessed: April 2016.

MWLAP (Ministry of Water, Land and Air Protection). 2002 A Field Guide to Fuel Handling, Transportation and Storage. 3rd edition. 46 pp. available at: http://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/oilandgas/fuel_handle_guide.pdf

Opus Dayton Knight Consultants Ltd. 2013. *Comprehensive Regional Water Plan* Final. prep. for Sunshine Coast Regional District

Price, W.A. 1997. *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials*. MEND Report.

Price, W.A. 2009. *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials*. MEND Report 1.20.1. Version CANMET – Mining and Mineral Sciences Laboratories, Smithers, BC.

Staats, Monte. 2014. *Water Availability and Climate Change: Chapman Creek Water System, Sunshine Coast, BC.* Final Project for the professional Master's Degree in Land and Water Systems at the University of British Columbia.

Triton. 2006. *Chapman Creek Watershed Drinking Water Source Assessment*. Final Report. Prepared for: Sunshine Coast Regional District.

Whitehead, Alan J. 1999. *Impact Assessment. Sunshine Coast's Proposed Water Storage Project (Floating Pump Station) on Chapman Lake, In Tetrahedron Provincial Park*. Prepared for: Sunshine Coast Regional District and Garibaldi/Sunshine Coast District. BC Parks.

Photographs

Photograph 1. ↑
Chapman lake downstream of dam left side

Photograph 2. ↑
Chapman lake downstream of dam right side

Photograph 3. ↑
Chapman Lake looking at lake and channel intersection

Photograph 4. ↑
Chapman Lake dam from inside lake area looking downstream

Photograph 5. ↑
Chapman Lake outlet top of waterfall looking downstream

Photograph 6. ↑
Chapman Lake aerial view of dam and outlet channel at low water

Photograph 7. ↑
Looking upstream at the south eastern stream that flows into Chapman Lake. Habitat assessment completed at this location (August 23, 2016).

Photograph 8. ↑
Looking downstream at the south eastern stream that flows into Chapman Lake. Habitat assessment completed at this location (August 23, 2016).

Photograph 9. ↑
Looking upstream at the north eastern stream that flows into Chapman Lake. Habitat assessment completed at this location (August 23, 2016).

Photograph 10. ↑
Looking downstream at the north eastern stream that flows into Chapman Lake. Habitat assessment completed at this location (August 23, 2016).

Photograph 11. ↑
Looking upstream at the north eastern stream that flows into Chapman Lake. Log jam at end of stream assessment location (August 23, 2016).

Photograph 12. ↑
Dolly Varden captured during electrofishing in the north eastern stream that flows into Chapman Lake.
(August 23, 2016).

Photograph 13. ↑
Dolly Varden captured in a gill net in Chapman Lake. Stomach contents shown below fish (August 25, 2016).

Photograph 14. ↑
Dolly Varden size differences of fish captured in gill nets in Chapman Lake (August 25, 2016).

Photograph 15. ↑
Regenerating zonal ecosystem dominated by Mountain Hemlock and Blueberry. Looking north east at the previously cleared area adjacent to the helipad. (August 23, 2016).

Photograph 16. ↑
Fen wetland north west of the helipad surrounding the ephemeral stream. (August 23, 2016).

Photograph 17. ↑
Juvenile tree frog observed within the wetland ponds adjacent to the helipad (August 23, 2016).

Photograph 18. ↑
Red fox tracks in the mud near the outlet end of Chapman Lake (August 23, 2016).

Photograph 19. ↑
Rear black bear paw print in mud found within the fen wetland adjacent to the helipad (August 23, 2016).

Photograph 20. ↑
Marsh wetland at stream confluence with Chapman Lake at north east corner of Chapman Lake.
(August 24, 2016).

Photograph 21. ↑
Extensive fen wetland looking north, upland of the north east corner of Chapman Lake (August 24, 2016).

Photograph 22. ↑
Overview of wetland forest complex looking south from the eastern side of Chapman Lake (August 23, 2016).

Photograph 23. ↑
Mountain Hemlock - Amabilis Fir/ Blueberry old growth forest south of Chapman Lake (August 25, 2016).

Photograph 24. ↑
Dry Mountain Hemlock/Amabilis Fir – Mountain Heather Forest south of Chapman Lake.
(August 25, 2016).

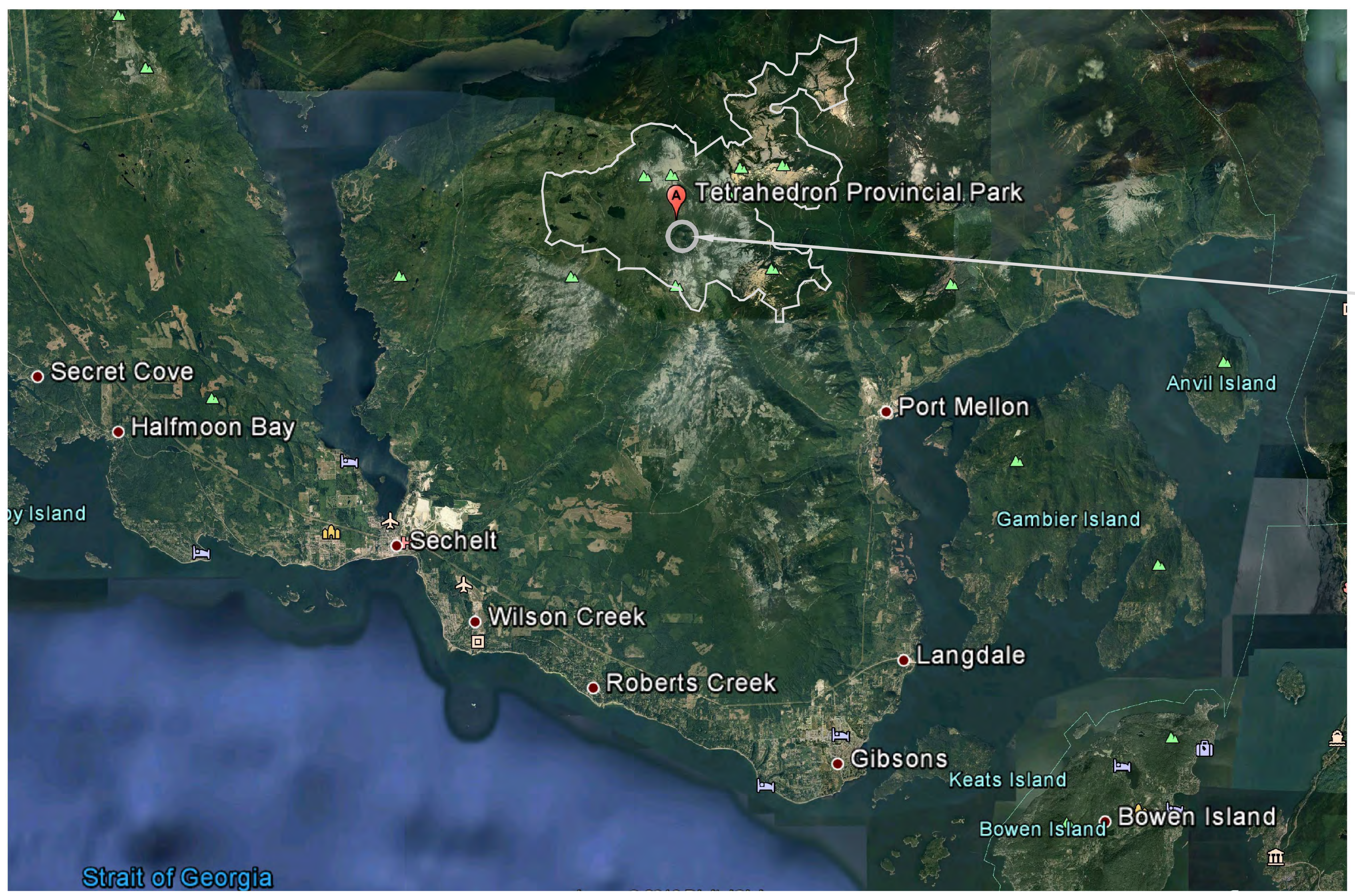
Photograph 25. ↑
Humo-feric Podzol located within an open riparian zone south east of Chapman Lake (August 25, 2016).

Photograph 26. ↑
Riparian area dominated by willow (Salix sp.) south east of Chapman Lake (August 25, 2016).

Drawings

SUNSHINE COAST REGIONAL DISTRICT

NORTH



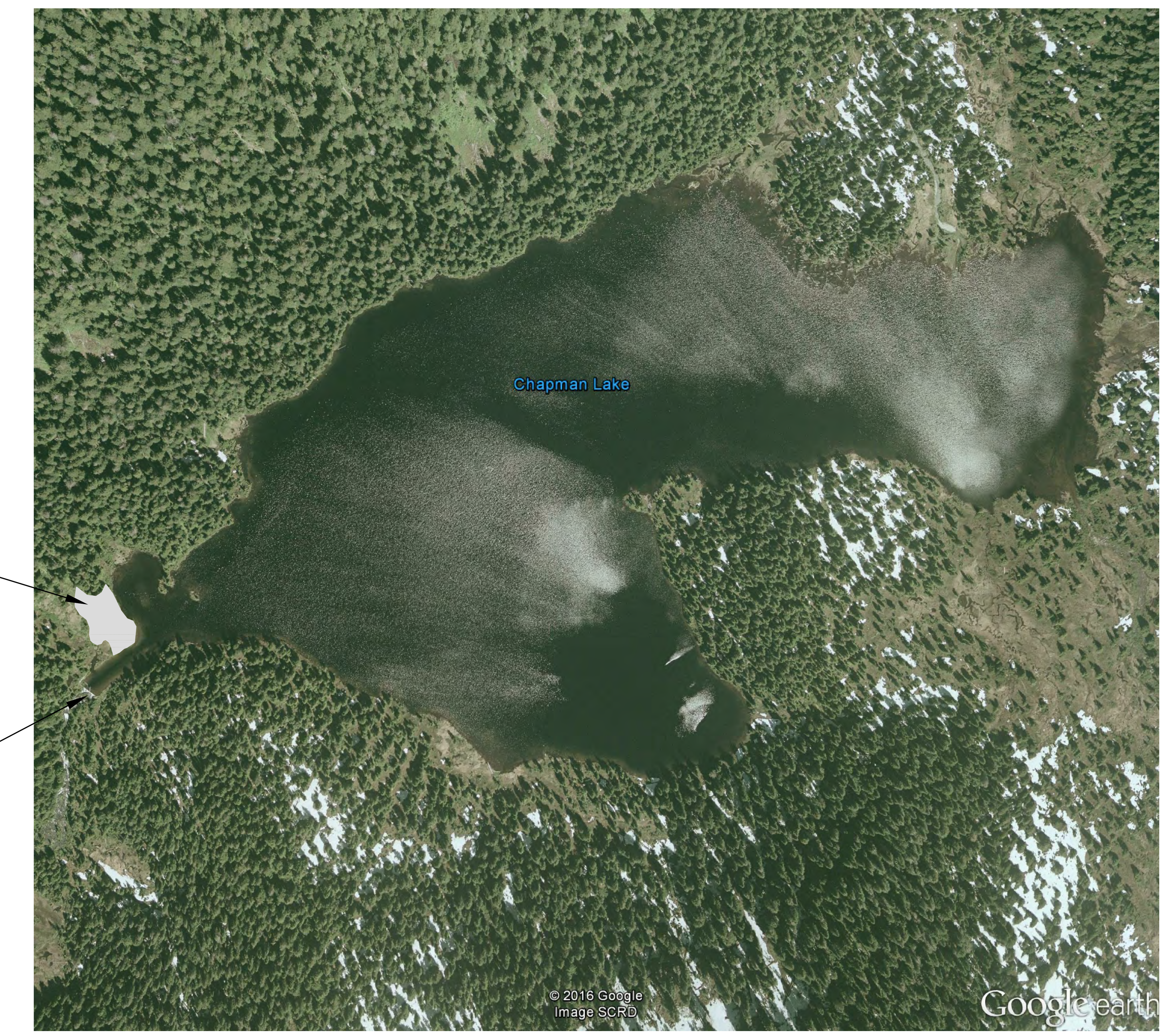
GOOGLE EARTH IMAGE

KEY MAP (NTS)

CHAPMAN LAKE JOB SITE. HELICOPTER OR HIKING ACCESS ONLY.

DISTURBED AREA FROM PREVIOUS CONSTRUCTION

EXISTING DAM TO BE MODIFIED



CHAPMAN LAKE SITE (NTS)

LIST OF DRAWINGS

CIVIL
C–100 SITE PLAN
C–101 PLAN AND PROFILE
C–102 SECTIONS
C–103 SECTIONS AND DETAILS
D–100 DEMOLITION

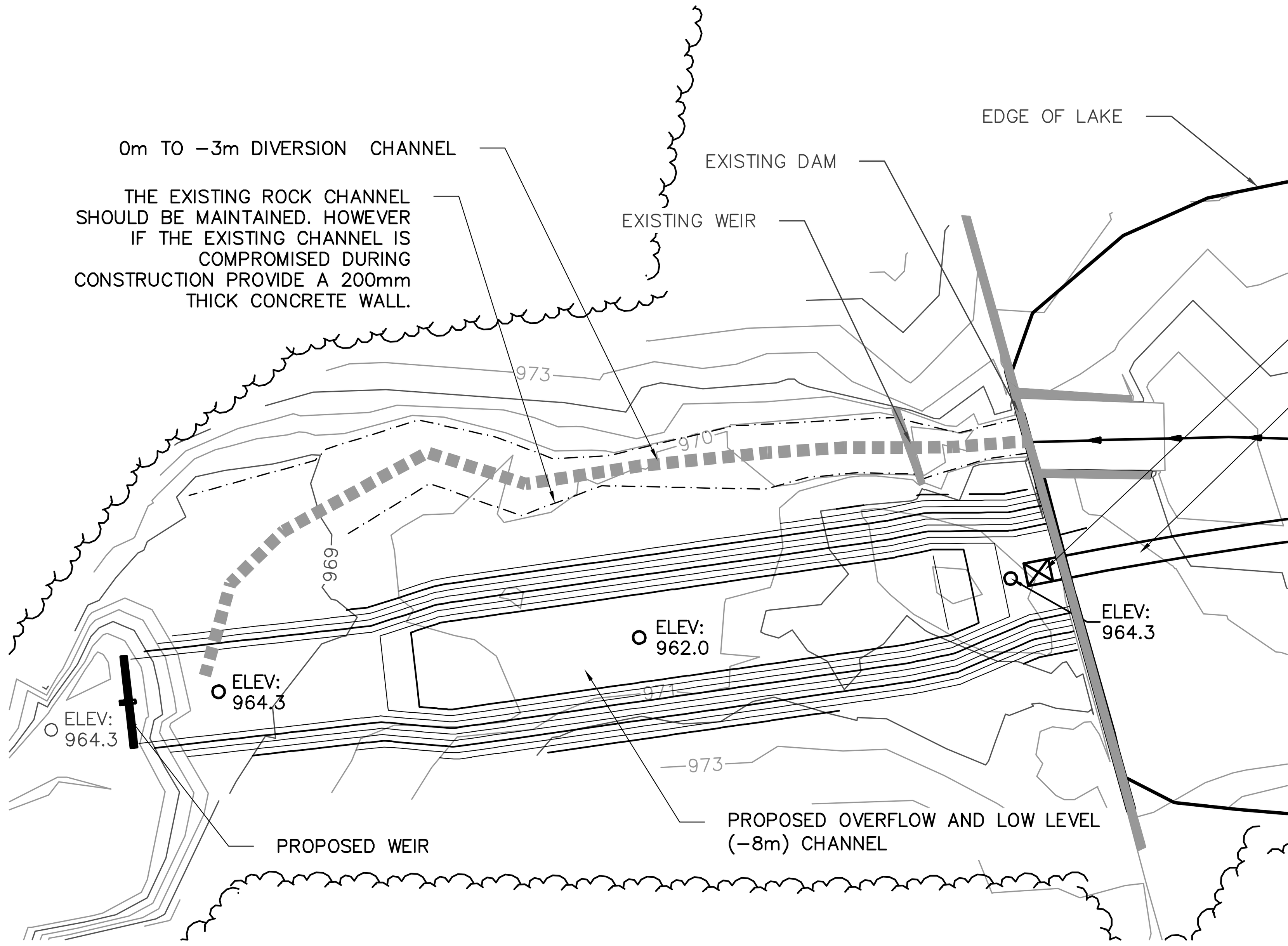
STRUCTURAL
S–100 PLAN AND SECTIONS (NOT IN THIS SUBMISSION)
S–101 DETAILS (NOT IN THIS SUBMISSION)

CHAPMAN LAKE SUPPLY IMPROVEMENTS

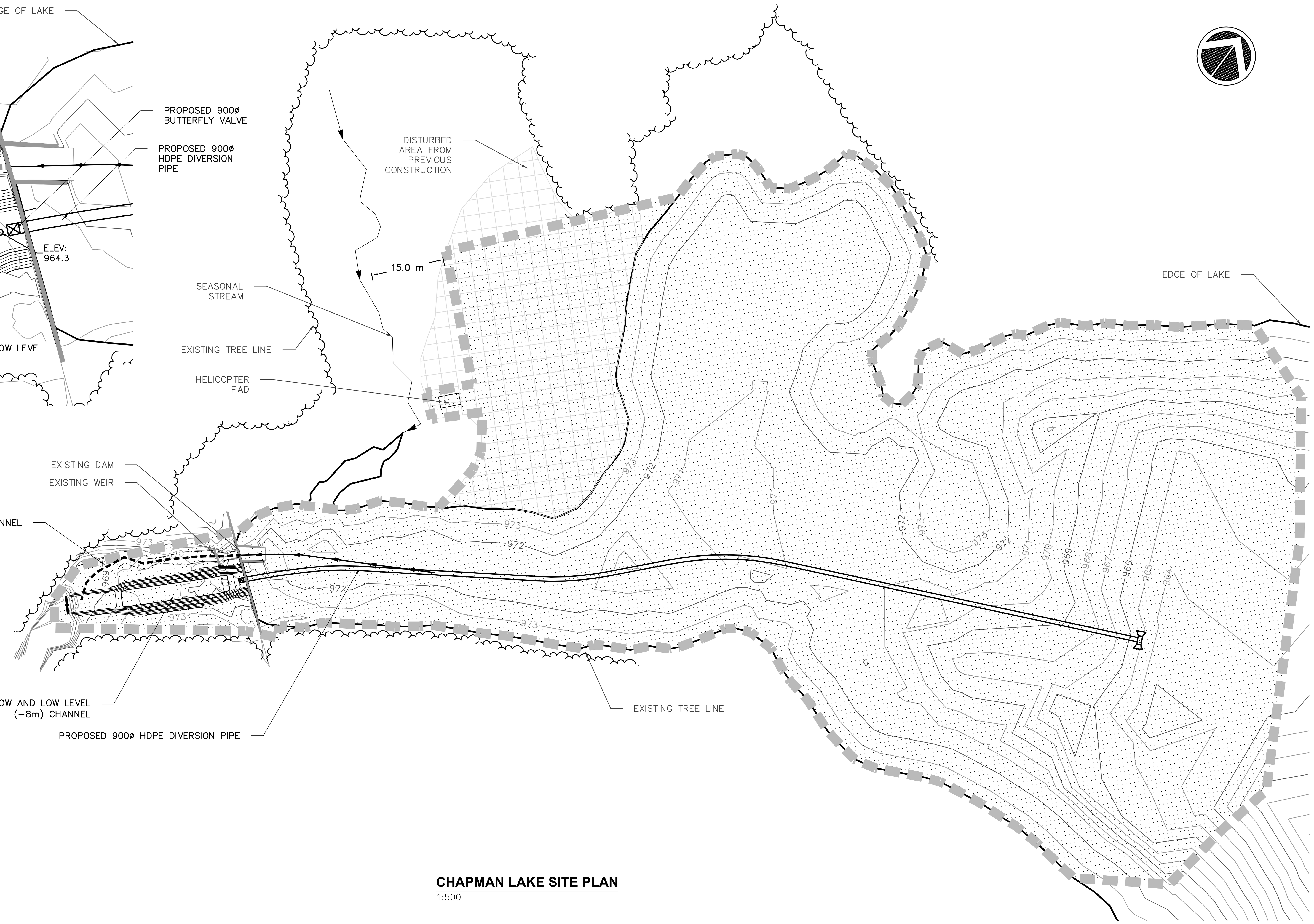
AECOM
60485918

NOT FOR CONSTRUCTION
NOVEMBER 2016

ISSUED FOR PERMIT APPLICATION



CHANNEL AND DAM DETAIL
1:200



CHAPMAN LAKE SITE PLAN
1:500

NOTES AND COMMENTS

CONTRACTOR WORK AREA (1.9 ha). THE LIMIT OF WORK SHALL BE MARKED WITH 1.2m FENCE THAT SHALL BE MAINTAINED DURING THE COURSE OF CONSTRUCTION. ONCE FENCE IS INSTALLED AND APPROVED IT SHALL NOT BE CROSSED.

1) A BYPASS OF RAW WATER FROM CHAPMAN LAKE SHALL BE DISCHARGED INTO CHAPMAN CREEK DURING THE CONSTRUCTION PERIOD. THE FLOW RATE SHALL BE A MINIMUM OF 300 L/s OR AS DIRECTED BY THE OWNER.

2) TURBID WATER GENERATED DURING THE COURSE OF CONSTRUCTION SHALL BE MANAGED WITHIN THE WORK AREA. SILT AND TURBIDITY SHALL NOT LEAVE THE WORK AREA.

3) THE MINIMUM WATER LEVEL DURING CONSTRUCTION IN CHAPMAN LAKE SHALL BE 966.0m.

4) MINIMIZE VEGETATION DISTURBANCE. ANY VEGETATION DISTURBED DURING CONSTRUCTION SHALL BE RESTORED TO EXISTING CONDITION WITH THE NATIVE PLANT SPECIES. THE RESTORED VEGETATION MUST SURVIVE FOR 1 YEAR AFTER THE COMPLETION OF THE RESTORATION PRIOR TO ACCEPTANCE.

5) PRIOR TO MOBILIZATION A DETAILED EXECUTION PLAN NEEDS TO BE ACCEPTED BY THE CONTRACT ADMINISTRATOR. THE EXECUTION PLAN NEEDS TO PROVIDE A DETAILED DESCRIPTION FOR THE COMPLETION OF THE WORK IN A MANNER THAT MEETS ALL THE ENVIRONMENTAL MITIGATION AND WATER MANAGEMENT REQUIREMENTS.

6) NO MORE THAN 20m OF TRENCH SHALL BE OPEN AT ANYTIME.

7) A BLASTING PLAN SHALL BE DEVELOPED TO GENERATE ROCK THAT CAN BE USED FOR BACKFILL. THE GOAL IS TO OBTAIN BROKEN ROCK 75mm TO 300mm IN ANY DIRECTION, OVER PRESSURES FROM BLASTING THAT REACH CHAPMAN LAKE MUST MEET DFO BLASTING GUIDELINES. SEE INFO FROM HTTP: //WWW.DFO-MPO.GC.CA/PNW-PPE/MEASURES-MESURES/MEASURES-MESURES-ENG.HTML

LEGEND

- STREAM/CREEK
- EDGE OF LAKE
- EXISTING CONTOUR – MAJOR
- EXISTING CONTOUR – MINOR
- PROPOSED CONTOUR – MAJOR
- PROPOSED CONTOUR – MINOR
- ROCK CUT
- CONTRACTOR WORK AREA

NOT FOR CONSTRUCTION

30 mm — VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE (Y/M/D)
A	ISSUED FOR PERMIT APPLICATION	RT	BdW	2016/11/08

DRN BY: RT
DES BY: BdW
CHK BY: BdW
APP BY: BdW

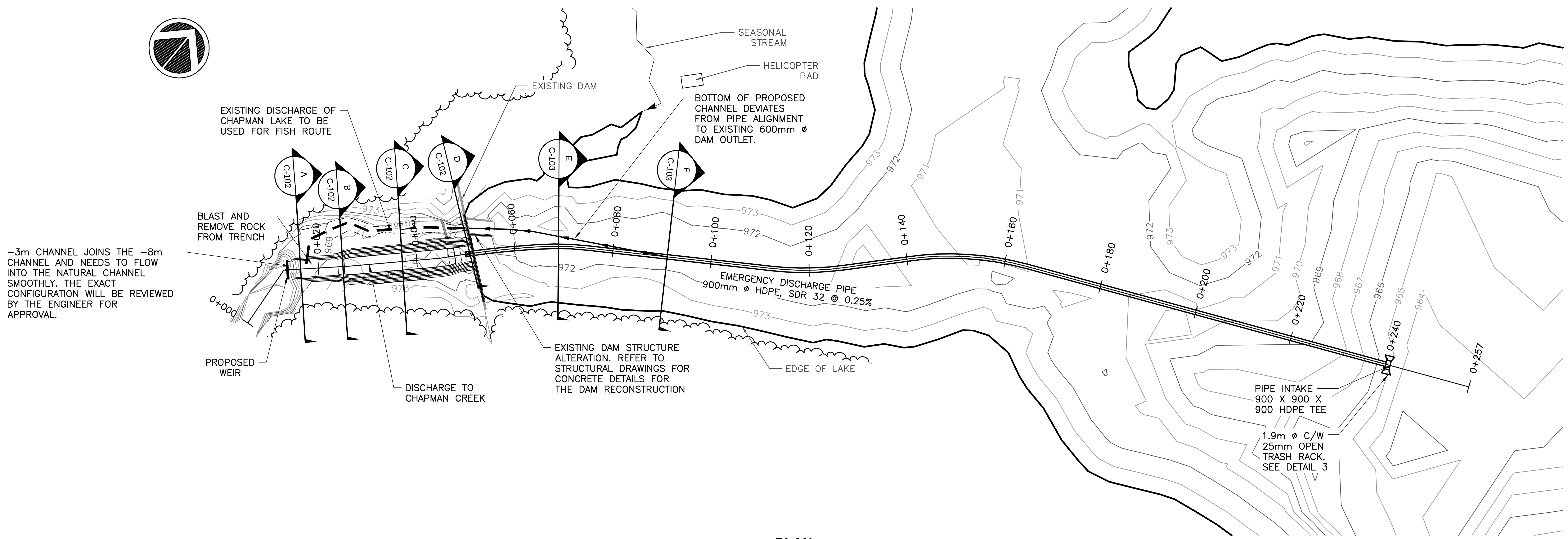
AECOM

SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

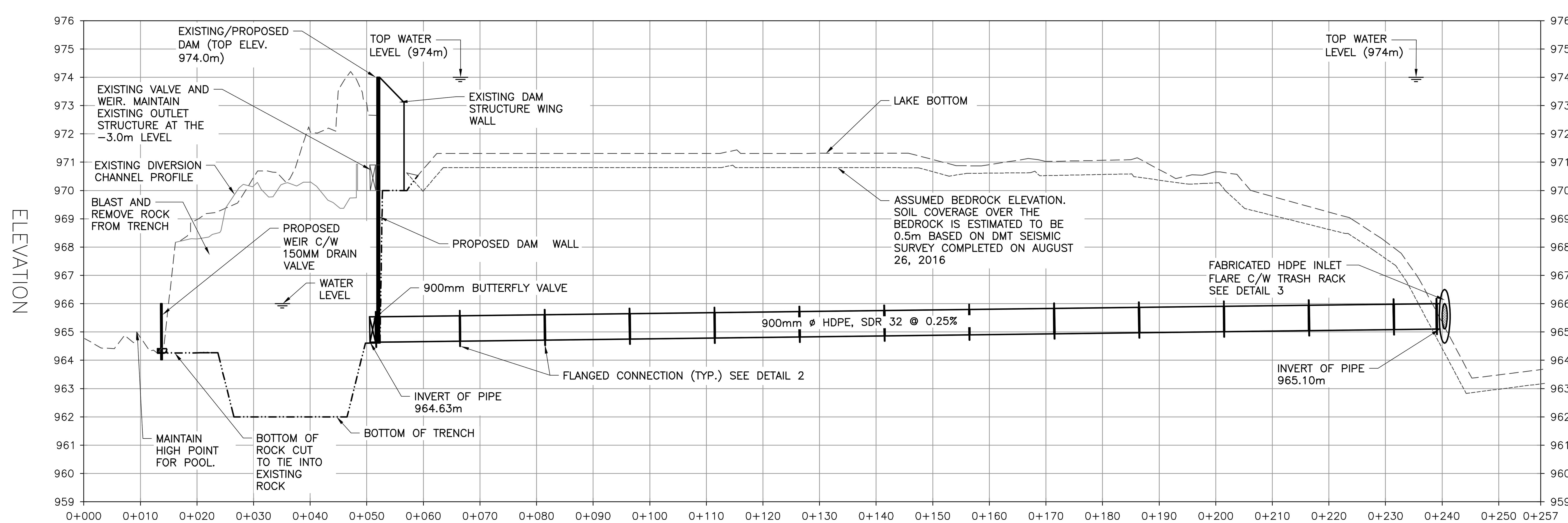
CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
SITE PLAN

PROJECT START DATE (M/Y): Mar 2016
PROJECT NO.: 60485918
FILENAME: 60485918 C-100.dwg
SHEET NO.:
DRAWING NO.: C-100

Plotted By: TevesR
Plot File Date Created: Nov/08/2016 11:29 AM
Layout-Sheet Name: C-100
Filename: P:\60485918\900-WORK\910-CAD\20-SHEETS\A\60485918 C-100.DWG



PLAN
1:500



PROFILE
1:500 H 1:100

Plotted By: TevesR
Plot File Date Created: Nov/08/2016 11:30 AM
Layout-Sheet Name: C-101
Filename: P:\60485918\900-WORK\910-CAD\20-SHEETS\A\60485918 C-101.DWG

NOT FOR CONSTRUCTION

30 mm — VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE (Y/M/D)
B	ISSUED FOR PERMIT APPLICATION	RT	BdW	2016/11/08
A	ISSUED FOR DISCUSSION	RT	BdW	2016/03/15

DRN BY:	GDV
DES BY:	KJW
CHK BY:	BD
APP BY:	BD

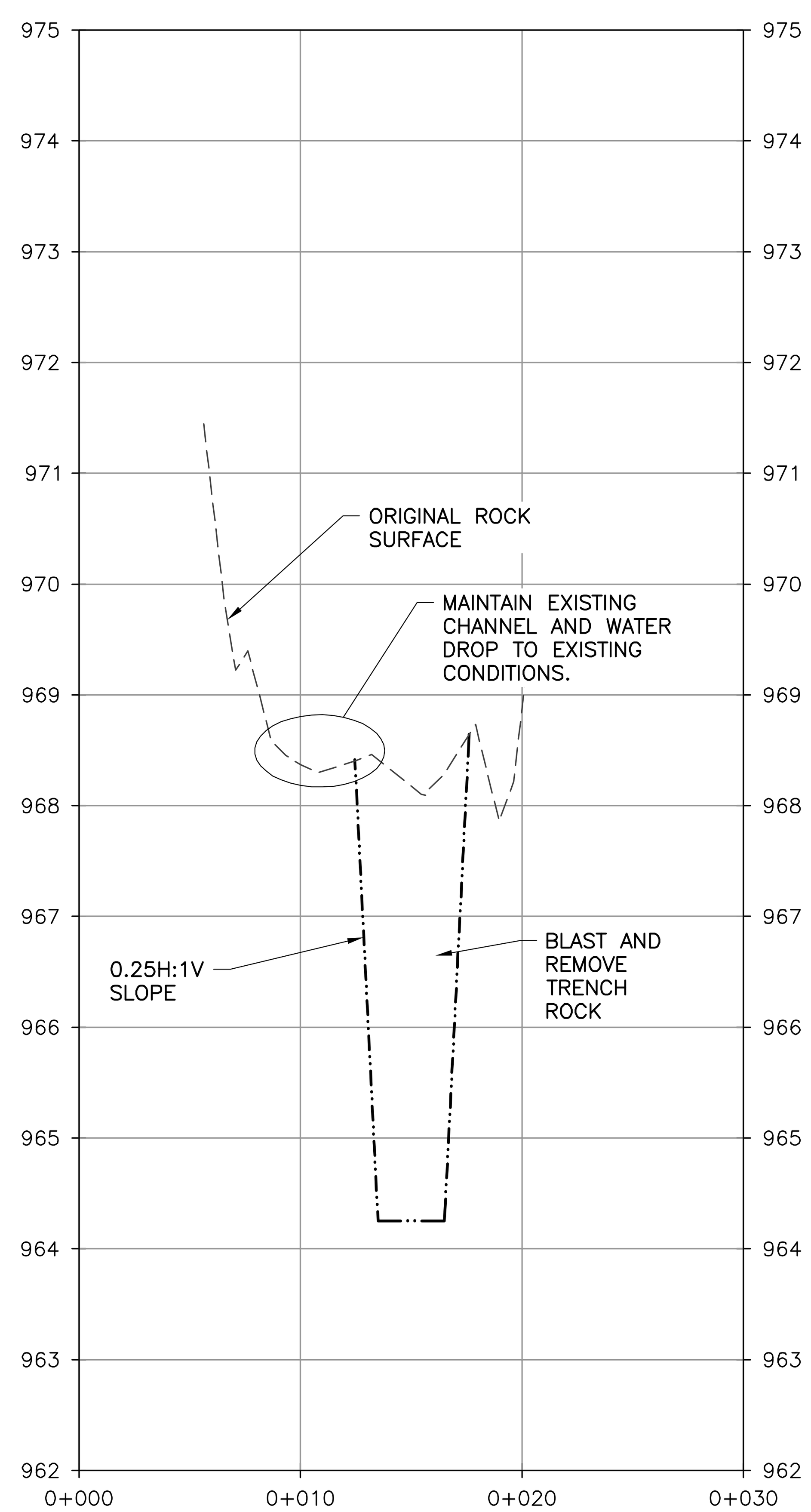
SUNSHINE COAST REGIONAL DISTRICT

AECOM

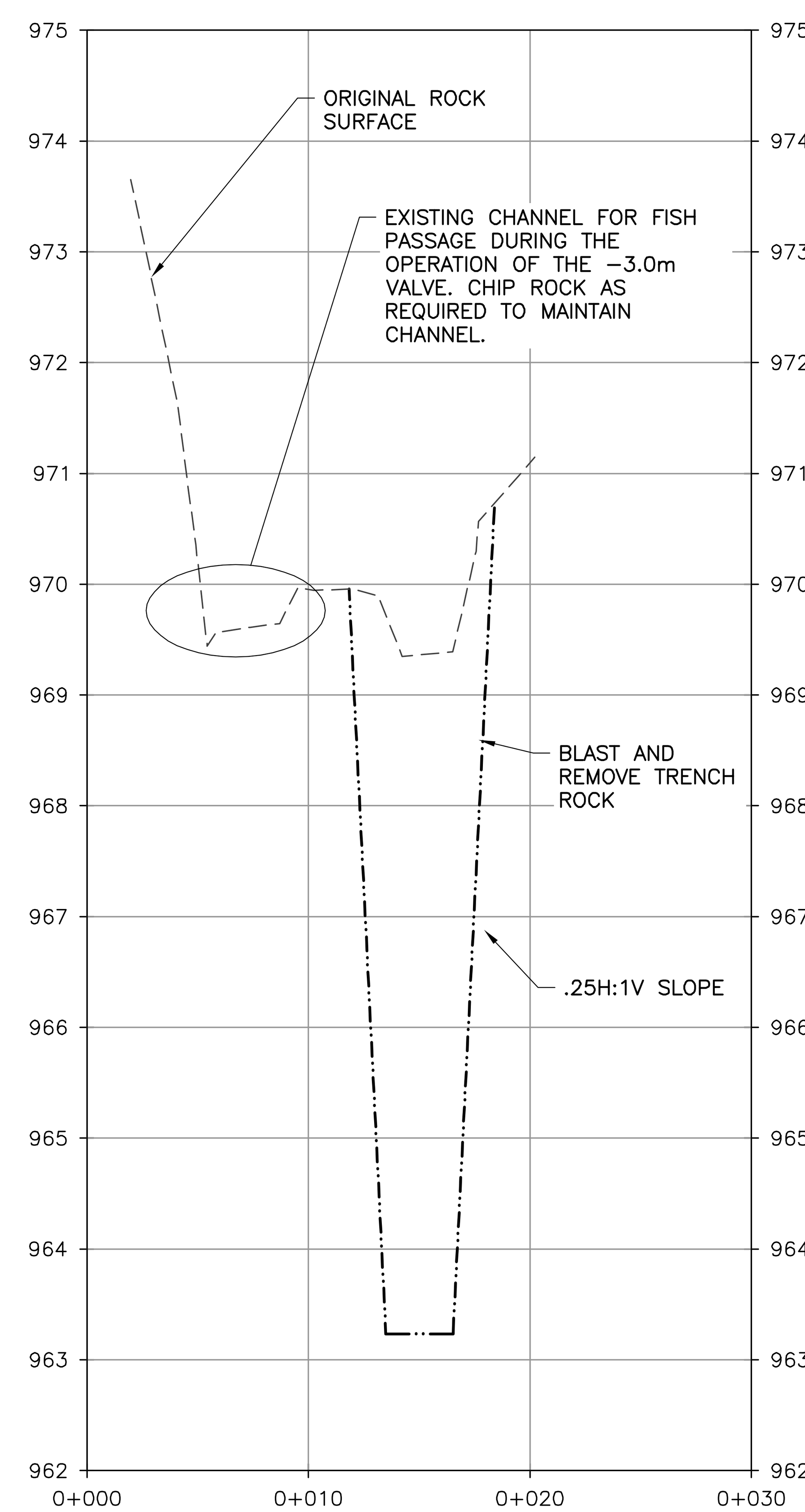
SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
PLAN AND PROFILE

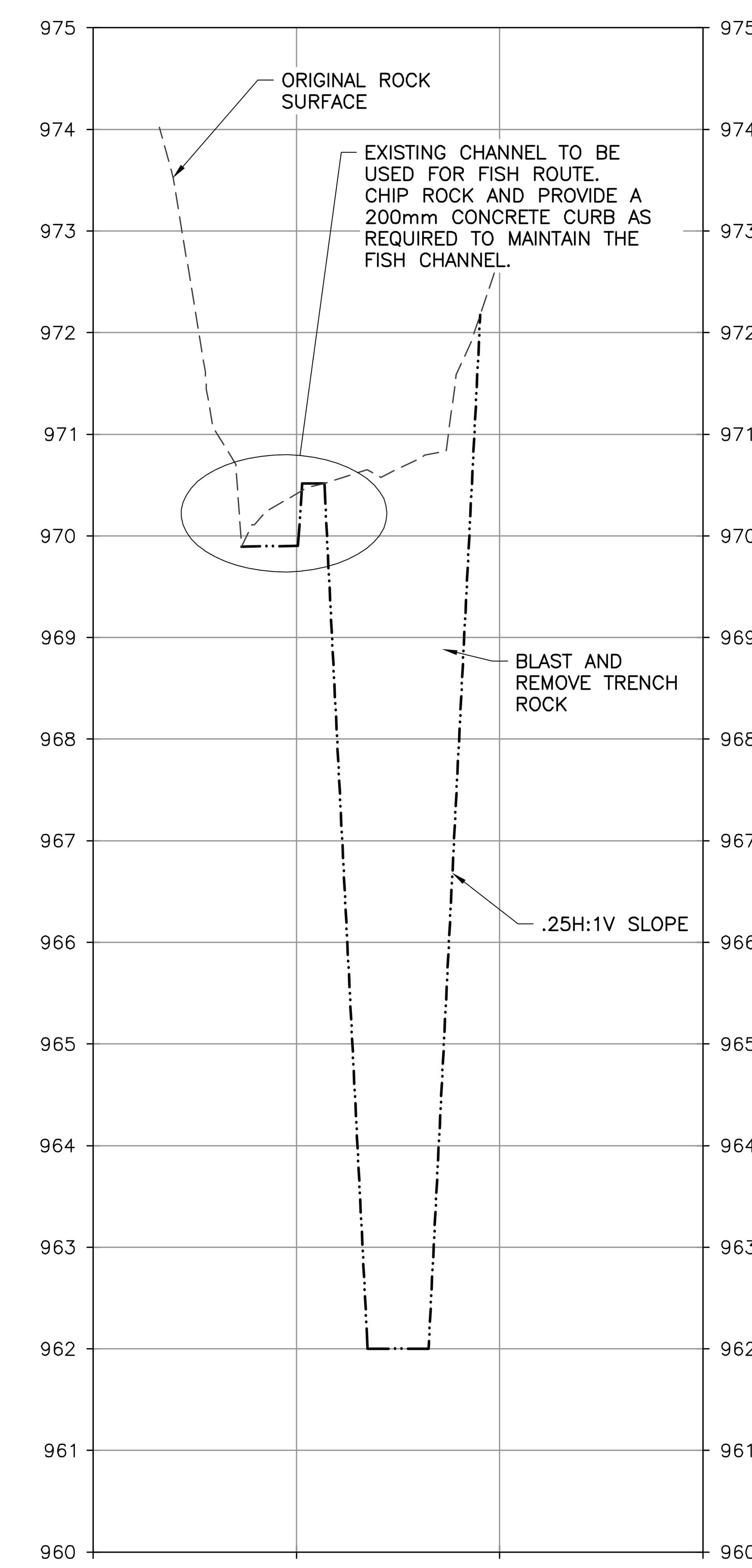
PROJECT START DATE (M/Y): Mar 2016
PROJECT NO.: 60485918
FILENAME: 60485918 C-101.dwg
SHEET NO.:
DRAWING NO.: **C-101**



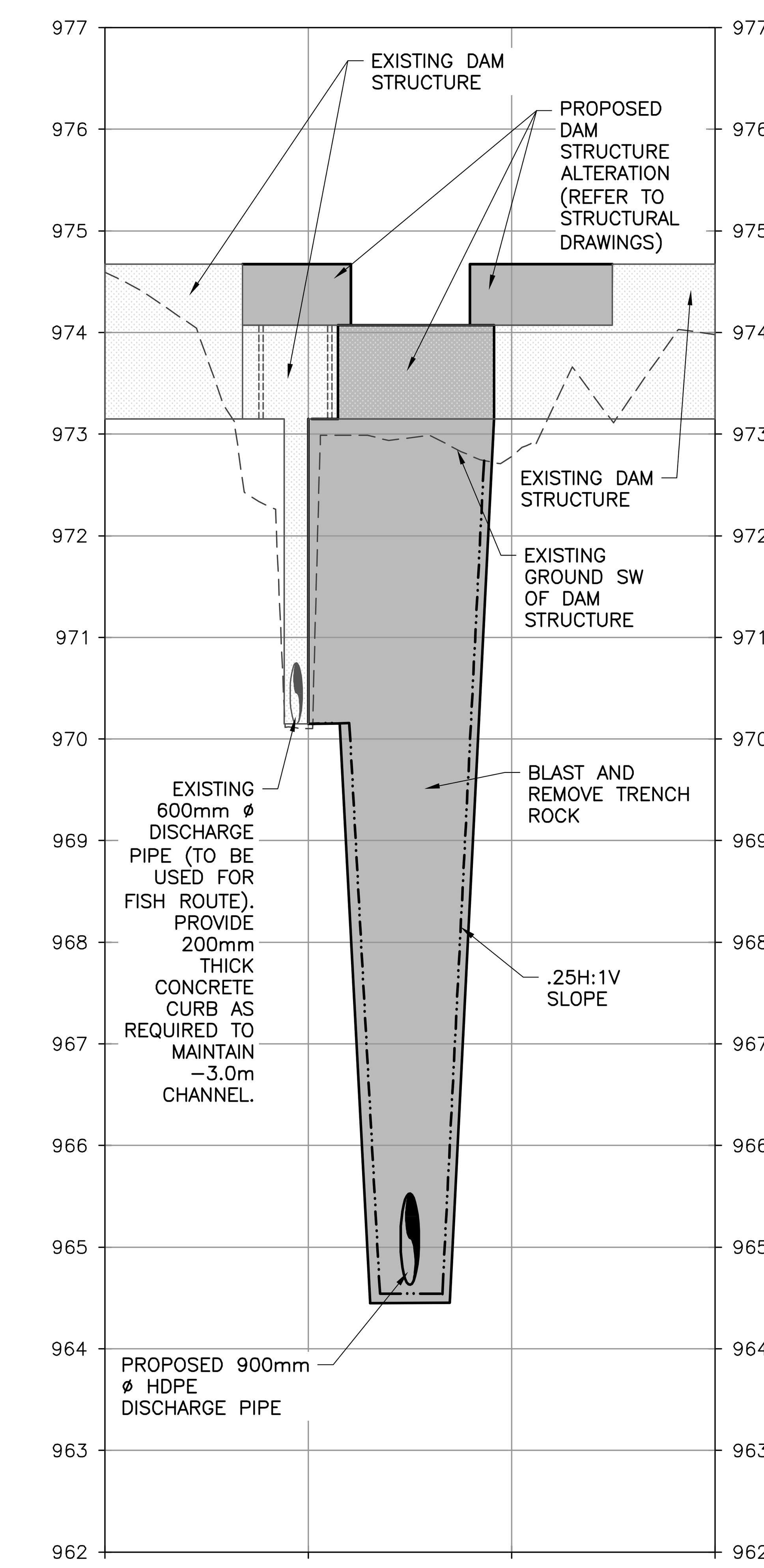
A C-101 **SECTION** H 1:250 V 1:50



B C-101 **SECTION** H 1:250 V 1:50



C C-101 **SECTION** H 1:250 V 1:50



D C-101 **SECTION** H 1:250 V 1:50

NOT FOR CONSTRUCTION

30 mm — VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE (Y/M/D)
A	ISSUED FOR PERMIT APPLICATION	RT	BdW	2016/11/08

DRN BY: RT
DES BY: BdW
CHK BY: BdW
APP BY: BdW

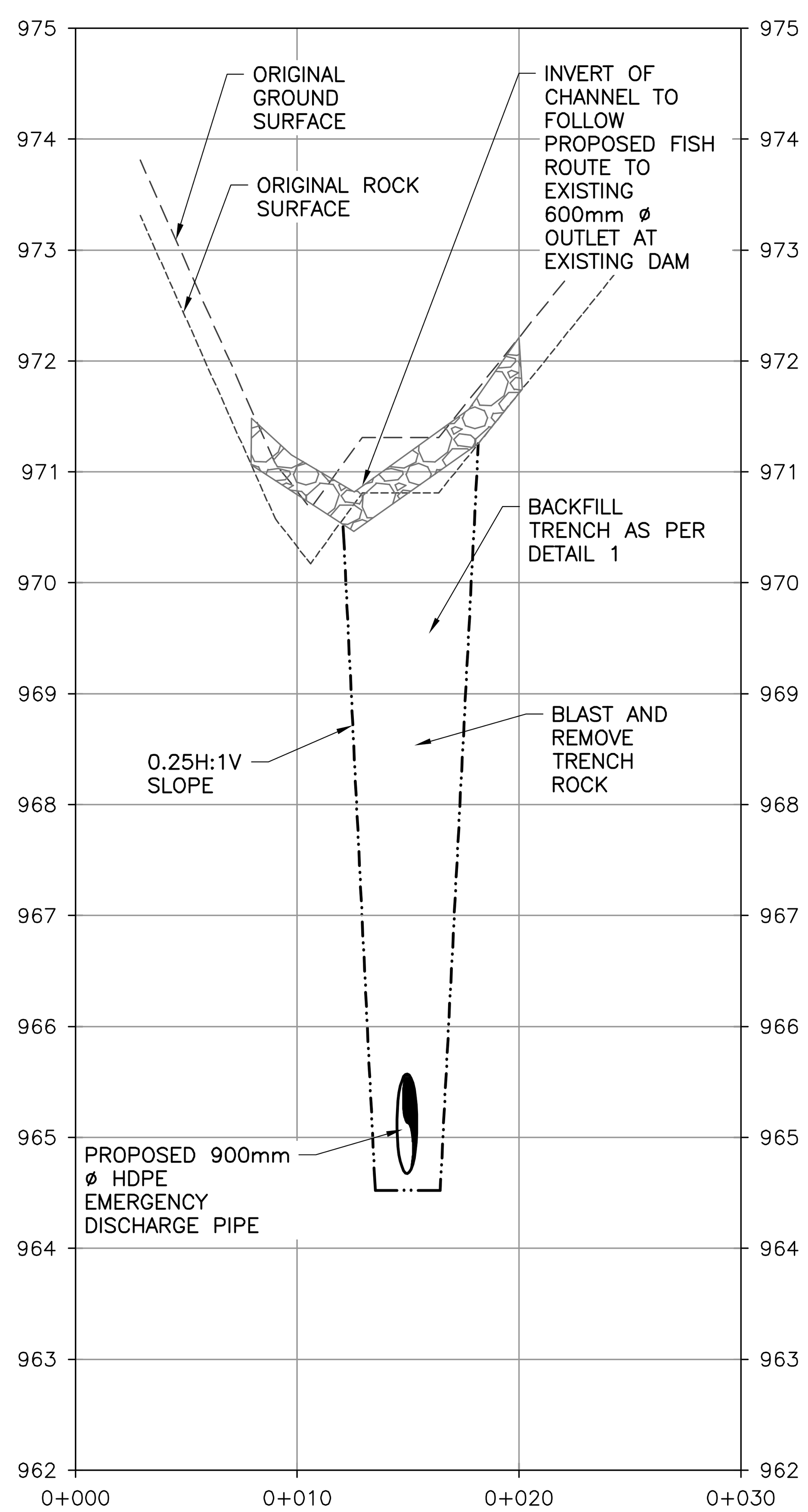
SUNSHINE COAST REGIONAL DISTRICT

AECOM

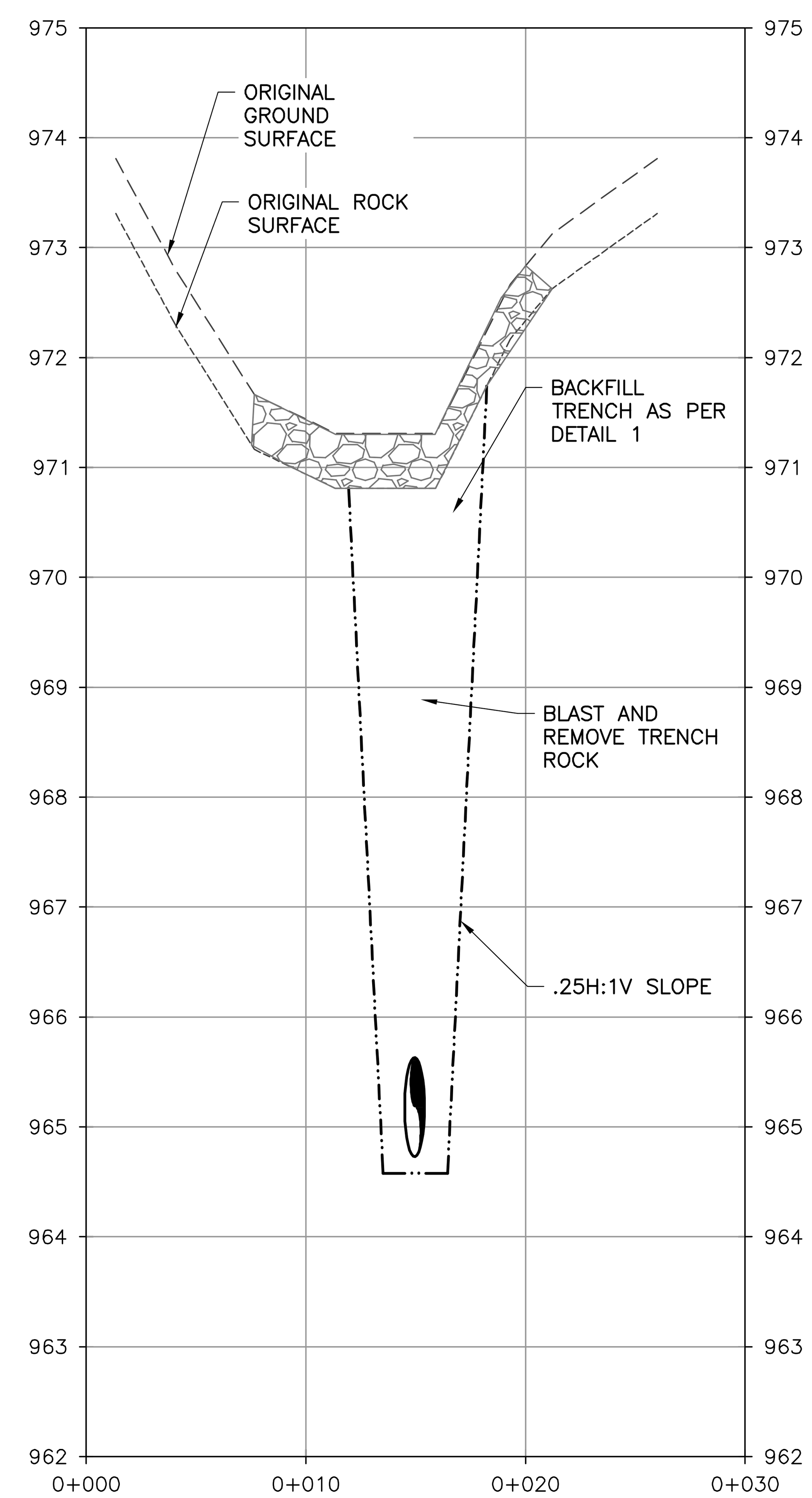
SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
SECTIONS

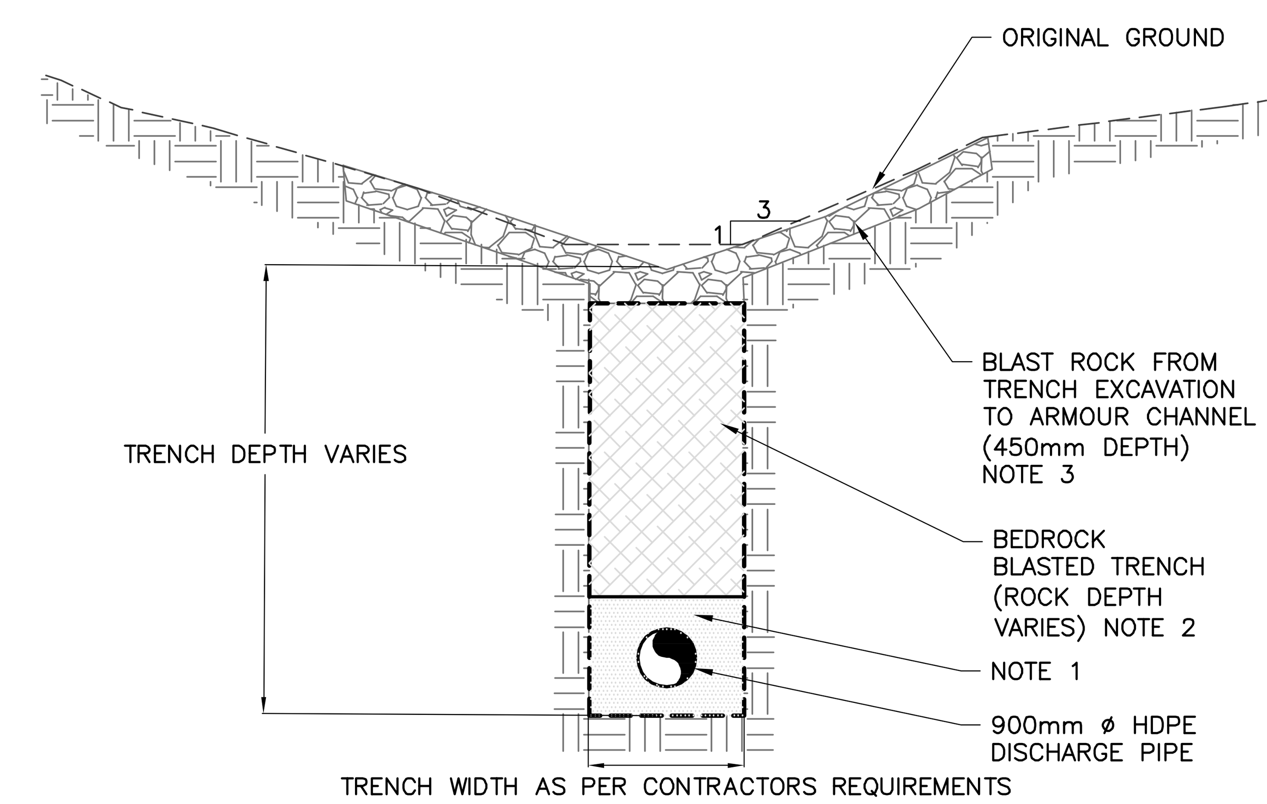
PROJECT START DATE (M / Y) Mar 2016
PROJECT NO. 60485918
FILENAME 60485918 C-102.dwg
SHEET NO.
DRAWING NO. **C-102**



E | SECTION
C-101 H 1:250 V 1:50

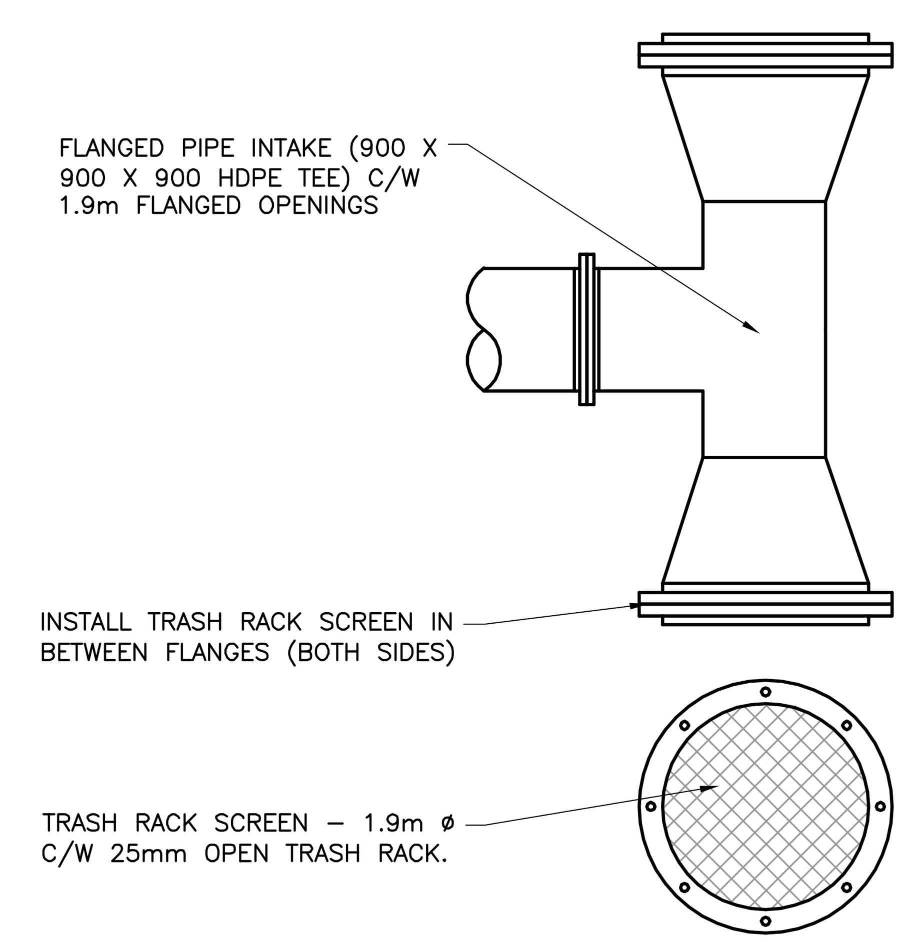


F | SECTION
C-101 H 1:250 V 1:50

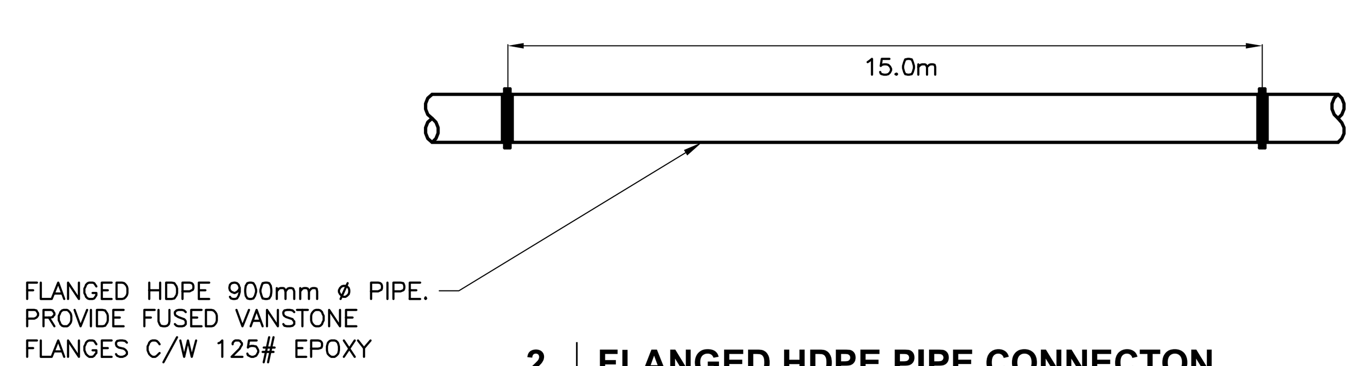


NOTES:
1) STRIP SOIL OVERBURDEN ALONG THE TRENCH FOR THE PROPOSED PIPE AND STOCKPILE. THE STOCKPILED SOIL SHALL BE USED FOR PIPE BEDDING AND SURROUND. COMPACT TO 95% SPD.
2) TRENCH BACKFILL SHALL BE COMPLETED WITH BLAST ROCK. ALL OVERSIZED PIECES (GREATER THAN 300mm IN ANY DIRECTION) SHALL BE BROKEN PRIOR TO BACKFILLING.
3) CLEAN BLAST ROCK GREATER THAN 75mm AND LESS THAN 300mm SHALL BE SCREENED/SEPARATED AND USED TO ARMOUR CHANNEL.

1 | TRENCH BACKFILL DETAIL
- 1:100



3 | FABRICATED SUPPLY PIPE INLET
- 1:50



2 | FLANGED HDPE PIPE CONNECTON
- NTS

NOT FOR CONSTRUCTION

REV	DESCRIPTION	DRN	CHK	DATE (Y/M/D)
A	ISSUED FOR PERMIT APPLICATION	RT	BdW	2016/11/08

DRN BY: RT
DES BY: BdW
CHK BY: BdW
APP BY: BdW

30 mm VERIFY SCALE IF PLAN SHEET IS REDUCED

SUNSHINE COAST REGIONAL DISTRICT

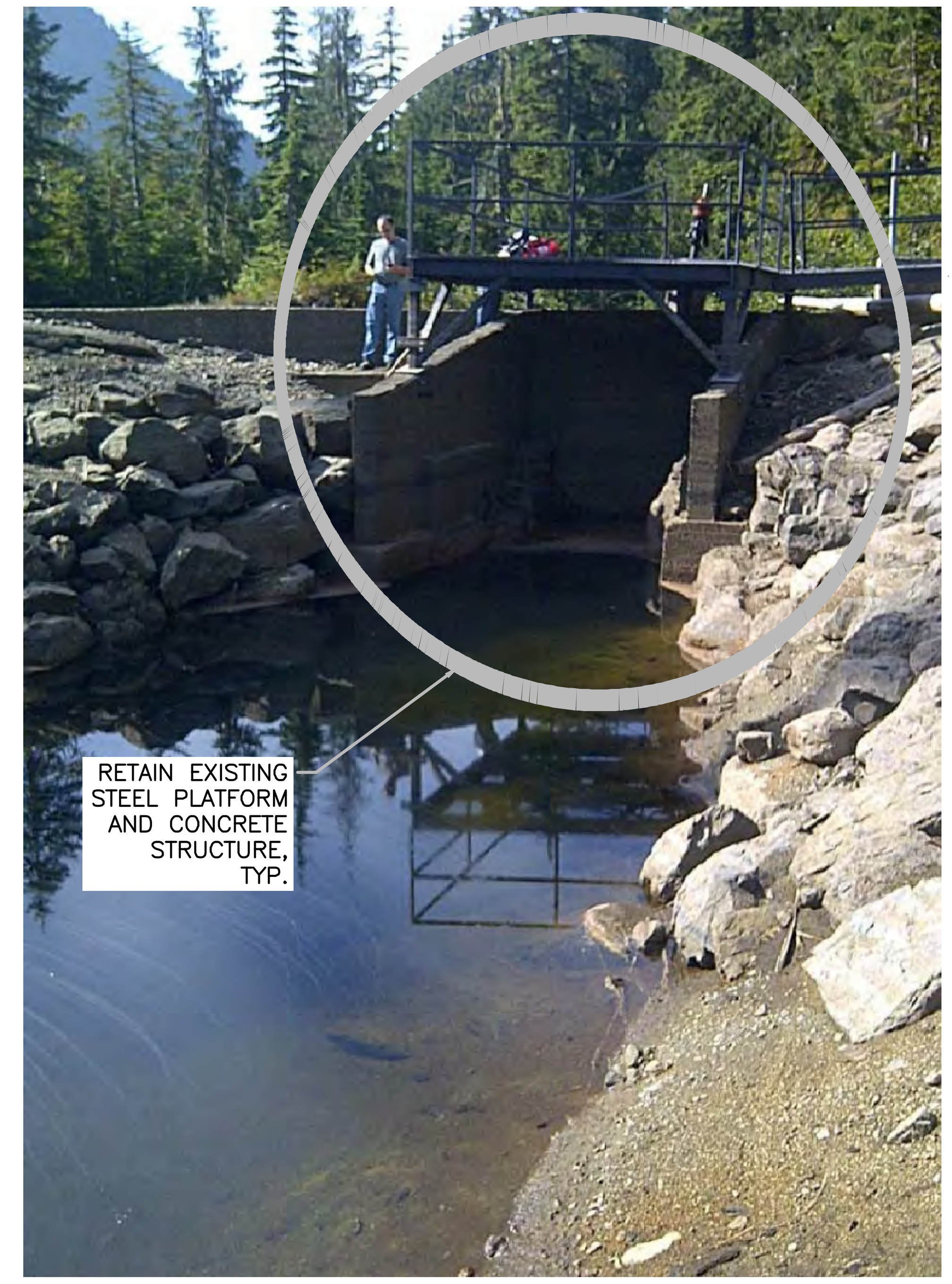
AECOM

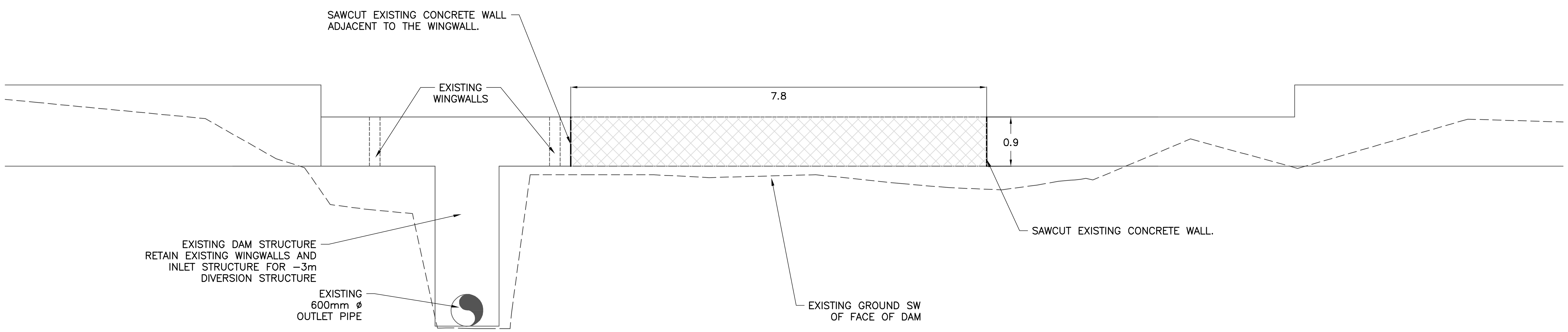
SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
SECTIONS AND DETAILS

PROJECT START DATE (M / Y) Mar 2016
PROJECT NO. 60485918
FILENAME 60485918 C-103.dwg
SHEET NO.
DRAWING NO. C-103

Plotted By: TevesR
Plot File Date Created: Nov/08/2016 11:31 AM
Layout-Sheet Name: C-103
Filename: P:\60485918\900-WORK\910-CAD\20-SHEETS\A\60485918 C-103.DWG





- | **EXISTING FACE OF DAM**
1:50

Plotted By: TevesR
Plot File Date Created: Nov/08/2016 11:34 AM
Layout-Sheet Name: D-100
Filename: P:\60485918\900-WORK\910-CAD\20-SHEETS\A\60485918 D-100.DWG

DRN BY:	RT
DES BY:	BdW
CHK BY:	BdW
APP BY:	BdW

30 mm — VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE (Y/M/D)
A	ISSUED FOR PERMIT APPLICATION	RT	BdW	2016/11/08

AECOM

SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
DAM DEMOLITION

PROJECT START DATE (M / Y) Mar 2016
PROJECT NO. 60485918
FILENAME 60485918 D-100.dwg
SHEET NO.
DRAWING NO. **D-100**

NOT FOR CONSTRUCTION

Appendices

Appendix A Climate Change Memo

AECOM
3292 Production Way, Floor 4
Burnaby, BC, Canada V5A 4R4
www.aecom.com
604 444 6400 tel
604 294 8597 fax

Memorandum

To	Brett Dewynter	Page	1
CC	Bruce Ford		
Subject	**Projected Climate Changes for the Chapman Lake Expansion Project**		
From	Chee F. Chan		
Date	October 11, 2016	Project Number	6048-5918

1. Introduction

The Sunshine Coast Regional District's (SCRD) Chapman Water System supplies potable water to approximately 10,000 clients on the Sunshine Coast from Howe Sound to Secret Cove. Water is drawn from Chapman Creek, which is supplemented by two alpine lakes, Chapman Lake (primary reservoir) and Edwards Lake (secondary reservoir). Severe Stage 4 outdoor water use restrictions imposed in summer 2015 highlighted the vulnerability of the Chapman Water System to dry spells and warm summer season temperatures. Furthermore, population growth over the next few decades in Sunshine Coast communities and First Nations would continue to increase demands placed on the Chapman Water System.

The SCRD Board approved plans in 2015 to move ahead with the Chapman Lake Water Supply Expansion Project (the Project) to access additional water stored at Chapman Lake. The project effectively increases the water quantity available to the drinking water supply, and will likely mitigate potential drought conditions in the near future. However, a changing climate, in the form in increased year-round temperatures, decreased wintertime snowpack and drier and hotter summer seasons are projected to change the timing and availability of source waters feeding the reservoirs and creek. As part of the Project, AECOM was asked to assess the potential implications of climate change on the longevity of future drought mitigations afforded by Project.

The following memo provides an assessment of the project climate changes that affect the timing and availability of source waters in the Chapman Creek Watershed. A brief overview of a climate change adaptation framework is described to situate the information presented within the overall climate adaptation process. The method and data sources used to obtain projection information are then described. Finally, the results of the desktop review for high temperatures, annual precipitation, snowpack levels and dry spell durations are presented.

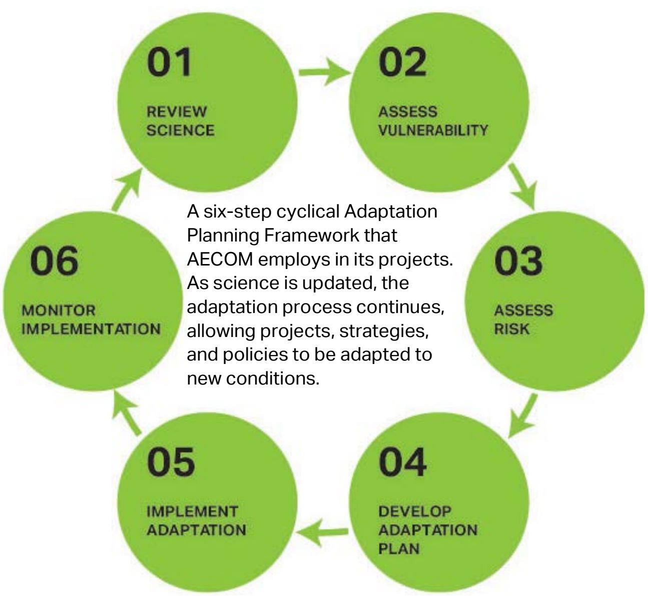
It should be noted that further analysis beyond this memo is required to estimate the thresholds for vulnerability of the Chapman Water System's source waters, and ultimately the longevity of the Project in affording future drought mitigation. Climate projections for temperature and precipitation are only the preliminary inputs into hydrological and hydraulic studies to assess water balance, timing and availability for the Chapman Water System.

1.1 Climate Change and Adaptation

Until public policies by cities, regions and countries around the globe are able to achieve tangible and substantial reductions in our GHG emissions, ongoing changes to the earth's climate system will continue to be a challenge for our built and natural environments. Furthermore, even if GHG emissions were to cease today, the inertia in the global climate system would mean that warming will persist in this century. Therefore, the process of adapting to climate change is as much about the outcomes - more robust and resilient infrastructure, communities, societies – as it is about the process by which these outcomes are achieved. Given the moving target that is climate change, it is therefore prudent to consider adapting to climate change in an ongoing manner within planning, design, and operations, all while considering the latest science and best practices in engineering, operations and management available.

An Adaptation Planning framework typically employed in AECOM projects is presented in Figure 1. It reflects the practice that adapting to climate change as a continual process.

Figure 1 Adaptation Planning Framework



In the first step, the latest science on climate change projections are reviewed (Step 1) to determine the magnitude and frequency of changes to climate affecting a project or infrastructure system, in this case the water storage capacity afforded by upgrades at Chapman Lake. Based on this information, a vulnerability assessment can be conducted to identify infrastructure systems or parts which are exposed to weather related hazards, are sensitive, and lack adequate capacity to adapt or accommodate projected changes (Step 2). The most vulnerable parts can then be put through a risk assessment (Step 3), where the likelihood of damage of infrastructure or failure of services and the consequences of such effects, are evaluated. This helps infrastructure owners to focus on the parts of the system which are most critical to its function and ongoing operations.

Adaptation plans (Step 4), can then be drawn up for the parts which are most at risk or critical. Adaptation plans can encompass a whole scope of actions, including protecting or strengthening systems, designing them to accommodate projected changes, removing and relocating them, and changing operational, maintenance, and emergency response procedures and practices. Adaptation actions can be applied at all stages of an infrastructure's lifecycle, from design, planning, construction, operations, rehabilitation and decommissioning. Next, organizations implement identified actions (Step 5), and monitor the performance of their system and adaptation measures over time (Step 6). This provides valuable information, which in combination with the latest science, allows infrastructure owners to reassess the resilience of their infrastructure system (Step 1 again) at the next infrastructure design, planning, construction or rehabilitation phase.

The following memo provides information to support the first step in the Adaptation Framework. It reviews climate change projections for a range of climate parameters which influence the availability and timing of source waters in the Chapman Creek watershed.

1.2 Description of the Project

Currently, infrastructure at Chapman Lake can only use water from the top three metres of the 32 metre deep lake to supplement Chapman Creek flows. The Project essentially consists of building or upgrading infrastructure to allow the SCRD to draw water for an additional five metres below the current three meter depth limit of water from Chapman Lake. A deeper channel between Chapman Lake to Chapman Creek, upgrades to the existing dam and installation of a large diameter gravity-fed pipe will allow more water to be transferred from Chapman Lake to Chapman Creek.

2. Method and Data Sources

Climate change projections reported in this memo are drawn from a recent report by Metro Vancouver completed by the Pacific Climate Impacts Consortium[1]. This report encompasses the most current and best available downscaled data for the Study area[2]. However, it should be noted that the climate projection data from the Metro Vancouver report is centered over the Metro Vancouver region, and the Chapman Creek watershed, which encompasses Chapman Lake, is located at the edge of the Metro Vancouver study area and partially encompassed within. While some absolute values from the Metro Vancouver based study are presented, they cannot be applied directly to the Chapman Creek watershed. Relative % changes in temperature, precipitation patterns, and snowpack are a more useful indicator to illustrate anticipated climate changes, and are presented in this memo.

The degree of climate change is dependent upon future emissions of greenhouse gases (GHG), which in turn depend upon future global socio-economic changes, technology advancements and action on reducing GHG emissions. To represent possible future GHG conditions, internationally recognized GHG emissions scenarios, known as Representative Concentration Pathways (RCP), have been developed. RCP 8.5, known as the “business as usual” scenario, most closely mirrors GHG emissions trends to date, and represents emissions to the end of the century given past and current public policy on climate change. Until widespread global initiatives take hold and lead to tangible reductions in GHG emissions, it is prudent to plan to adapt to a future climate following the RCP 8.5 business as usual trajectory. Climate projection data for precipitation presented in this memo is based on the RCP 8.5 scenario.

[1] *Metro Vancouver (2016). Climate Projections for Metro Vancouver. Prepared by the Pacific Climate Impacts Consortium and Pinna Sustainability for Metro Vancouver. Available at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/ClimateProjectionsForMetroVancouver.pdf*

[2] *A brief summary of the report’s method is presented in this memo. Readers are invited to consult the public report for a fuller description of the method used.*

Projections for precipitation indicators are derived using sophisticated climate (mathematical) models to simulate how the earth's climate responds to changes in atmospheric GHG concentrations. Climate models account for complex interactions occurring between solar radiation and land, sea, and air masses, including chemical and biological factors. The modelling exercise inherently gives rise to uncertainties based on the assumptions and methods used by each model to handle the complex interactions. To overcome some of the uncertainty associated with different climate models, the outputs from multiple models are usually reported together, known as the ensemble approach, to describe the limits of projected climate changes.

For temperature and precipitation data reported here, the results of a 12 global climate models selected from the Coupled Model Intercomparison Project 5 (CMIP5) were used. Climate projection information are reported either an averages of the values from the 12 models, or as high or low values from the range of model results[3]. Global climate model outputs were downscaled to a 10 km grid over Metro Vancouver, and draped over an 800 m grid of 1971 – 2000 weather data averages to generate higher resolution outputs for the Metro Vancouver region.

3. Results

3.1 High Temperatures

Projections indicate that daytime high temperatures are expected to increase year round. Table 1 shows the seasonal averages of daytime high temperatures by projected by the ensemble of climate models.

Table 1 Seasonal Daytime High Projections

	Past	2050s Average Projected Change		2080s Average Projected Change	
	(°C)	(°C)	(%)	(°C)	(%)
Annual	13	2.9	22%	4.9	38%
Winter	5	2.4	48%	4.4	88%
Spring	12	2.9	24%	4.7	39%
Summer	21	3.7	18%	6.0	29%
Fall	13	2.8	22%	4.5	35%

It is important to note that the largest absolute increases are projected to occur in the summer season, while the largest relative increases will occur in the winter season. Summer season high temperatures are projected to increase by 18% by the 2050s, and by 29% by the 2080s. Winter season high temperatures are projected to increase by 48% by the 2050s, and by 88% by the 2080s. Warmer temperatures in the wintertime are projected to result in more precipitation falling as rain rather than snow, and also contributes to a lower wintertime snowpack. On the other hand, hotter summer days will result in greater evaporation, evapotranspiration, and demand for water use.

3.2 Precipitation

Projections for overall precipitation indicate that the Metro Vancouver region will experience a modest increase of about 5% in total annual precipitation by the 2050s, and 11% by the 2080s compared to

[3] High and low values represent the 90th and 10th percentile values of the ensemble of model results. They reflect the uncertainty between different model projections as well as climate variability.

the present. However, increases in rainfall will not be distributed evenly throughout the year as the summer time is projected to become drier, while the fall, winter and spring are projected to be wetter. Table 2 shows average of model ensemble projection results for precipitation in Metro Vancouver region.

Table 2 Seasonal total precipitation – average of model ensemble projections

	Past	2050s		2080s	
	(mm)	Average Projected Change (mm, %)	Projection range (% change)	Average Projected Change (mm, %)	Projection range (% change)
Annual	1869	1953 (5%)	-1 to 9%	2068 (11%)	10 to 38%
Winter	683	714 (5%)	-3 to 12%	780 (14%)	2 to 27%
Spring	400	430 (8%)	-4 to 15%	447 (12%)	3 to 25%
Summer	206	168 (-19%)	-41 to 1%	147 (-29%)	-53 to -6%
Fall	580	642 (11%)	-1 to 24%	693 (20%)	10 to 38%

Projected decreases shown in red.

Total seasonal precipitation projections indicate that the winter season (Dec – Jan) will still continue to be the wettest season. Average model ensemble results show that the winter season precipitation is projected to increase by 5% on average by the 2050s, and by 20% by the 2080s. Summertime is projected to become drier, with precipitation projected to decrease by -19% on average by the 2050s, and by -29% by the 2080s. Therefore, more precipitation is projected to fall in already wet seasons, while less precipitation is expected in the drier summer months. Additionally, the report indicates that September is projected to become drier over time, extending the dry season into the fall, while more precipitation is expected in the months of October to January (Metro Vancouver 2016, p. 14).

It should be noted that BC's year to year weather is also influenced by two global climate patterns, the Pacific Decadal Oscillation (PDO) and the El-Nino-Southern Oscillation (ENSO). PDO varies between warm and cool phases, while El Nino brings about warmer and drier winter and spring, and La Nina results in cooler and wetter winter and spring. Projection values shown above do not adequately reflect the contributions of these two global climate patterns because of the method by which projection values are derived are averaged over 30 years, cancelling out their effects. However, in future, PDO and ENSO patterns from year to year will likely be felt overtop the projected climate changes and either exacerbate or attenuate projected changes in precipitation and temperature.

3.3 Snowpack

Snowpack depth refers to the amount of snow on the ground for a given duration or at a given date. Projected snowpack depths were developed for three Metro Vancouver Watersheds, Capilano (farthest west), Seymour (middle) and Coquitlam (farthest east) for April 1 and May 1. Data for the Capilano Watershed are presented in Table 3 as an approximation of Chapman Creek Watershed as they are both located geographically closest to one another.

Table 3 Snowpack Depth on April 1st and May 1st

	Past	2050s		2080s	
	Depth (cm)	Average Projected Change (cm, %)	Projection range (% change)	Average Projected Change (cm, %)	Projection range (% change)
April 1	256	105 (-59%)	-73 to -47%	45 (-83%)	-95 to -64%
May 1	229	77 (-67%)	-80 to -56%	29 (-88%)	-97 to -76%

Projected decreases shown in red.

Snowpack depths are projected to decrease significantly, by more than 50% on average by the 2050s, and by more than 80% by the 2080s relative to the past (1970 – 2000 baseline).

3.4 Dry Spell

The dry spell indicator presents the number of consecutive days when daily precipitation is less than 1 mm, which typically occurs in the summertime. Table 4 shows projections for dry spells around the 2050s and 2080s.

Table 4 Annual Dry Spells

	Past	2050s		2080s	
	(days)	Average Projected Change (days, %)	Projection range (% change)	Average Projected Change (days, %)	Projection range (% change)
Dry Spell Duration	21	26 (22%)	3 to 40%	29 (37%)	16 to 65%

The average durations of dry spells in the summertime is projected to increase by 22%, although high projection values indicate they may increase by up to 40% by the 2050s. By the 2080s, average durations of dry spells are projected to increase by 37%, while they may reach a high of 65% longer durations compared to the past (1970 – 2000 baseline).

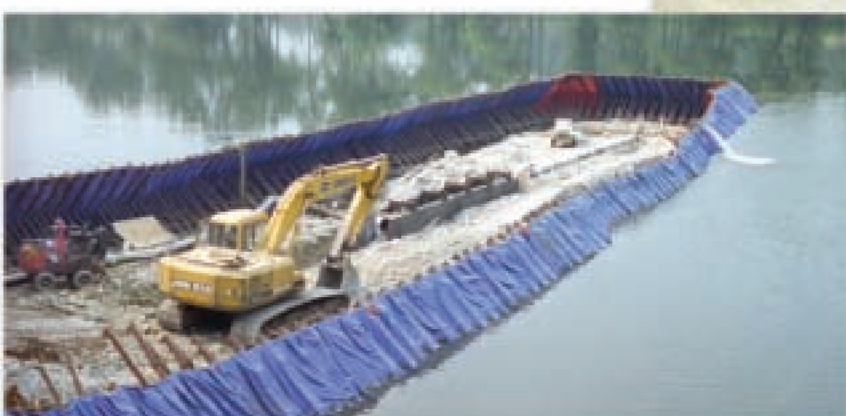
3.5 Summary

Climate change projections suggest a hotter, drier summer season, and a warmer, wetter winter, spring and fall are coming. These changes are likely to adversely affect the availability and timing of source waters in the Chapman Creek Watershed from a water supply perspective. While total annual precipitation is projected to increase slightly, seasonal projections suggest that rainfall will be lessened further during the dry summer season, and that the dry season will extend into September, further exacerbating the stress on water supplies. Increased precipitation in all other months will contribute to increasing water availability in the watershed and its reservoirs. However, with increased winter and spring temperatures, more precipitation will likely fall as rain rather than snow. Consequently, snowpack depths are also projected to decrease by over half by the 2050s. This raises the issue as to whether there is adequate capacity in the watershed to store increased runoff during the wetter winter and spring seasons. Otherwise, the loss of water storage capacity in the snowpack could negatively impact the Chapman Creek water system's ability to sustain water demand through the increasing longer, drier summer months.

It is recommended that the next steps in this evaluation require a more detailed hydrological and hydraulic assessment of water balance in the watershed based on climate projection information. Furthermore, recall that climate projection information presented in this memo was developed for Metro Vancouver. To further confirm the relevance of climate projections presented in this memo to the Chapman Creek watershed, geographic (e.g. watershed elevation, size) and local climate data for the latter should be compared against the values used to develop Metro Vancouver projections.

Appendix B Coffer Dam Example

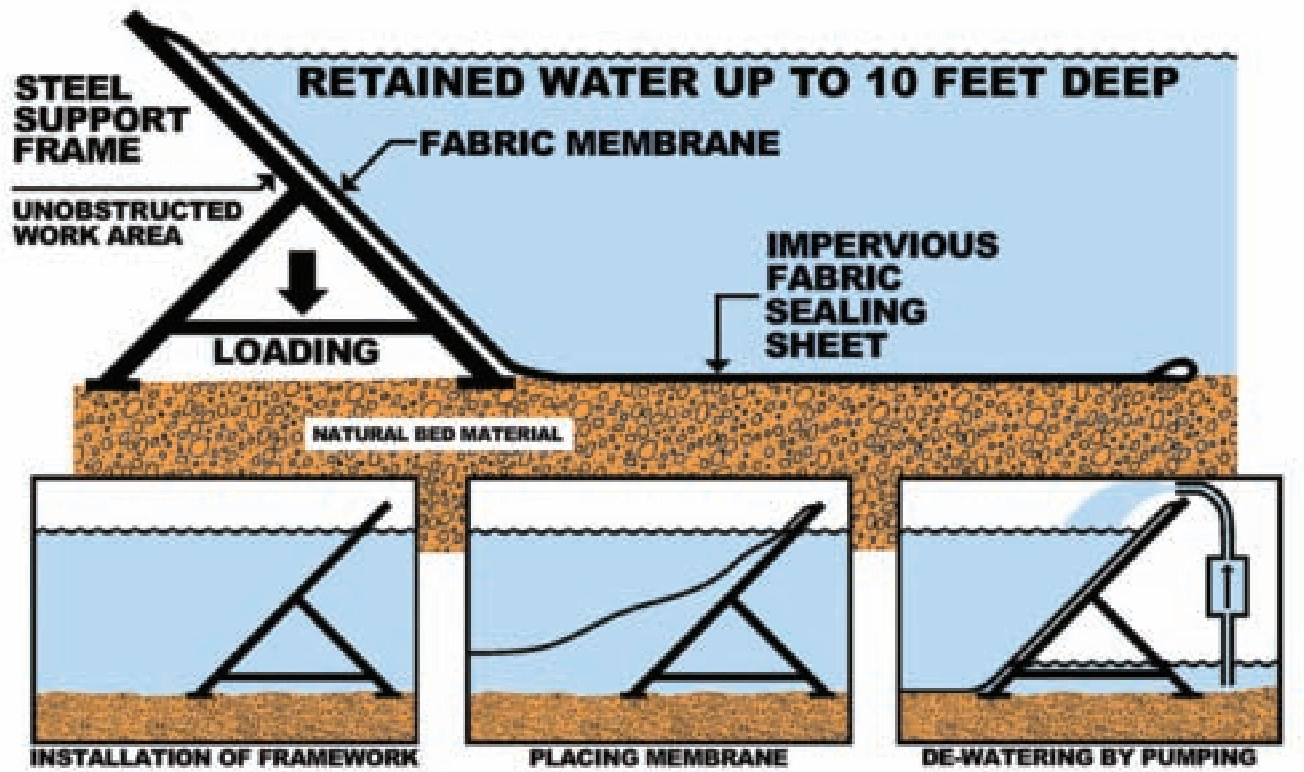
PORTADAM



Building cofferdams, diversion structures and above ground impoundments for over 30 years.

With today's ever-growing concerns over environmental issues, Portadam, Inc., is equipped to provide you with approved technologies, recognized throughout the U.S. as the clean alternative to water diversion, cofferdamming and water impoundment.

We view each potential project with a plan to provide a clean, feasible, engineered product to assist agencies and contractors in a combined effort to keep our waterways pristine for future generations. We pride ourselves in finding solutions to complex water control problems.



INDEX

The **PORTADAM** concept utilizes a steel supporting structure with a continuous reinforced liner/membrane to effectively provide a means of water diversion, retention or impoundment. The support structure is designed to transfer hydraulic loading to a near vertical load, thereby creating a free-standing structure with no back brace to interfere with your work area. The liner system is very flexible, creating ease of sealing over most irregular contours. This system can be installed almost anywhere, in any configuration and to any length. The equipment is offered as rental item in heights of 3', 5', 7' and 10'.

If you have a need to control standing or flowing water—whether for construction, repair of structures, flood control, storage or diversion—let us help you. Portadam, Inc., offers free consultation, site surveys and budget pricing. We can handle your water control problems.

In the following pages you'll see a sampling of the various types of projects we have successfully handled in the past.

Flood Control & Prevention

Flood protection at a fraction of the cost, setup in a fraction of the time compared to sandbags.

The PORTADAM system can be used to divert floodwaters away from buildings, treatment plants, reservoirs, even entire towns. The flexibility of the equipment permits quick installation on unprepared surfaces and along almost any desired line.

Raise the height of existing levees with PORTADAM, which is 1/10th the weight of standard sandbag extensions, installs in less than 1/10th the amount of time and can achieve an added height of up to 9 feet over top of the existing levee. In addition, the long sealing apron used with the standard PORTADAM equipment will extend down the riverside face of the levee, effectively reducing saturation of the levee soils.

Anyone who has ever endured a flood fight realizes that clean-up after the floodwaters recede is very difficult. Not only is there a major disposal (sandbags) problem, but volunteers are not as easily found for the cleanup operation. The PORTADAM system equipment is completely RE-USABLE. All of the equipment is easily removed from the site and stored for the next flood fight. No need to re-purchase and dispose of thousands of sandbags all over again.

Protection of buildings, treatment plants and reservoirs can be accomplished with a system that is installed and removed more quickly and easily than sandbags, which does not produce an eyesore for the community. Normal plant operations can continue during installation. The skeletal steel framework system can be pre-installed, with access gaps, with the liner being placed only at the final moments. The equipment is offered in various heights from 3' high to 12' high to allow for the desired measure of protection.

Low head dam rehabilitation and retrofit can easily be accomplished behind a PORTADAM cofferdam system.

Water flow can be diverted to one side of the river in a two phase construction sequence, or diverted through an alternate bypass channel.

The PORTADAM steel framework and liner components adapt easily to the spillway shape to construct a continuous cofferdam line, both upstream and downstream.

Dewatering upstream of a hydro plant intake structure can facilitate repair or replacement of old trashracks.

PORTADAM technology is also used for tailrace area de-watering, gate replacement and concrete spillway repairs. This equipment offers plant operators alternatives for dewatering areas without the problems associated with earthfill or the costs of sheet piling operations.

Dam Rehabilitation

Divert river flow to allow spillway repairs under any conditions.

Repair entire dam, forebay, trash rack or tailrace structures.

Portadam is used extensively for additions of fish ladders and gate structures.

Boat Ramps (Rehabilitation & New Construction)

Build your next boat ramp in the dry without costly sheet piling...

...tie rebar, form and pour...

...to a beautiful completed project.

Installation or repair of boat ramps becomes an easy, land-based operation with the use of the PORTADAM cofferdam system. A 3-sided structure, open to the shore, allows full, open access to the boat ramp work area. No cross bracing is required, leaving the entire work area free of obstruction.

Since the main component of the PORTADAM system is a nylon reinforced vinyl liner, the water body is completely protected from the work area. All excavation and concrete work is conducted behind a barrier that keeps the lake, river or stream completely free of siltation, turbidity and pollution.

No floating equipment or heavy pile driving machinery is needed to install a PORTADAM.

PORTADAM

The flexibility of the PORTADAM system equipment allows for installation in practically any configuration and over almost any contour. This feature permits installation along stream banks for restoration such as bulkheads, gabion structures, architectural walls and geoliners.

Dewatering these work areas allows for better control of excavation at toe of slope, so that proper "key-in" can be made to achieve the best possible construction techniques.

Bank Restoration & Stream Channelization

Make your revetment job easier by dewatering the work area.

Channelizing the flow permits access to both sides of the stream.

...even makes building a seawall easier.

PORTADAM

Environmental Remediation Projects

Environmental shoreline cleanup completed from the river side of your site.
Remove the water from your remediation site.
Access almost any area using “Best Management Practices”.

Keeping the affected area separated from the clean area is a major consideration on all HazMat remediation sites. Especially in water, there is a great advantage to keeping the clean water from making contact with the contaminated materials.

The PORTADAM system offers an effective method of surrounding an in-water remediation site and separating the clean water from the work area while maintaining natural stream or river flow. In addition, by working in a dry area, excavated material dewatering is minimized.

This cofferdam method is clean and re-usable. It can be utilized in a multi-phase remediation project while offering clear, unobstructed access to the work area (lake or river bed). No fill material is typically required, therefore the customer does not add more contaminated materials to the site being remediated.

Bridge Piers (Rehabilitation & New Construction)

Use laborers, not divers to complete your next bridge pier rehabilitation project...

dewater areas of any size...

...even under bridge spans where driven sheet piling is difficult.

Portadam can be installed in virtually any configuration. Also, since it is a lightweight system, it can be installed under existing spans, allowing for continued traffic flow. Span removal is not required as with driven sheeting methods.

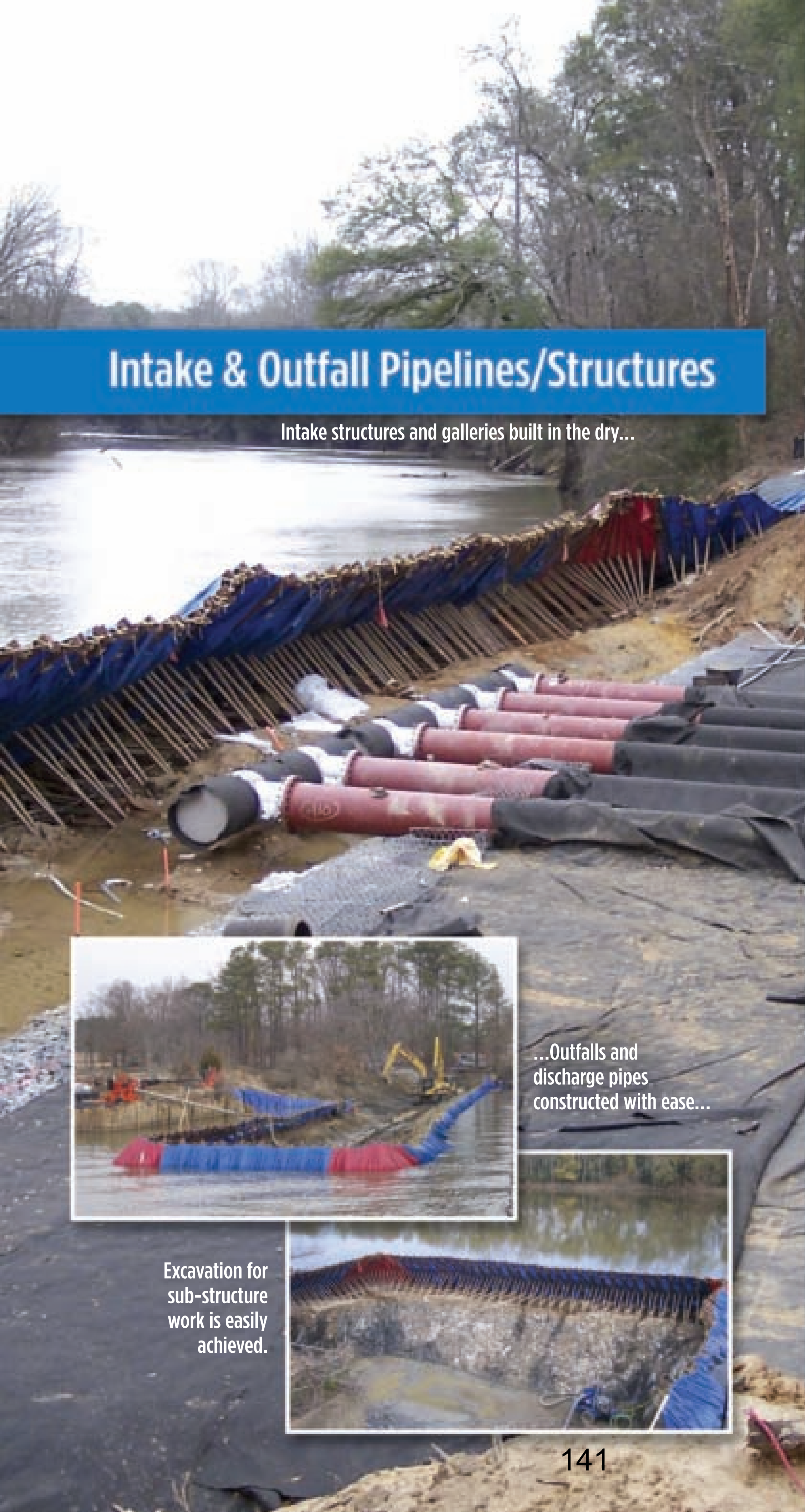
Culvert rehabilitation is made easy by de-watering or diverting stream flows with the Portadam system.

If the bridge pier work area is close to shore, the customer might opt for a 3-sided cofferdam structure so that they can access the pier directly from the shore. This configuration will allow for construction equipment and supplies to be utilized directly from the river bed (fill material is not required). Excavation is made easier because the equipment operator is closer to the work (not digging through added fill) and can readily see the entire work area (not digging underwater).

If the bridge pier is away from shore, as in large multi-span bridges, the PORTADAM system can be installed in a box or rectangular configuration. Again, fill material is not normally required. The cofferdam is positioned directly on the river or lake bed. Access to the work area is either from the bridge deck or from floating equipment.

Because the system is "free-standing", the pier work area is unobstructed by cross-bracing or tie-backs to the pier face. This open space allows for clear access to excavate, assemble form-work and place protective measures. Also, with the area dry, concrete pours become more visible, controllable, non-polluting and successful.

Intake & Outfall Pipelines/Structures



Intake structures and galleries built in the dry...
...Outfalls and discharge pipes constructed with ease...
Excavation for sub-structure work is easily achieved.

Concrete intake structures situated along the edge of a river or lake can be repaired or constructed in a dry work area behind a PORTADAM system.

The system can be installed in a 3-sided configuration to provide access into the water body without adverse effects to the water system. This cofferdam method produces an unobstructed work area for excavation and forming as required to construct a new intake structure.

Outfall pipelines with diffuser sections are easily installed in the dry behind a PORTADAM structure. The Portadam system provides river bed access in an unobstructed work area for trench excavation, pipe assembly and concrete encasement. Typically, no river bed preparation or fill material is required to install a PORTADAM system. No costly fill removal or contour grade adjustments are required after removal of the PORTADAM system. The water course remains virtually unaffected.

Holding Basins & Impoundments

Adaptability of the PORTADAM system equipment has made it very useful as a temporary holding basin on land. By inverting the equipment installation procedure, the PORTADAM can be used to produce a holding basin of almost any size and configuration. Installation over irregular, unprepared contours makes it far superior to other, less flexible, equipment.

Thru-wall connection fittings are easily made with “boots” attached to the liner. Inlet and outlet pipes of any size can be added prior to shipping or in the field.

The unique structural steel wall configuration of the PORTADAM holding basin keeps the bracing system inside of the overall basin “Footprint”, eliminating external bracing. Containment of most fluids can be achieved with the standard VCN liners, but the PORTADAM holding basin can be easily fitted with special liners to accommodate various hazardous liquids.

Freestanding temporary basins can be constructed to any size or capacity.

Patent Pending

PORTADAM

Pipeline River Crossings & Repairs

Pipeline river crossing in a two-phase operation.

Portadam can be used in most streams and rivers.

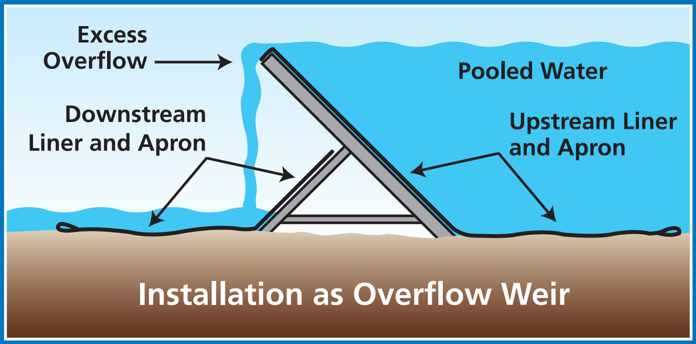
Much less costly than directional drilling.

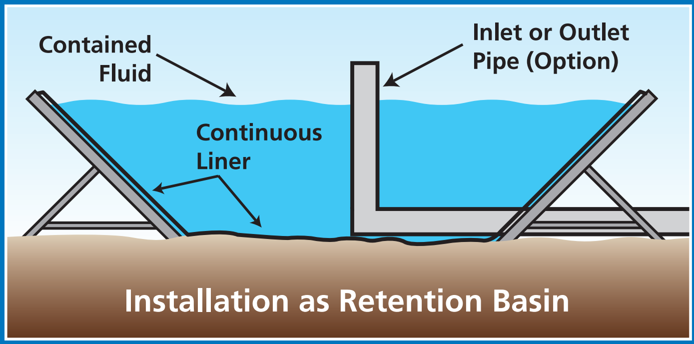
The PORTADAM system has proven to be a clean and effective method of performing open cut construction of pipelines across rivers and streams. A two-phase operation allows for unimpeded flow of water around the work site while offering an environmentally-friendly cofferdam system with no introduction of harmful materials to the watercourse.

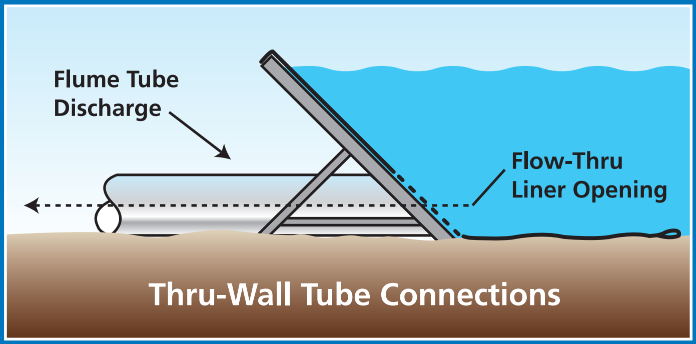
Adjustment of the river or streambed prior to installation is normally not required. Flexibility of the PORTADAM system equipment allows for installation over irregular contours and around obstructions.

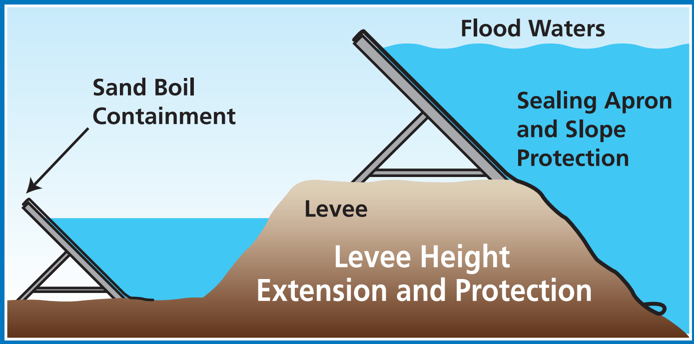
The "free-standing" characteristic of this system leaves the work area unobstructed and completely free of cross bracing, allowing the pipeline installation to proceed from the land portion directly to the riverbed. Since no fill material is required, excavation depths are greatly reduced. Concrete encasement can be poured in the dry without fear of watercourse contamination.

Installation Variations & Attachments









PORTADAM

Corporate Office,
Mid-Atlantic & Midwest Regions
3082 South Black Horse Pike
Williamstown, NJ 08094
856-740-0606 *phone*
856-740-0614 *fax*
800-346-4793 *toll-free*

Northeast Region
92 Lincoln Street
Dover-Foxcroft, ME 04426
207-564-7878 *phone*
207-564-7877 *fax*

Southeast Region
6 Falcon Drive, Suite 103
Peachtree City, GA 30269
770-632-4250 *phone*
770-632-4246 *fax*

Southwest Region
2761 Oakland Avenue
Garland, TX 75041
972-278-1640 *phone*
972-278-6640 *fax*

West Coast Region
805-451-7740 *phone*

www.portadam.com

PLANNING

LIMITATIONS

- Do not apply in water temperatures below 35°F (2°C)
- Do not apply in water temperatures above 90°F (32°C)
- Minimum application thickness is 1 in. (2.5 cm) neat, 2 in. (5.1 cm) extended
- Maximum application thickness is 6 in. (15.2 cm)
- Maximum 134 fl. oz. (3.9 L) water per bag
- Continual agitation required to maintain fluidity
- Underwater product placement should only be attempted by certified and experienced diving contractors

PREPARATION

SURFACE PREPARATION

Surface must be at least 35°F (2°C) prior to application. All surfaces must be sound, free of loose rust, marine growth, oil, and other contaminants. Consult a qualified professional engineer in all cases when section loss exceeds 25 percent.

Concrete: Prepare surface by high-pressure water blasting or other mechanical means to achieve ICRI Guideline 310.2R CSP 6-9. Repair or replace any reinforcing steel as determined by a qualified professional engineer.

Steel: Prepare surface by high-pressure waterjetting or other mechanical means necessary to achieve SSPC-SP12/NACE 5 WJ-4. Repair or replace any structural steel elements with excessive section loss as determined by a qualified professional engineer.

Wood: Prepare surface by high-pressure water blasting or other mechanical means necessary to achieve a sound surface, free of all contaminants.

All submerged forms should be installed by certified professional divers. All forms must be sealed appropriately to prevent grout leakage during installation.

MIXING

For optimal product performance, condition to 70°F (21°C). Do not prepare more material than can be used in the pot life of the product. Mix with a mortar mixer or a low-speed (300–600 rpm) drill and mixing paddle. Use a maximum of 134 fl. oz. (3.9 L) of potable water per 55 lb. bag (24.9 kg), adjusting water content for desired consistency. For best results, add 90% of total mixing water and slowly add entire contents of FX-225 while mixing to avoid clumping. Adjust using remaining mixing water until desired consistency is achieved, scraping unmixed material from the sides and bottom of mixing container as needed to ensure all material is mixed. Mix for approximately 3 minutes. Do not re-temper. Continue to slowly agitate to prevent product from setting in the mixer up to the maximum working time of 30 minutes at 75°F (24°C).

FX-225 can be extended with ⅜ in. (0.9 cm) pea gravel up to 30 lb. (13.6 kg) per bag, and requires the use of a concrete mixer. Aggregate used must be non-reactive, clean, well-graded, saturated surface dry (SSD), have low absorption and high density in compliance with ASTM C 1260, C 227 and C 289.

EXECUTION

APPLICATION

FX-225 can be troweled, pumped, or tremied. For pumping applications, pump properly mixed FX-225 through a port installed at the bottom of the form (FX-70® Jacket) and fill to the desired level, allowing water to displace from either the top of the form or through a port installed at the top of the form. All submerged forms should be inspected by a professional diver during the filling process to check for leaks and proper placement. For tremie applications, make sure the hose extends all the way to the bottom of the form. Fill the form to the desired level, allowing water to displace from the top of the form. Depending on the depth of the pour and size of the vessel, the tremie hose may need to be retracted as the form fills to maintain flow.

SAFETY

CAUTION

May cause serious eye and skin irritation or damage. When combined with water may cause moderate to severe alkali burns.

Protective Measures: The use of safety glasses and chemically resistant gloves is recommended. Use appropriate clothing to minimize skin contact. The use of a NIOSH-approved respirator is required to protect respiratory tract when ventilation is not adequate to limit exposure below the PEL. Refer to Material Safety Data Sheet (MSDS) available at **www.strongtie.com/msds** for detailed information.

FIRST AID

Eye Contact: Immediately flush eyes with plenty of cool water for at least 15 minutes while holding the eyes open. If redness, burning, blurred vision, or swelling persists, **CONSULT A PHYSICIAN**.

Skin Contact: Remove product and wash affected area with soap and water. Do not apply greases or ointments. Remove contaminated clothing. Wash clothing with soap and water before reuse. If redness, burning, or swelling persists, **CONSULT A PHYSICIAN**.

Ingestion: DO NOT INDUCE VOMITING. CONSULT A PHYSICIAN OR POISON CONTROL CENTER IMMEDIATELY FOR CURRENT INFORMATION. Never administer anything by mouth to an unconscious person. Rinse mouth out with water. Never leave patient unattended. If vomiting occurs spontaneously, lay individual on their side, keeping head below hips to prevent aspiration of material into lungs.

Inhalation: Remove patient to fresh air. If patient continues to experience difficulty breathing, **CONSULT A PHYSICIAN**.

CLEAN UP

Spills: Sweep or vacuum material and place in a suitable container. Keep out of sewers, storm drains, surface waters, and soils.

Surface Clean: Remove any residue with hot soapy water. Cured material can only be removed by mechanical means.

Tools and Equipment: Clean with soap and water immediately after use.

Skin: Use a non-toxic pumice-based soap, citrus-based hand cleaner, or waterless hand cleaner towel. Never use solvents to remove product from skin.

Disposal: Dispose of container and unused contents in accordance with federal, state, and local requirements. Containers may be recycled; consult local regulations for exceptions.

Distributor

IMPORTANT INFORMATION

It is the responsibility of each purchaser and user of each product to determine the suitability of the product for its intended use. Prior to using any product, consult a qualified design professional for advice regarding the suitability and use of the product, including whether the capacity of any structural building element may be impacted by a repair. As jobsite conditions vary greatly, a small-scale test patch is required to verify product suitability prior to full-scale application. The installer must read, understand and follow all written instructions and warnings contained on the Limited Warranty, product label(s), Product Data Sheet(s), Material Safety Data Sheet(s) and the **www.strongtie.com** website prior to use. For industrial use only by qualified applicators. KEEP OUT OF REACH OF CHILDREN!

Proposition 65: Products contained within this document contain materials listed by the state of California as known to cause cancer, birth defects, or reproductive harm.

Appendix C Consultation

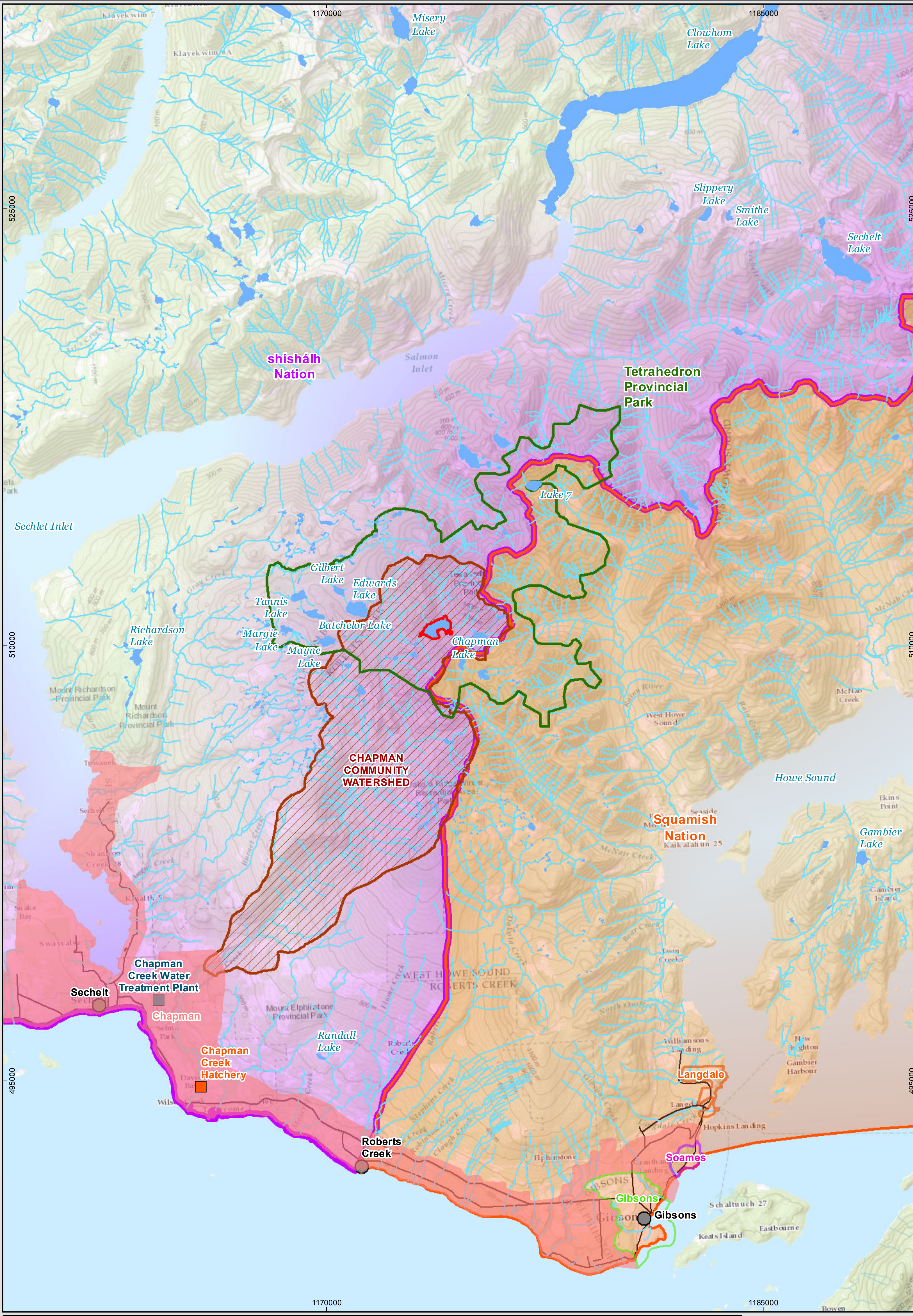
1. Consultation and Stakeholder Engagement Plan

The Project has prepared and is implementing an Aboriginal Consultation and Public Participation Plan. The Plan describes the Project, the purpose and objectives of Aboriginal consultation and public participation and the activities to fulfil regulatory requirements of meaningful consultation and active public participation in the planning process, in order to consider potential social, cultural and environmental effects and mitigation measures. The process follows extensive First Nation and public consultations undertaken as part of approval for the Sunshine Coast's Comprehensive Regional Water Plan in 2013.

Chapman Lake and the Chapman Creek watershed are located solely within shíshálh Nation territory. Tetrahedron Provincial Park is within the territories of the shíshálh Nation and the Squamish Nation (Figure 5). Given that the Chapman water system supplies water to 80% of Sunshine Coast's residents and businesses that are within First Nation Territories, consultation is proceeding with both the shíshálh Nation and the Squamish Nation. Detailed project information has been provided to both nations. Regulatory submissions will be reviewed through the shíshálh Nation's Lands and Resources Decision-making Policy and process, before being presented to Chief and Council. Squamish Nation will determine whether it chooses to actively participate in the consultation process now underway.

Public engagement is also proceeding with interested groups and individuals. A plain-language information package and map showing relevant project features has been prepared and distributed. Following an initial meeting with the shíshálh Nation, discussions were held with representatives from a number of local associations and organizations including the Sunshine Coast Conservation Association, the Tetrahedron Outdoors Club, the Tetrahedron Alliance and the Tuwanek Ratepayers Association. Informal discussions and information-sharing have also included the Sunshine Coast Salmonid Enhancement Society (Chapman Creek Hatchery) and the Ruby Lake Lagoon Nature Reserve Society. The District of Sechelt and town of Gibsons will continue to participate in the Project through the SCRD board, staff presentations to local councils and periodic updates. The Vancouver Coastal Health Authority will be invited to participate through the Sunshine Coast's local representative. The process will document all interests, comments and issues expressed, providing a report of this information to the SCRD, BC Parks and other regulatory agencies.

Planned Aboriginal consultation and public participation activities include a presentation to the SCRD's Infrastructure Committee, followed by consideration of the consultation process findings prior to approval of the Project's final design by the SCRD Board. An Open House to share Project details, proposed timelines and answer public questions will be held at the conclusion of the consultation and public participation process.



Basemapping from ESRI Online Topographic,
First Nation Territories from GeoBC

N
W E
S

0 2 4 6
Kilometres
1:130,000
NAD 1983 BC Environment Albers

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced, or relied upon by third parties, except as agreed by AECOM and its client, as required by law, or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Legend

- Project Area (Chapman Lake)
- Squamish Nation Territory
- shíshálh Nation Territory
- Park and Protected Area
- Community Watershed
- Waterbody
- Champan Creek Water Treatment Plant
- Chapman Creek Hatchery
- City
- Main Road (Arterial / Collector / Highway)
- Stream

Water Service System

- Chapman
- Gibsons
- Langdale
- Soames

Overview Map

Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

First Nation Territories

03 March 2016

AECOM

Figure 1

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\First Nation\2016-03-01-FNTerritories\Figx-2016-03-01-FNTerritoriesPortrait-60485918-002.mxd Date Revised: March 03, 2016 Reviewed By: AM Paper Size: 11"x17" Scale is referenced to the specified paper size.

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Sunshine Coast Regional District
Chapman Lake Water Supply Expansion Project
Information Package (UPDATED JUNE 2016)

Project Background

The Sunshine Coast Regional District's (SCRD) Chapman Water System supplies potable water to approximately 10,000 properties from West Howe Sound north to Secret Cove. This water supply is carefully managed to ensure that the environmental needs of the watershed are maintained, providing flow for fish in Chapman Creek, water for fire protection, while serving as the primary source of potable water for 90% of the residents within the Regional Water Service Area. The Chapman Creek watershed, located in shíshálh Nation territory, includes two alpine lakes that supplement flows into Chapman Creek:

- Chapman Lake (primary reservoir with 900,000 cubic metres (m^3) of current storage), and
- Edwards Lake (secondary reservoir with 800,000 m^3 of current storage).

Chapman Lake, located in Tetrahedron Provincial Park, is approximately 32 m deep, with only the top 3 m currently available as usable water supply storage.

In 2013, after extensive First Nations consultation and public participation, the SCRD Board adopted a Comprehensive Regional Water Plan. The Plan examined several different options for the near and long-term supply of potable water to Sunshine Coast communities. The preferred short-term option selected is to allow for the potential diversion of 1 million m^3 more water from Chapman Lake by increasing the available draw-down by 5.0 m from the current 3.0 m to 8.0 m, within limits established by the 1999 Environmental Assessment of a plan to expand the region's water supply options during seasonal periods of drought.

Following imposition of Stage 4 water restrictions in late summer 2015, the SCRD was granted a Short Term Use of Water approval by the Province permitting the installation of a temporary siphon that would enable the additional Chapman Lake draw-down of approximately 5 m from current levels. After rainfall replenished water reserves at Chapman Lake in early September 2015 and water use restrictions were removed, the SCRD Board subsequently approved a plan to move forward with the design and regulatory approvals of a permanent system to access additional stored water at Chapman Lake for future drought mitigation management requirements. In approving this plan, the SCRD Board resolved that the additional water supply:

> …will only be utilized during periods of drought and until long-term source development specified in the Comprehensive Regional Water Plan are constructed… (Source: SCRD Resolution 347/15)

The plan to make additional storage accessible (the Project) proposes to deepen the channel from Chapman Lake to Chapman Creek by 5 m, replacing or upgrading the existing dam, the installation of a large diameter gravity-fed pipe and release valves at both the existing 3 m depth and at 8 m depth. The Project requires environmental assessment and is subject to BC Parks and other regulatory approvals. The SCRD is also committed to consulting with affected First Nations and public participation.

Environmental Assessment (EA) Process

BC Parks has developed a policy and guidance for the assessment of projects, activities or management decisions that have the potential to cause an impact on the natural, cultural, heritage and/or recreation environment of a park. The process is rigorous and requires meaningful consultation with affected First Nations, as well as participation by the public. This process provides adequate review for other related regulatory approvals and permitting.

Environmental assessment helps describe current conditions within a Project Area in order to understand and mitigate potential impacts. The proposed plan to deepen the channel from Chapman Lake into Chapman Creek benefits from the availability of a number of reports and studies prepared for the creation of Tetrahedron Park, completed by SCRD and other groups, accessible through provincial and other public sources. An environmental assessment was also completed in 1999 for an alternative option (a floating pump) to access additional storage at Chapman Lake for use in drought conditions. To supplement this data, BC Parks has requested that additional environmental field studies be conducted in summer 2016.

Long-term Water Source Development and Project Alternatives

As part of the Comprehensive Regional Water Plan, in addition to the proposed Project, the SCRD is implementing a range of initiatives which aim to conserve, maintain and expand a sustainable water supply. These efforts include:

1. Universal metering of water for all Sunshine Coast residential and commercial customers, to measure, manage and conserve treated water usage
2. Investigation of other groundwater sources of water supply
3. Refinements to the SCRD Drought Management Plan
4. Future planned development of an engineered lake to increase water system storage capacity

In terms of alternative options to the proposed Project, as mentioned above, a 1999 environmental assessment considered the use of a floating pump system to access additional water from Chapman Lake. This option would require ongoing maintenance of the pump and infrastructure during and after operation and diesel fuel or propane to power the pump. During operation, noise may be generated in the surrounding park area. Contingencies would also be needed in case of pump failure. In assessing this option and its overall costs, the preferred plan of deepening the Chapman Lake channel and installation of a gravity-fed pipe and valve system was developed.

Proposed Timeline

The Project schedule below has been updated to reflect additional environmental studies in summer 2016 and construction in 2017, after regulatory approvals have been received. To minimize environmental impacts within Tetrahedron Park and project costs, improvements to the Chapman Water System construction would need to start in early July, for completion in late September. This tentative Project schedule assumes active First Nations consultations and public participation while environmental permitting proceeds at the same time.

2016 February	**April**	**June**		**October**	**December**
First Nation Consultations and Public Participation					
Environmental Assessment & Permitting					

2017 February	**April**	**June**		**October**	**December**
Tendering and Award			Construction Period		Project Close-out

Aboriginal Consultation and Public Participation

Aboriginal Consultation and public participation is intended to facilitate meaningful consultation with the shíshálh and Squamish First Nations and the participation of interested parties and the general public in Project planning. This will be achieved through an active process of information-sharing and a discussion of the Project that includes potential impacts and mitigation measures.

Appendix D Water Quality Data

Appendix D: Chapman Water Quality Analysis

RESULTS OF CHEMICAL ANALYSES OF WATER							
				Sampling Name	**CHP-01**	**CHP-02**	**CHP-03**
				Sampling Date	24-Aug-2016	24-Aug-2016	24-Aug-2016
Parameter Name	**Units**	**RDL**	**CCME[a]**	**BC Water Guidelines**	**Surface**	**Thermocline**	**Bottom**
In Situ							
Temperature	°C	-			16.95	6.11	3.92
Dissolved Oxygen	mg/L	-			9.51	11.93	8.02
Specific Conductivity	uS/cm	-			18	14	15
ORP	mV	-			248.7	243	234
pH	pH	-			5.95	5.78	5.92
Physical Properties							
Conductivity	uS/cm	2.0			19.7	15.1	18.6
pH	pH	0.10	6.5 - 9.0	6.5 -9.0	6.90	6.78	6.81
Total Suspended Solids	mg/L	3.0	Above Background[m]	Change over Background[m]	<3.0	<3.0	<3.0
Total Dissolved Solids	mg/L	10			25	27	29
Misc. Inorganics							
Alkalinity, Total (as CaCO3)	mg/L	1.0			6.6	4.9	6.2
Anions							
Nitrite (N)	mg/L	0.0010	0.06	0.06[o]	<0.0010	<0.0010	<0.0010
Sulphide as S	mg/L	0.020			<0.020	<0.020	<0.020
Sulphide (as H2S)	mg/L	0.021			<0.021	<0.021	<0.021
Calculated Parameters							
Nitrate (N)	mg/L	0.0050	550 Acute; 13 Chronic[h]	32.8	<0.0050	<0.0050	0.0288
Total Hardness (CaCO3)	mg/L	0.5			7.79	6.28	7.73
Nutrients							
Ammonia, Total (as N)	mg/L	0.0050	5.7-12.6	23.9-24.5	<0.0050	<0.0050	0.0068
Total Kjeldahl Nitrogen	mg/L	0.050			0.079	0.071	0.089
Total Organic Nitrogen	mg/L	0.060			0.079	0.071	0.082
Total Nitrogen	mg/L	0.050			0.079	0.071	0.118
Orthophosphate-Dissolved (as P)	mg/L	0.0010			<0.0010	<0.0010	0.0011
Phosphorus (P)-Total	mg/L	0.0020		0.005-0.015	0.0020	<0.0020	0.0023
Organic/Inorganic Carbon							
Total Organic Carbon	mg/L	0.50			1.52	2.05	2.37
Plant Pigments (Filter)							
Chlorophyll a	mg/L	0.000020			0.000216	0.000309	0.000073
Total Metals by ICPMS							
Total Aluminum (Al)	mg/L	0.0050	0.1		0.0551	0.0875	0.111
Total Antimony (Sb)	mg/L	0.00050		0.009[v]	<0.00050	<0.00050	<0.00050
Total Arsenic (As)	mg/L	0.00050	0.005	0.005	<0.00050	<0.00050	<0.00050
Total Barium (Ba)	mg/L	0.020		1[v]	<0.020	<0.020	<0.020
Total Beryllium (Be)	mg/L	0.0010		0.00013[v]	<0.0010	<0.0010	<0.0010
Total Boron (B)	mg/L	0.10	29(Acute); 1.5 (Chronic)	1.2	<0.10	<0.10	<0.10
Total Cadmium (Cd)	mg/L	0.0000050	0.00004[c]		0.0000269	0.0000272	0.0000310
Total Calcium (Ca)	mg/L	0.10			2.93	2.34	2.88
Total Chromium (Cr)	mg/L	0.0010			<0.0010	<0.0010	<0.0010
Total Cobalt (Co)	mg/L	0.00030		0.11	<0.00030	<0.00030	<0.00030
Total Copper (Cu)	mg/L	0.0010	0.002[e]	0.0026-0.0027[u]	<0.0010	<0.0010	0.0015
Total Iron (Fe)	mg/L	0.030	0.3	1	0.050	0.041	0.171
Total Lead (Pb)	mg/L	0.00050	0.001[f]	0.003	<0.00050	<0.00050	<0.00050
Total Lithium (Li)	mg/L	0.0010			<0.0010	<0.0010	<0.0010
Total Magnesium (Mg)	mg/L	0.10			0.12	0.11	0.13
Total Manganese (Mn)	mg/L	0.00030		0.61-0.63[n]	0.00773	0.00804	0.0265
Total Mercury (Hg)	mg/L	0.0000050	0.000026 (inorganic)		<0.0000050	<0.0000050	<0.0000050
Total Molybdenum (Mo)	mg/L	0.0010	0.073	2	<0.0010	<0.0010	<0.0010
Total Nickel (Ni)	mg/L	0.0010	0.025[g]	0.025[v]	<0.0010	<0.0010	<0.0010
Total Potassium (K)	mg/L	2.0			<2.0	<2.0	<2.0
Total Selenium (Se)	mg/L	0.000050	0.001	0	0.000055	0.000068	0.000052
Total Silver (Ag)	mg/L	0.000020	0.00025	0.0001[p]	<0.000020	<0.000020	<0.000020
Total Sodium (Na)	mg/L	2.0			<2.0	<2.0	<2.0
Total Thallium (Tl)	mg/L	0.00020	0.0008	0.0008[v]	<0.00020	<0.00020	<0.00020
Total Tin (Sn)	mg/L	0.00050			<0.00050	<0.00050	<0.00050
Total Titanium (Ti)	mg/L	0.010			<0.010	<0.010	<0.010
Total Uranium (U)	mg/L	0.00020	0.033 (Acute); 0.015 (Chronic)	0.0085[v]	<0.00020	<0.00020	<0.00020
Total Vanadium (V)	mg/L	0.00050			<0.00050	<0.00050	<0.00050
Total Zinc (Zn)	mg/L	0.0050	0.030	0.033[t]	<0.0050	<0.0050	<0.0050

Appendix D: Chapman Water Quality Analysis

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007. http://www.ccme.ca/publications/ceqg_rcqe.html

b) Guideline based on range from field pH and temperature; CCME guideline converted to mg/L total ammonia-N by multiplying value by 0.08224.

c) 0.11 µg/L at hardness <5.3 mg/L; calculated as $10^{\{1.016(\log[hardness]) - 1.71\}}$ at hardness ≥5.3 mg/L to ≤360 mg/L; 7.7 µg/L at hardness >360 mg/L

d) Guideline values represent concentrations of the chloride ion for CCME standards and NaCl chloride for BC WQ Guidelines

e) 2 µg/L at hardness <82 mg/L; calculated as $e^{\{0.8545[\ln(hardness)]-1.465\}}$x0.2 at hardness ≥82 mg/L to ≤180 mg/L; 4 µg/L at hardness >180 mg/L

f) 1 µg/L at hardness <60 mg/L; calculated as $e^{\{1.273[\ln(hardness)]-4.705\}}$ at hardness >60 mg/L to ≤180 mg/L; 7 µg/L at hardness >180 mg/L

g) 25 µg/L at hardness ≤60 mg/L; calculated as $e^{\{0.76[\ln(hardness)]+1.06\}}$ at hardness >60 mg/L to ≤180 mg/L; 150 µg/L at hardness >180 mg/L

h) Guideline values represent concentrations of the nitrate in ion form, must multiply concentrations by 4.43 to convert to mg NO3-N/L

i) Clear flow: Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from for a longer term exposure High flow or turbid waters: Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when > 80 NTUs. (e.g., 30-d period).

j) Guideline is short term maximum of 100 µg/L at pH ≥6.5 and long term average of 50 µg/L

k) 0.4 mg/L at hardness 10mg/L; calculate -51.73+92.57log10(hardness) x 0.01

l) 3 ug/L at hardness ≤ 8 mg/L; $e^{(1.273\ 1n\ [hardness])-1.460)}$ at hardness > 8 mg/L; expressed as total hardness of samples; 30 day guideline (3.31+e(1.273 1n mean hardness)-4.704)

m) Clear flow: Maximum increase of 25mg/L from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from for a longer term exposure (e.g., 30-d period). High flow: Maximum increase of 25 mg/L from background levels at any one time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when ≥250 mg/L.

n) Instantaneous maximum calculated from 0.01102(hardness) + 0.54; expressed using total hardness of samples; 30 day guideline calculated from 0.0044(hardness)+0.605

o) Guideline is a maximum based on chloride values less than or equal to 2 mg/L, chloride was not analyzed

p) 0.1 ug/L at hardness ≤ 100mg/L; 3 ug/L at hardness >100mg/L; 30-d mean guideline 0.05 ug/L at hardness ≤ 100mg/L; 1.5 ug/L at hardness >100mg/L

q) Guideline for total sulphate; 128 mg/L at hardness 0-30 mg/L; 218 mg/L at hardness 31-75 mg/L; 309 mg/L at hardness 76-180; 429 at hardness 181-250 mg/L

t) 33 ug/L at hardness of ≤90 mg/L (Acute); and 33+0.75(hardness mg/L-90) for hardness that exceeds 90 mg/L; 30 day guideline 7.5 ug/L at hardness <90 mg/L and 7.5+0.75(hardness mg/L-90) for hardness that exceeds 90 mg/L

u) calculated as 0.094 (hardness) +2; expressed using total hardness of samples; 30 day is 2 ug/L for hardness <50 mg/L and 0.04(avg hardness) for hardness >50 mg/L

v) A compendium of working water quality guidelines for British Columbia, 2006. http://www.env.gov.bc.ca/wat/wq/BCguidelines/working.html

w) Calculated as e[1.03*ln(hardness)-5.274] short term and e[0.736*ln(hardness)-4.943] long term; expressed using total hardness of samples

x) Detection limit higher than guideline

"<"	Less than detection limit.
0.125	Value exceeds CCME guideline.
0.125	Value exceeds BC WQ guidelines
0.125	Value exceeds both CCME and BC WQ guidelines

RDL = Reportable Detection Limit

Appendix E Fish Collection Data

Appendix E: Chapman Lake 2016 Fish Data

Date	Sample Method	Location Reference	Fish#	Species	Length (mm)	Weight (g)	Condition Factor
23-Aug	EF	Stranded pool d/s of dam	1	DV	143	24	0.821
			2	DV	117	15.5	0.968
			3	DV	127	20.5	1.001
			4	DV	97	8.5	0.931
			5	DV	136	23.5	0.934
		Inlet stream at NE of lake	1	DV	113	17.5	1.213
			2	DV	74	4.5	1.110
			3	DV	109	13	1.004
			4	DV	74	4.5	1.110
			5	DV	55	2	1.202
			6	DV	44	1	1.174
			7	DV	58	1.5	0.769
			8	DV	47	1	0.963
			9	DV	44	1	1.174
25-Aug	GN	Floating gillnet	1	DV	164	48.5	1.100
			2	DV	166	48.5	1.060
			3	DV	140	28	1.020
			4	DV	153	38.5	1.075
			5	DV	126	20.5	1.025
			6	DV	136	25.5	1.014
			7	DV	124	20.5	1.075
			8	DV	116	17.5	1.121
			9	DV	113	17	1.178
		Sinking Gillnet	10	DV	510	1095.5	0.826
			11	DV	127	19.5	0.952
			12	DV	150	36	1.067
			13	DV	120	17.5	1.013
			14	DV	130	24	1.092
			15	DV	141	23.5	0.838
			16	DV	123	19	1.021
			17	DV	132	24	1.043
			18	DV	115	19	1.249
			19	DV	127	21	1.025
			20	DV	126	20	1.000
			21	DV	128	24	1.144
			22	DV	115	16.5	1.085
			23	DV	125	20.5	1.050
			24	DV	148	32.5	1.003
			25	DV	126	22	1.100
			26	DV	177	53.5	0.965
			27	DV	182	56	0.929
			28	DV	128	21.5	1.025
			29	DV	170	47.5	0.967
			30	DV	156	36	0.948
			31	DV	143	28.5	0.975
			32	DV	128	20.5	0.978
			33	DV	124	18	0.944
			34	DV	149	31.5	0.952
			35	DV	127	22	1.074
			36	DV	141	28	0.999
			37	DV	119	17	1.009
			38	DV	117	17	1.061
			39	DV	127	20	0.976
			40	DV	116	17	1.089
			41	DV	134	24.5	1.018
			42	DV	174	49	0.930
			43	DV	147	34.5	1.086
			44	DV	149	29.5	0.892
			45	DV	127	19	0.928
			46	DV	133	23.5	0.999
			47	DV	129	20.5	0.955
			48	DV	137	27	1.050
			49	DV	120	18	1.042
			50	DV	140	24.5	0.893
24-Aug	MT	MT#1	1	DV	91	7.5	0.995
25-Aug	MT	MT#13	1	DV	55	1	0.601
			2	DV	50	1	0.800
			3	DV	55	1	0.601
			4	DV	53	1	0.672
			5	DV	52	1	0.711
			6	DV	51	1	0.754
			7	DV	49	1	0.850
			8	DV	49	1	0.850
			9	DV	47	1	0.963
		MT#19	1	DV	102	10.5	0.989
			2	DV	-	-	-
			3	DV	56	2	1.139
			4	DV	76	4.5	1.025
			5	DV	69	3.5	1.065
			6	DV	62	2.5	1.049

Appendix F Fish Stream Habitat Quality

Appendix F: Stream Habitat Quality Characteristics

Habitat Category	Habitat Characteristic	SE Stream	NE Stream
		2016-08-23 13:22:21	**2016-08-23 16:08:54**
Channel	**Avg Wetted Width**	4	3.3
	Avg Bankfull Width (m)	7.2	6.9
	Avg Channel Depth (cm)	49	56
	Residual Pool Depth (cm)	16	5
	Bankfull Channel Depth (cm)	30	99
	Gradient (%)	4	2
	Stage	Low: 30% of bankfull	Low: 30% of bankfull
Morphology	**Pool (%)**	20	10
	Riffle (%)	80	70
	Run (%)	0	20
	Organics (%)	Trace	0
	Fines (%)	5	5
	Small Gravels (%)	5	10
	Large Gravels (%)	10	15
	Small Cobbles (%)	15	30
	Large Cobbles (%)	25	10
	Boulders (%)	30	15
	Bedrock (%)	10	5
	Dominant Bed Material	Boulders: >25.6 cm	Cobbles: 6.4-25.6 cm
	Subdominant Bed Material	Cobbles: 6.4-25.6 cm	Gravels: 0.2-6.4 cm
	D_{95} (cm)	30	33
	D (cm)	25	15
	Morphology	Riffle-pool	Riffle-pool
	Pattern	Straight	Straight
	Islands	None	Occassional
	Coupling	Decoupled	Decoupled
	Confinement	Confined	Occassionally confined
	Bars	Side	Side, mid
	Disturbance Indicators	Eroding banks, LWD	Eroding banks
Cover	**Right Bank Height (m)**	1	2
	Right Bank Slope (%)	30	80
	Right Bank Stability	Medium: some erosion by slumping/sloughing with bare soil and moderate amounts of vegetation	Medium: some erosion by slumping/sloughing with bare soil and moderate amounts of vegetation
	Right Bank Shape	Sloping	Sloping
	Right Bank Texture	Fines, cobbles	Organics, fines, gravels, cobbles
	Right Bank Veg Cover (%)	90	90
	Right Bank Riparian Veg	Shrubs, coniferous, deciduous, mixed	Shrubs, coniferous
	Right Bank Riparian Veg Stage	Mature forest	Mature forest
	Left Bank Height (m)	2	1.5
	Left Bank Slope (%)	45	75
	Left Bank Stability	High: minor to no noticeable erosion and well vegetated	Medium: some erosion by slumping/sloughing with bare soil and moderate amounts of vegetation
	Left Bank Shape	Sloping	Sloping
	Left Bank Texture	Fines, cobbles	Organics, fines, cobbles
	Left Bank Veg Cover (%)	85	90
	Left Bank Riparian Veg	Shrubs, coniferous, deciduous, mixed	Shrubs, coniferous
	Left Bank Riparian Veg Stage	Mature forest	Mature forest

Appendix F: Stream Habitat Quality Characteristics

Habitat Category	Habitat Characteristic	SE Stream	NE Stream
		2016-08-23 13:22:21	2016-08-23 16:08:54
Cover Continued	Total Cover	Moderate: 5-20%	Abundant: >20%
	Functional LWD	Few	Few
	Crown Closure	1-20%	1-20%
	Deep Pool Location	Primary channel	Primary channel
	Overhanging Veg Amount	Trace	Dominant
	Undercut Bank Amount	Trace	Dominant
	Deep Pool Amount	Trace	Subdominant
	LWD Amount	Subdominant	Subdominant
	Boulder Amount	Dominant	Dominant
	SWD Amount	Trace	Subdominant
	Instream Veg Amount	None	None
Habitat Quality	Stream Classification	S2: Fishbearing; >5-20 m channel width	S2: Fishbearing; >5-20 m channel width
	Spawning Habitat	No	Yes
	Spawning Habitat Comments	Suitable Gravels for Salmonids (clean and free of fines) are minimal	Suitable Gravels for Salmonids (clean and free of fines)
	Overwintering Habitat	Yes	Yes
	Overwintering Habitat Comments	Numerous pools 0.5 m deep	Numerous pools 0.5 m deep
	Staging/Holding Areas	No	Yes
	Staging/Holding Comments	Limited staging/holding areas	Good overhead cover
	Migration Corridor	Yes	Yes
	Migration Comments	Migration possible but habitat suitibility is moderate	No barriers to fish migration
	Rearing Habitat	Yes	Yes
	Rearing Habitat Comments	Frequent riffles and pools	Abundant cover, LWD, overhanging veg, undercut banks, frequent riffles and pools, good habitat complexity
	Overall Habitat Quality	Low - Moderate	High

Appendix G FSCI Letter Regarding Flows in Lower Chapman Creek

FSCI Biological Consultants

November 4, 2016 Our File No.: FSCI-16-0024

Mr. Dave Crosby
Sunshine Coast Regional District
1975 Field Road
Sechelt, BC V0N 3A1

Re: Review of low summer flow on salmonid habitat/passage in Chapman Creek

Dear Mr. Crosby:

This letter provides an update and additional information on available anadromous fish habitat and upstream passage during low summer flows in Chapman Creek. The information provided has been merged with data collected in 2015[1] using 2016 low summer flow information and is intended to accompany my 2015 letter report.

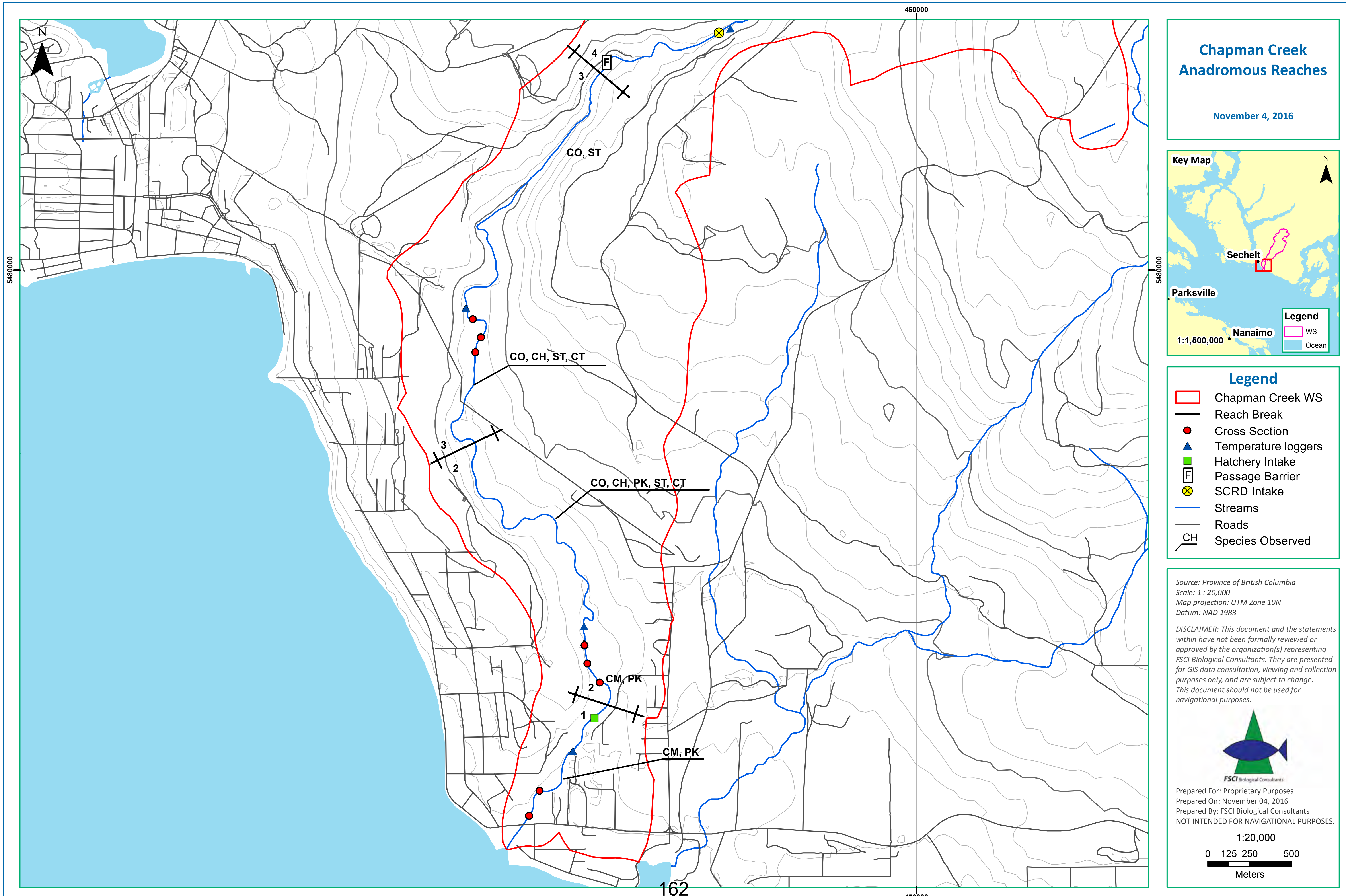
There remains public and regulator concerns about possible detrimental effects of targeted low summer flows on rearing juvenile salmonids, specifically Coho salmon, Steelhead and Cutthroat trout and migrating adult Pink, Chum and early Coho salmon. In 2016 the SCRD, using recommendations presented in 2015[1], maintained an estimated summer flow of approximately 0.20-0.22 cms. The maintained flow occurred after water in Chapman Lake stopped flowing over the control weir. The habitat, stage and channel morphology data collected in 2016 targeted this period of instream flow.

The period of greatest concerns remains the same, namely August and September, as natural watershed flows decrease and regional potable water demands increase. It's during this period that Pink and early Coho salmon enter the river. The majority of Coho and Chum migration occurs in October/November with returning Chum peaking near the end of October. In most years the October rains return and river flows have increased by mid October. At that point upstream access is not an issue.

In order to update the summer low flow information and the influence on fish and fish habitat, habitat assessments were repeated on the anadromous reaches. These assessments and measurements occurred during the summer (August/September, 2016) and targeted 0.20 to 0.22 cms discharge. The assessment followed the modified fish habitat procedures used in 2015 (Johnston and Slaney, 1996[2]) and was completed for the same anadromous stream length reported in 2015 (**Figure 1**). This was approximately 3.5-km of river, which represents greater than 50% of the entire anadromous stream length. As in previous years the effort focused on Reach 1, 2 and the lower portion of Reach 3.

[1] Letter to Dave Crosby from D. Bates dated December 6, 2015.
[2] Johnston, N.T. and Slaney, P.A. 1996. Fish Habitat Assessment Procedures. Watershed Restoration Technical Circular No 8., BC Ministry of Environment, Lands and Parks, Victoria, BC.

8-5520 McCourt Road, Sechelt, BC, Canada, V0N 3A7
604-740-2637 (tel)
dbates@fsci-biological.ca


Chapman Creek Anadromous Reaches
November 4, 2016
Key Map
Sechelt
Parksville
Nanaimo
1:1,500,000
Legend
WS
Ocean
Legend
Chapman Creek WS
Reach Break
Cross Section
Temperature loggers
Hatchery Intake
Passage Barrier
SCRD Intake
Streams
Roads
Species Observed
Source: Province of British Columbia
Scale: 1 : 20,000
Map projection: UTM Zone 10N
Datum: NAD 1983
DISCLAIMER: This document and the statements within have not been formally reviewed or approved by the organization(s) representing FSCI Biological Consultants. They are presented for GIS data consultation, viewing and collection purposes only, and are subject to change. This document should not be used for navigational purposes.
FSCI Biological Consultants
Prepared For: Proprietary Purposes
Prepared On: November 04, 2016
Prepared By: FSCI Biological Consultants
NOT INTENDED FOR NAVIGATIONAL PURPOSES.
1:20,000
0 125 250 500
Meters
CO, ST
CO, CH, ST, CT
CO, CH, PK, ST, CT
CM, PK
CM, PK
450000
5480000

In addition to the habitat survey a series of 8 cross sections were established throughout the 3 anadromous reaches (**Figure 1**). The cross sections were located in riffle areas, selected to represent areas that could be potential passage barriers at low flows. Cross-sections were benchmarked and pinned for future reference. The creation of barriers to migration may occur where insufficient swimming depth cannot be maintained. The selection of riffles was based on channel morphology (riffles) that could provide access issues.

Anadromous fish distribution in Chapman Creek varies throughout its accessible length (**Figure 1**). In the summer low flow period, Reach 1 (lower reach) must be passable by Coho, Chinook, Pink and Chum salmon while the majority of Reach 2 and 3 must be accessible for early Pink and Coho salmon and possibly Chinook salmon. It should be noted that Chinook access might always be problematic. This hatchery-enhanced species is typically large and may require substantial depth to migrate upstream. Design flows to accommodate the few returning large Chinook may not be possible. Minimum passage depths used to determine the possibility of passage at 0.20 cms are presented in **Table I**.

Table I: *Minimum water depth and maximum velocity that enable upstream migration of select adult migrating salmon (Thompson, 1972[3]).*

Species	*Minimum migration depth (m)*	*Maximum migration velocity (m/s)*
Summer Chinook	0.24	2.44
Pink Salmon	0.18	2.13
Chum Salmon	0.18	2.44
Coho Salmon	0.18	2.44

Finally, at each area with surveyed cross sections, stage changes were recorded using Solinst® pressure transducers. These will provide insight to daily fluctuations in stage height that may help direct planned releases for summer returns of Pink and early Coho salmon.

Results Summary

Results of the 2016 habitat assessments are similar to the information collected in 2015. Habitat at lower flows typically provides less available wetted area, although the quality of habitat is high (**Figure 2**). Juvenile salmonids were observed throughout the length of surveyed stream and when the available wetted habitat data collected in 2016 was plotted with the 2015 data the target of 0.20-0.22 cms appears to provide adequate available habitat (**Figure 3**). This is also consistent with the results provided in the 2015 report. As a result of the additional data, it is my opinion that rearing salmonid populations are afforded adequate protection at the target low summer flow of 0.20 cms,

[3] Thompson, K. 1972. Determining stream flows for fish life. Pages 31-50 in Proceedings, Instream flow requirements workshop. Pacific Northwest River Basins Commission, Vancouver, Washington.

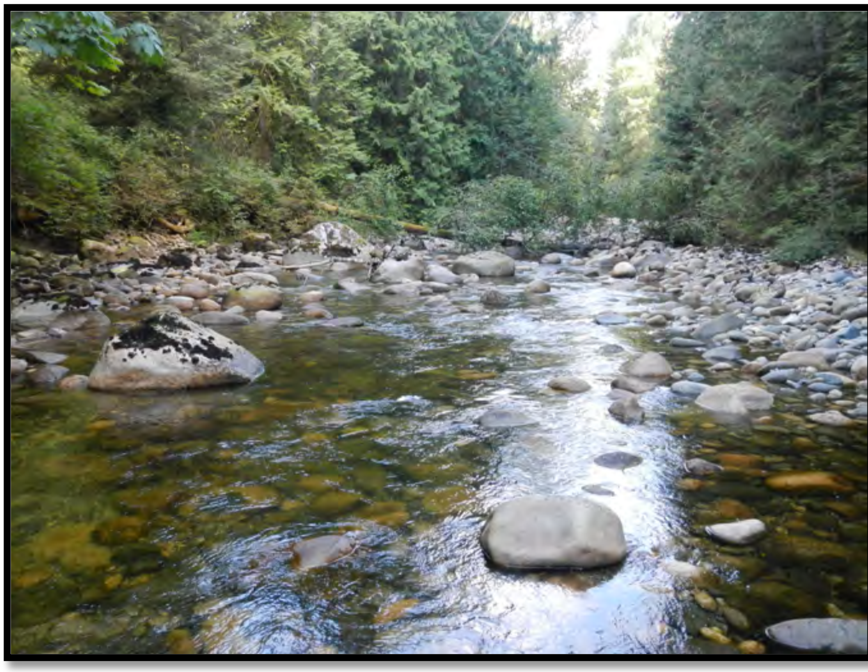


Figure 2: *Example of observed available rearing habitat found in Reach 2 and 3 of the Chapman Creek mainstem. The photos were taken August 10 at an estimated flow of 0.20 -0.22 cms.*

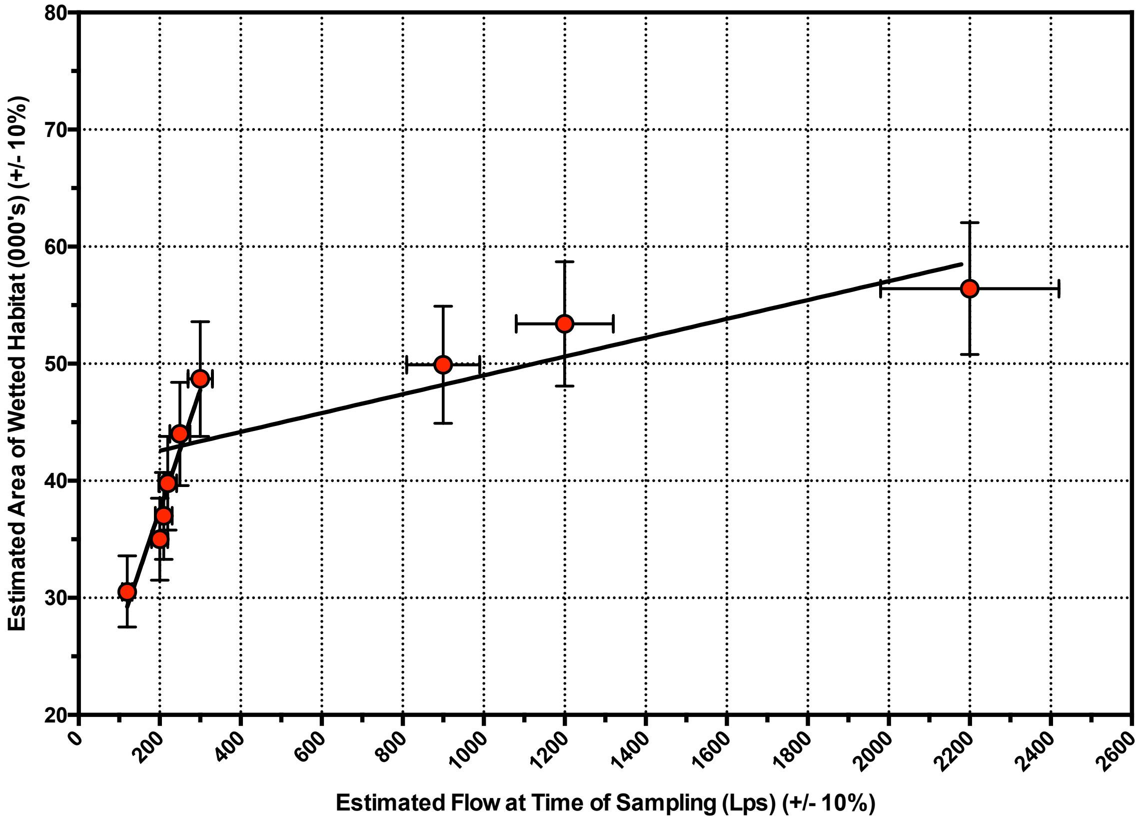


Figure 3: *The measured available wetted habitat versus the estimated flow (lops) documented on the lower anadromous length of Chapman Creek. The intersection or breakpoint of the linear relationships illustrates the point at which quality habitat area increase slows with increasing flow. This is intended as a guide representing a managed discharge to maximize habitat benefit.*

which has been estimated to represent approximately 5% of mean annual discharge below the intake[4].

While the target of 0.20 appear to provide abundant protection, it may be possible, under certain conditions to reduce the volume. This should only be considered in the event of emergency need and a robust water quality and habitat-monitoring plan should be implemented to ensure fisheries resources are protected. The greatest risk to severe reduced flows (0.10 cms) would be in mid August when solar heating and water temperatures are typically greatest.

In order to assess the influence of 0.20 cms flow on water temperature a set of Onset® Tidbit data loggers were installed in the target reaches (**Figure 1**). Temperature data was recorded during the summer low flow period. Water temperature during the summer low flow ranged from a high of 18.6°C (August 16) to a low of 10.2°C (Sept 27) (**Figure 4**). At higher temperatures and lower flows, thermal refuge is available in abundant pool and complex instream habitats (**Figure 5**).

---

[4] Bates, D. 2008. Letter report to G. Wilson, BC MoE. Chapman Creek low flow-GBLR Mainland coast water for fish.

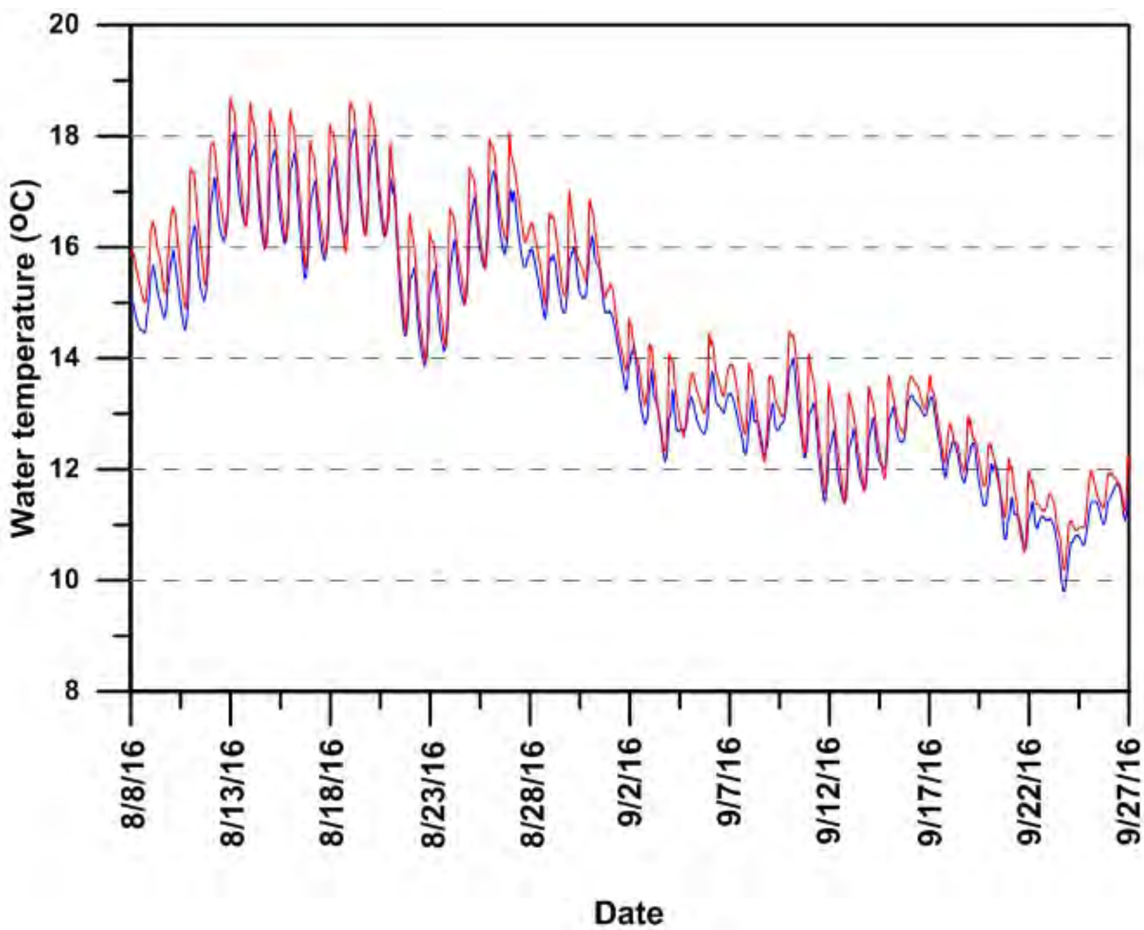


Figure 4: *Water temperatures recorded every 30 minutes from the beginning of August to the end of September 2016. The temperatures were recorded in Reach 2 (Red line) and 3 (Blue line). The temperatures peaked at daily highs greater than 18°C for a 10-day period.*

In Reach 1, water temperatures appeared to be higher during the same period. This will be confirmed after the next data download. It is probable that the diversion of surface water for the hatchery that subsequently reduces bypass flows, affects water temperature in this zone. The extent of difference has not been determined and will be provided to the SCRD once the loggers can be accessed.

There was no indication that the target flow (0.20 cms) has any detrimental affect on rearing salmonids with abundant quality and accessible habitat. While a flow of 0.20 cms appears adequate to protect rearing salmonids, there is a concern with lower flows creating a barrier to upstream migration. As described above a series of 8 cross sections were surveyed and the depth at these points measured to determine the depth through the thalweg. This thalweg depth determines the ability of larger adult salmonids to navigate upstream at lower flows.

In reviewing the surveyed cross sections reported above, all riffles were accessible at the target 0.20 cms (see attached). The cross sections represent sections of stream in each of the three reaches and areas that have access issues at low flows or have the potential to create access issues.

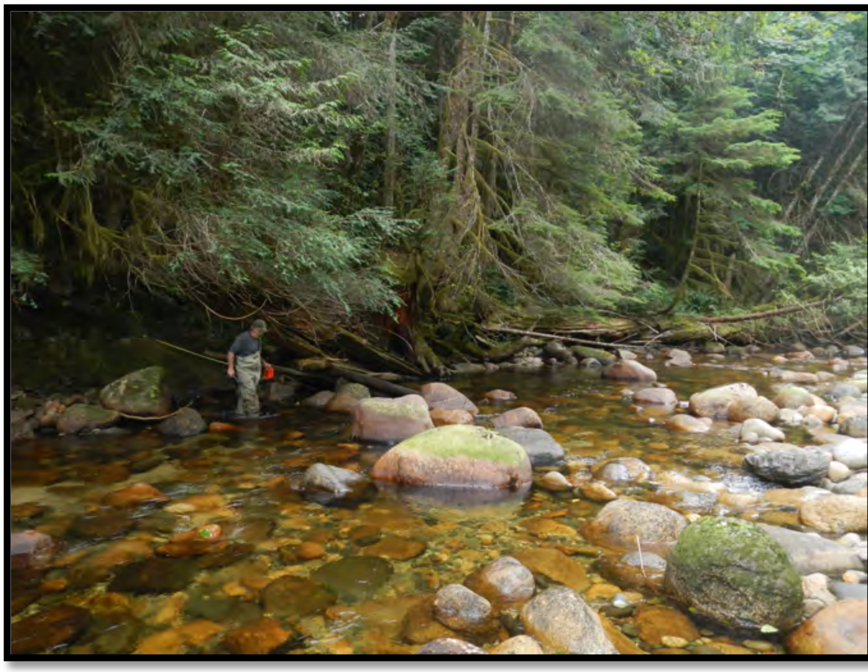


Figure 5: *Example of areas of instream habitat including cover and depth that provides thermal refuge during periods of increased water temperatures. The top photo is taken at a flow of 0.20 cms and the lower at 0.50 cms.*

These monitoring cross sections have been permanently fixed for continued monitoring as channel morphology changes.

The greatest area of concern is Reach 1, a channelized depositional reach. It is this area that most depth/barrier issues exist. Cross section 1 (see attachment of cross section plots) represents the first significant shallow riffle barrier. The survey shows a thalweg depth between 0.15 to 0.20 m at a flow of 0.20 cms. This flow, and associated depth may slow upstream migration and in years with a similar thalweg to 2016 and large Pink Salmon returns require “creative” mitigation to ensure spawning adults can move to spawning areas upstream.

This reach and the first riffle area changes seasonally and changes following each large flood event. The modified and channelized Reach is typically characterized by large bedload build-up and will continue to provide challenging conditions for upstream migration. Monitoring of adult salmon buildup should be implemented in partnership with local volunteer and regulatory agencies and a mitigation plan established for peak Pink salmon return years.

In reviewing the remaining cross sections (see attachments) there does not appear to be an issue with depth for upstream movement. The thalweg depth provides upstream access throughout Reach 2 and 3. The challenge in dry year with peak salmon returns will be facilitating adult movement through Reach 1 to Reach 2.

In summary, results of the 2016 assessment support the target flow of 0.20 cms and provide access to stable/quality rearing habitats during a critical growth period (summer). The target flow also provides adequate flow and depth to facilitate distribution of adult Pink and early Coho salmon in Reach 2 and 3. In Reach 1 access becomes more challenging at this volume and may require continual monitoring to ensure returning fish are not prevented from migrating up to and past the hatchery. The distribution, as reported in 2015 may require monitoring and planning to either entice movement with pulsed releases or physical movement.

It should be noted that the issue of shallow riffles and barriers in Reach 1 is not a reflection of the SCRD release flow (0.20 cms). This reach has been channelized (1950’s) and confined, resulting in areas of significant bedload build-up (lower area near Highway 101 bridge) (**Figure 6**). These areas of deposition change seasonally and will present an ongoing challenge for migrating summer run salmonids (Pink salmon).

In closing I want to re-iterate that the 2016 results support the findings presented in 2015 and that a release target flow of 0.20 cms provides substantial quality rearing habitat. This same release target appears to provide adequate flows across riffles in Reaches 2 and 3, ensuring upstream adult movement. This flow may provide adequate conditions for upstream access in Reach 1 but this should be monitored. This will be important in the dominant Pink salmon return years (2017, 2019 etc.).

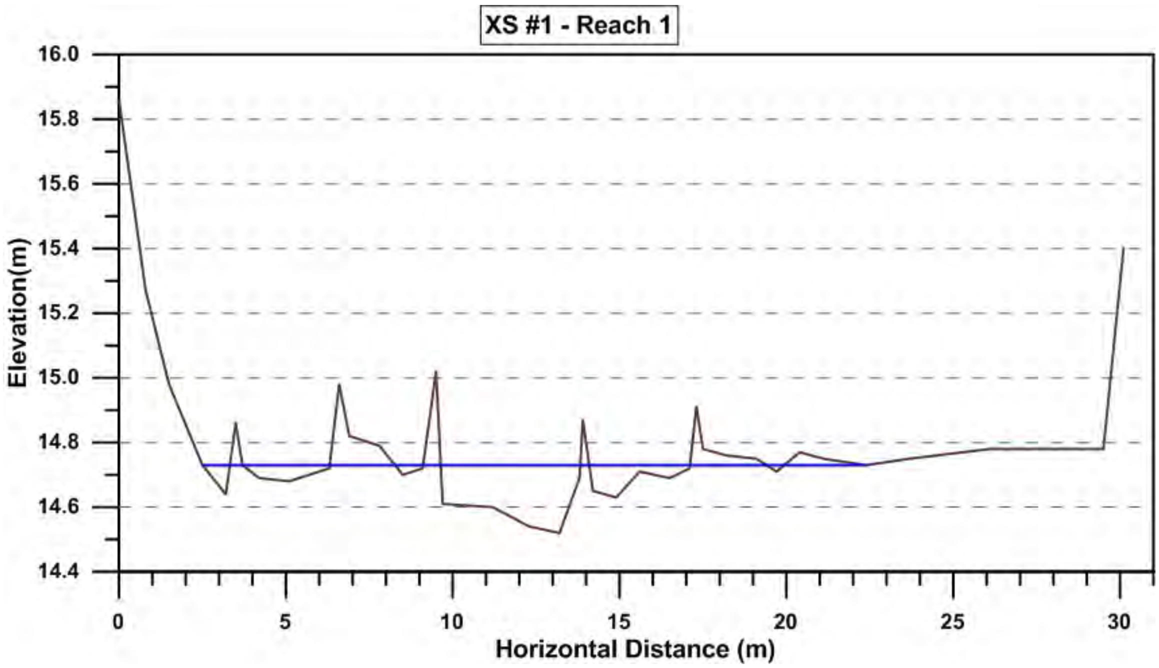
I trust this information is helpful. I welcome the opportunity to discuss in detail either the 2015 mitigation plans or the 2016 sampling results.

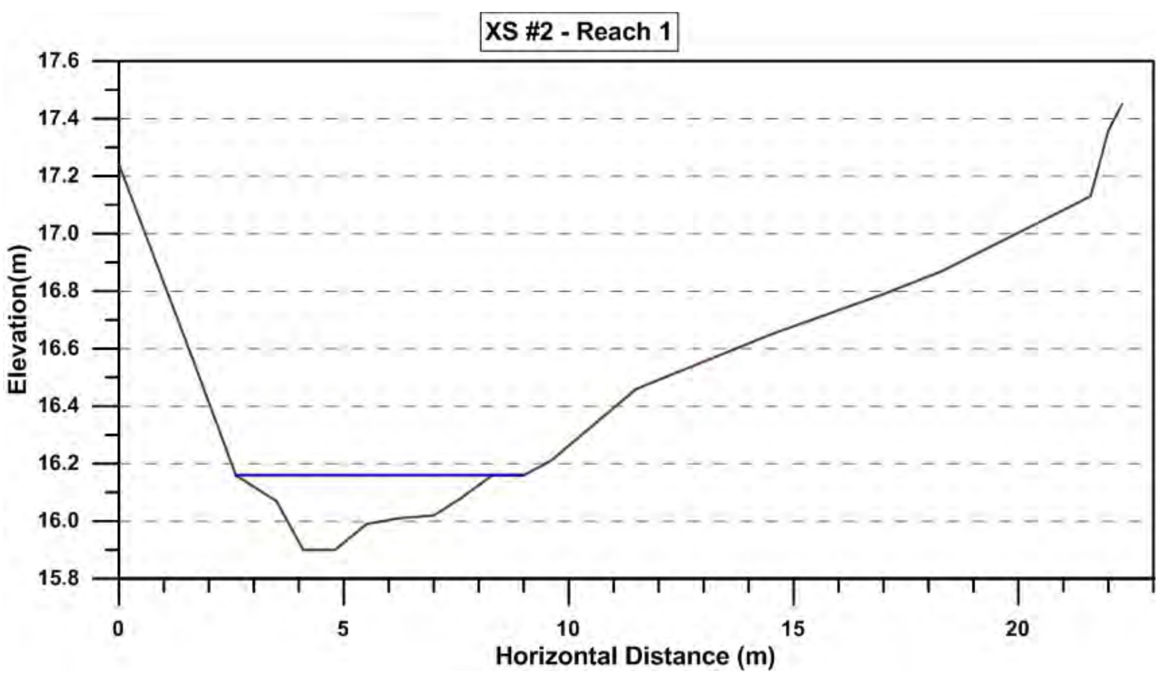
Sincerely

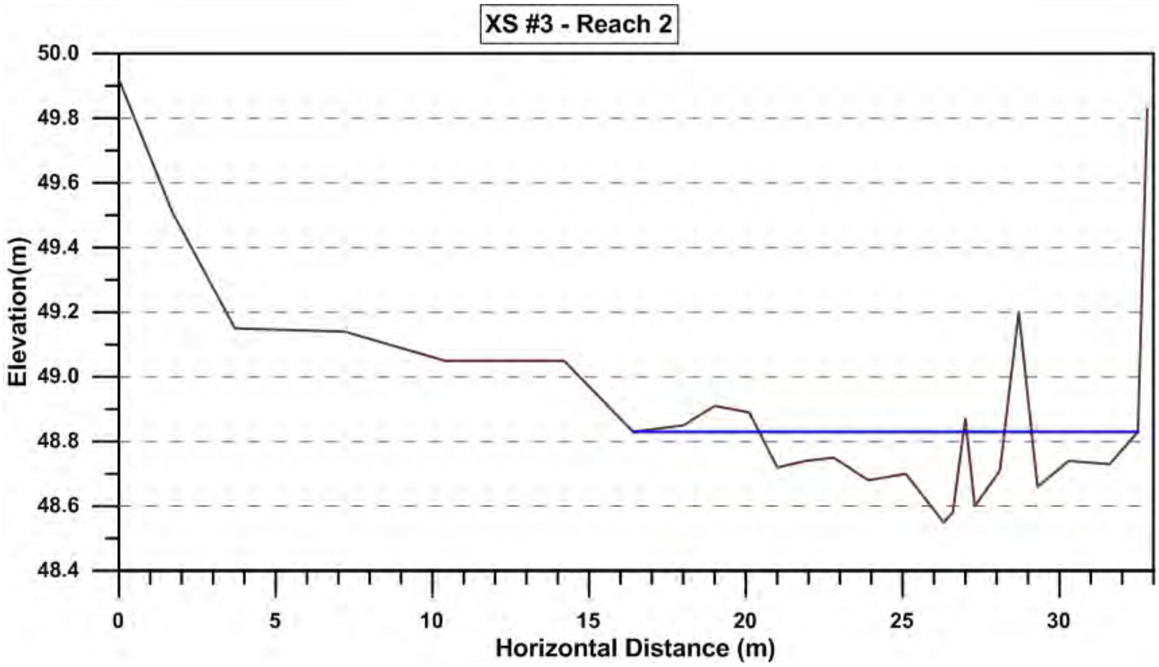
D. Bates, RPBio (#405)
Fisheries Biologist

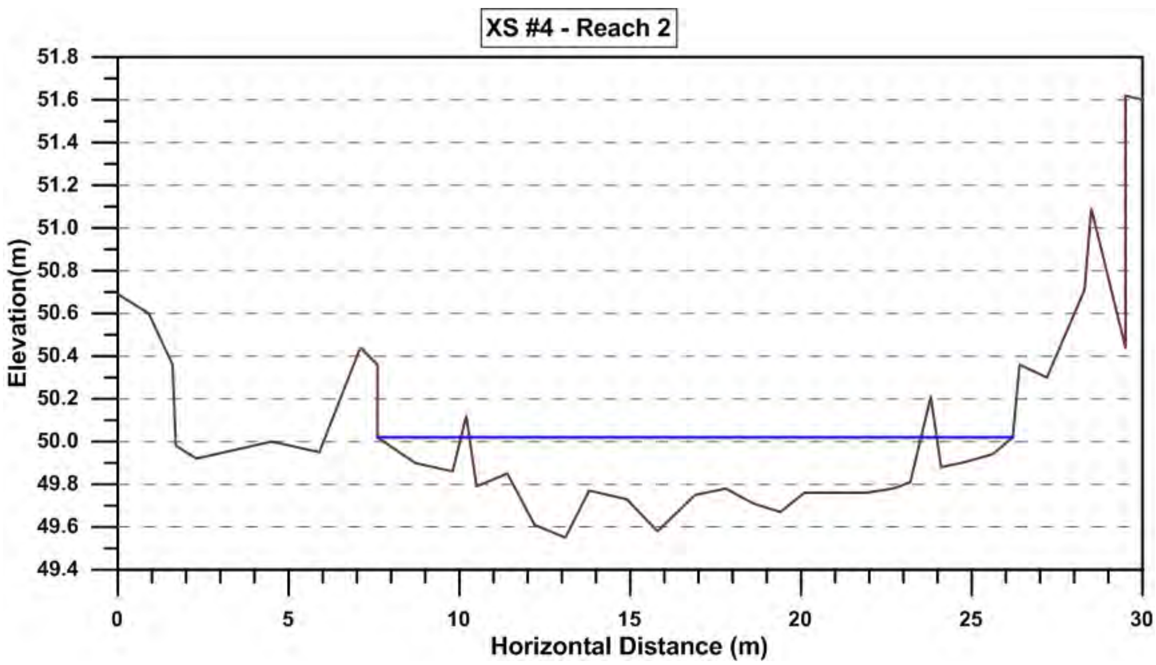
Figure 6: Photos of the first riffle above the high tide mark on lower Chapman Creek. This area is characterized by extensive bedload build-up and in some years presents a migration barrier at low flows. The pool immediately downstream provides the first significant adult holding location.

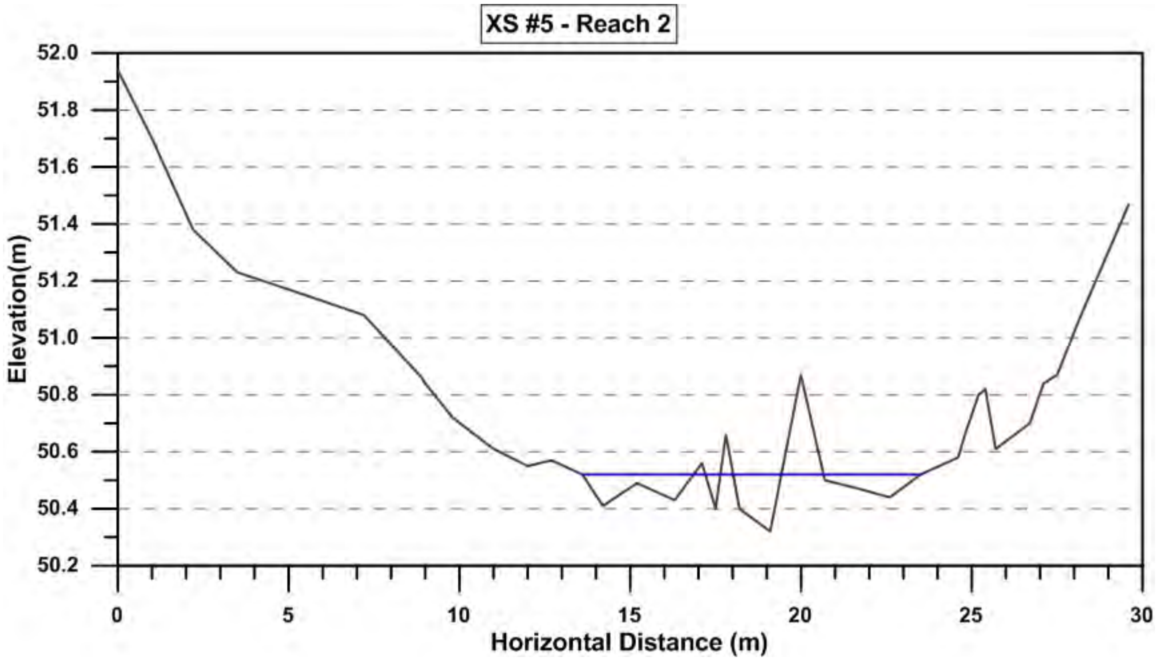
Attachment 1: Cross section plots of selected riffle crests that could, under summer low flow conditions present an upstream migration barrier to adult salmon. The plots show the approximate water surface level at 0.20 cms. The minimum depth for passage of key species is met at all locations.

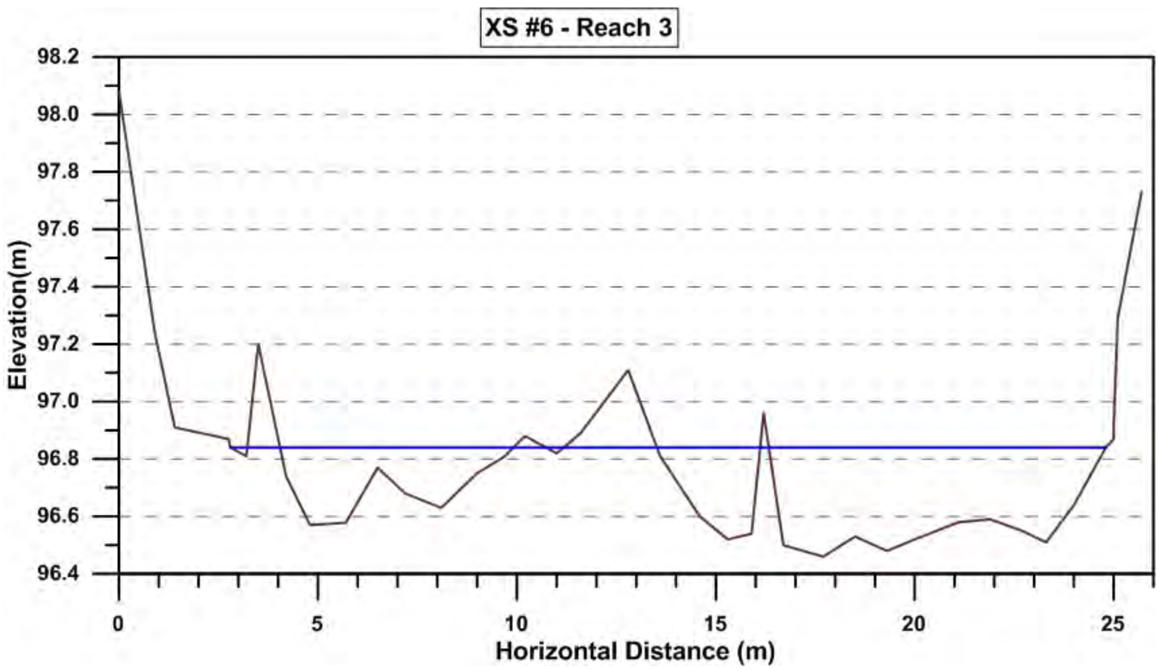


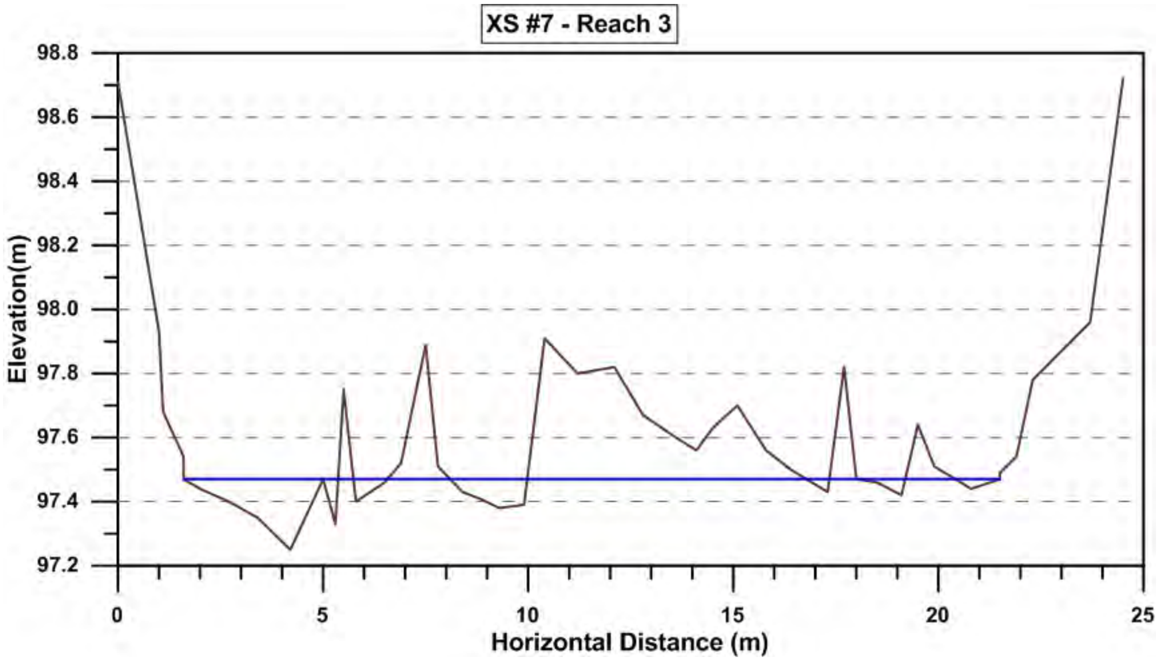


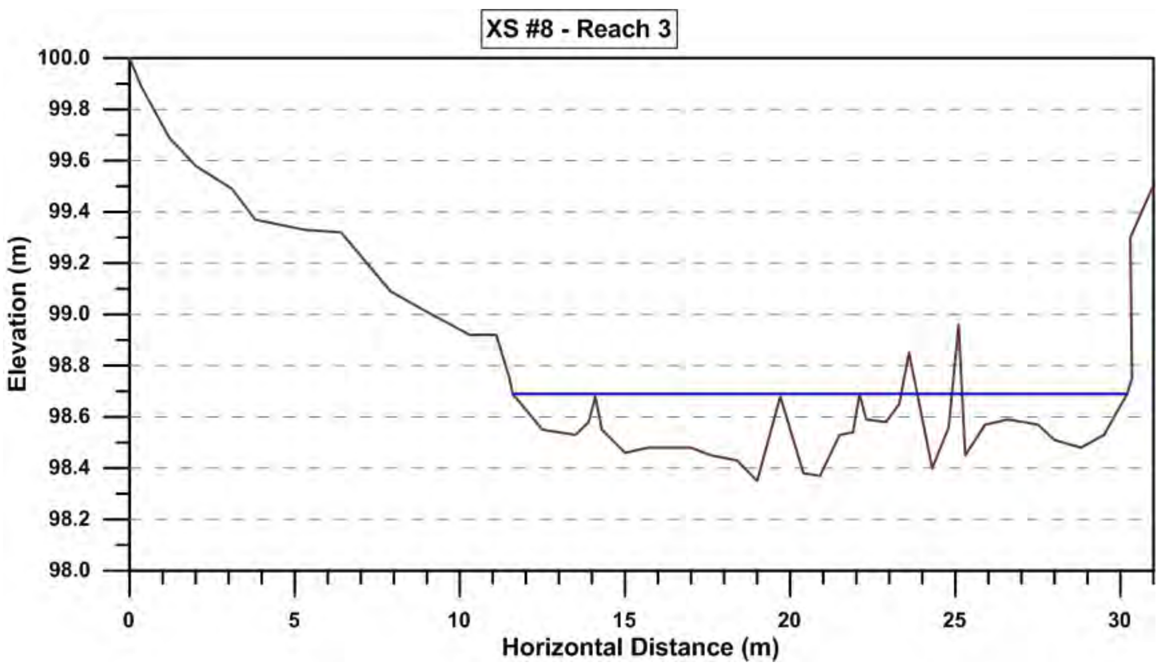

XS #3 - Reach 2
Elevation(m)
50.0
49.8
49.6
49.4
49.2
49.0
48.8
48.6
48.4
0
5
10
15
20
25
30
Horizontal Distance (m)


XS #4 - Reach 2
Elevation(m)
51.8
51.6
51.4
51.2
51.0
50.8
50.6
50.4
50.2
50.0
49.8
49.6
49.4
0
5
10
15
20
25
30
Horizontal Distance (m)


XS #5 - Reach 2
52.0
51.8
51.6
51.4
51.2
51.0
50.8
50.6
50.4
50.2
Elevation(m)
0
5
10
15
20
25
30
Horizontal Distance (m)


XS #6 - Reach 3
98.2
98.0
97.8
97.6
97.4
97.2
97.0
96.8
96.6
96.4
Elevation(m)
0
5
10
15
20
25
Horizontal Distance (m)


XS #7 - Reach 3
98.8
98.6
98.4
98.2
98.0
97.8
97.6
97.4
97.2
Elevation(m)
0
5
10
15
20
25
Horizontal Distance (m)


XS #8 - Reach 3
100.0
99.8
99.6
99.4
99.2
99.0
98.8
98.6
98.4
98.2
98.0
Elevation (m)
0
5
10
15
20
25
30
Horizontal Distance (m)

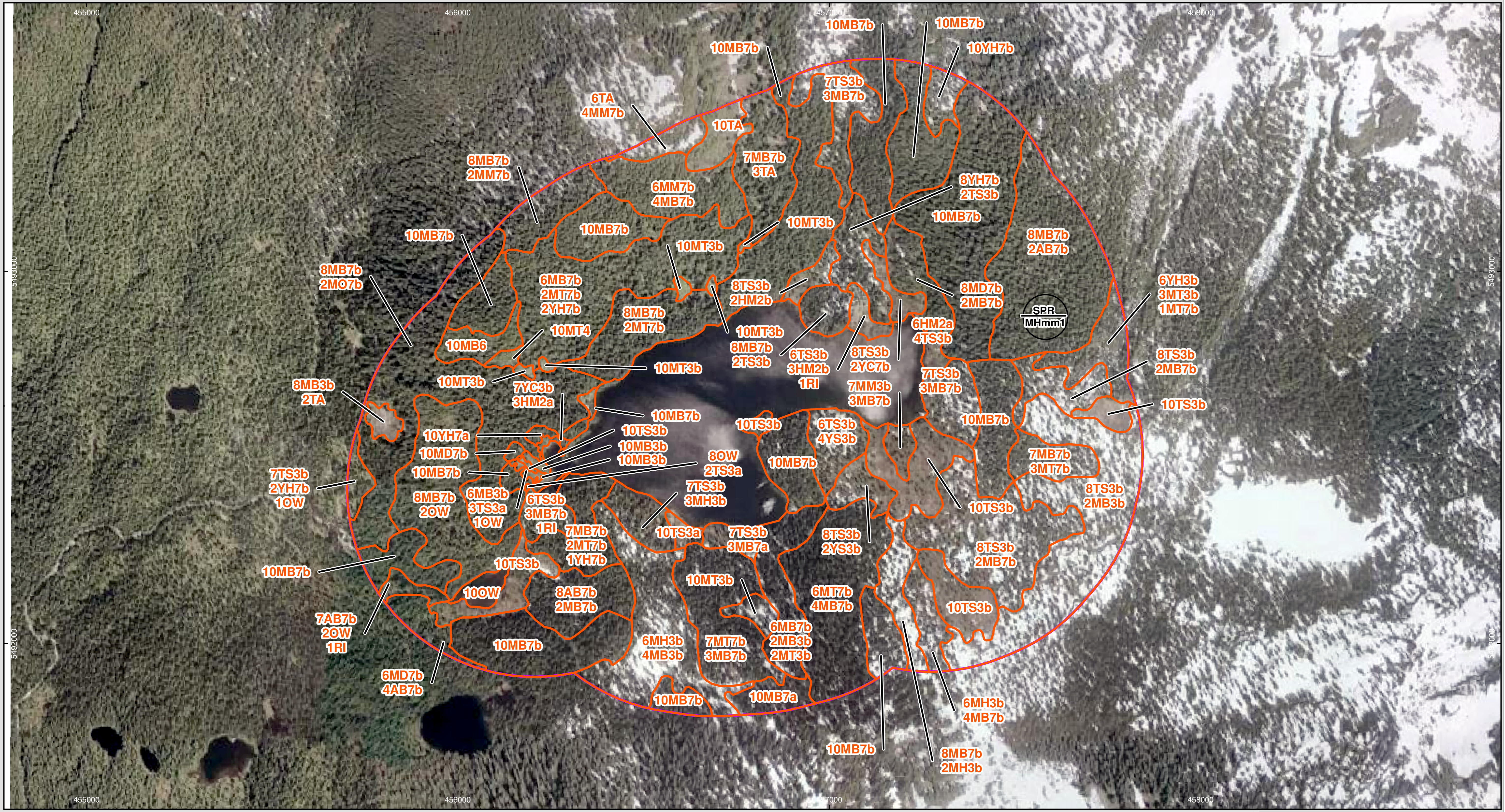
Appendix H Wildlife

Chapman Lake TEM Polygons

Polygon	Primary				Secondary				Tertiary			
	Decile 1	Site Series Number	Site Series Name	Structural Stage	Decile 2	Site Series Number	Site Series Name	Structural Stage	Decile 3	Site Series Number	Site Series Name	Structural Stage
0	8	01	MB	7b	2	04	AB	7b				
1	6	07	YH	3b	3	05	MT	3b	1	05	MT	7b
2	10	00	TS	3b								
3	8	00	TS	3b	2	01	MB	3b				
4	8	00	TS	3b	2	01	MB	7b				
5	7	01	MB	7b	3	05	MT	7b				
6	10	01	MB	7b								
7	10	00	TS	3b								
8	7	00	TS	3b	3	01	MB	7b				
9	6	00	HM	2a	4	00	TS	3b				
10	7	02	MM	3b	3	01	MB	7b				
11	10	00	TS	3b								
12	8	00	TS	3b	2	01	MB	7b				
13	6	00	MH	3b	4	01	MB	7b				
14	8	01	MB	7b	2	00	MH	3b				
15	10	01	MB	7b								
16	6	00	TS	3b	4	08	YS	3b				
17	10	01	MB	7b								
18	10	00	TS	3b								
19	8	00	TS	3b	2	08	YS	3b				
20	6	05	MT	7b	4	01	MB	7b				
21	6	01	MB	7b	2	01	MB	3b	2	05	MT	3b
22	7	00	TS	3b	3	01	MB	7a				
23	10	05	MT	3b								

24	10	01	MB	7a								
25	7	05	MT	7b	3	01	MB	7b				
26	10	00	TS	3a								
27	10	01	MB	7b								
28	6	00	MH	3b	4	01	MB	3b				
29	7	00	TS	3b	3	00	MH	3b				
30	7	01	MB	7b	2	05	MT	7b	1	07	YH	7b
31	8	04	AB	7b	2	01	MB	7b				
32	10	01	MB	7b								
33	6	06	MD	7b	4	04	AB	7b				
34	10	00	TS	3b								
35	10	00	OW									
36	7	04	AB	7b	2	00	OW		1	00	RI	
37	10	01	MB	7b								
38	8	01	MB	7b	2	00	OW					
39	7	00	TS	3b	2	07	YH	7b	1	00	OW	
40	8	01	MB	3b	2	00	TA					
41	10	01	MB	7b								
42	10	05	MT	3b								
43	10	05	MT	3b								
44	10	05	MT	4								
45	10	01	MB	6								
46	10	01	MB	7b								
47	10	05	MT	3b								
48	10	05	MT	3b								
49	10	05	MT	3b								
50	8	01	MB	7b	2	05	MT	7b				
51	6	01	MB	7b	2	05	MT	7b	2	07	YH	7b
52	8	01	MB	7b	2	02	MM	7b				
53	10	01	MB	7b								
54	6	00	TA		4	02	MM	7b				
55	10	00	TA									
56	6	02	MM	7b	4	01	MB	7b				
57	7	01	MB	7b	3	00	TA					

58	10	01	MB	7b							
59	8	00	TS	3b	2	00	HM	2b			
60	7	00	TS	3b	3	01	MB	7b			
61	10	01	MB	7b							
62	8	01	MB	7b	2	00	TS	3b			
63	6	00	TS	3b	3	00	HM	2b	1	00	RI
64	8	07	YH	7b	2	00	TS	3b			
65	8	00	TS	3b	2	09	YC	7b			
66	10	01	MB	7b							
67	8	06	MD	7b	2	01	MB	7b			
68	10	07	YH	7b							
69	10	01	MB	7b							
70	7	00	YC	3b	3	00	HM	2a			
71	10	07	YH	7a							
72	10	01	MB	3b							
73	10	01	MB	3b							
74	10	00	TS	3b							
75	10	06	MD	7b							
76	6	01	MB	3b	3	00	TS	3a	1	00	OW
77	8	00	OW		2	00	TS	3a			
78	8	01	MB	7b	2	03	MO	7b			
79	6	00	TS	3b	3	01	MB	7b	1	00	RI
80	10	01	MB	7b							



Basemapping from Google Earth, Spatial Data from SCRD, GeoBC, 2015

N
W E
S

0 90 180 270
Metres
1:10,000

NAD 1983 UTM Zone 10N

Legend

TEM Area

Buffer Boundary of Study Area (500m)

Ecosystem Label

6YH3b (Primary - Decile, Site Series Name, Structural Stage)
3MT3b (Secondary - Decile, Site Series Name, Structural Stage)
1MT7b (Teritary - Decile, Site Series Name, Structural Stage)

Ecosection/BEC Label

SPR
MHmm1

Overview Map

Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

TEM Area

02 November 2016

AECOM

DRAFT
Figure x

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\Vegetation\2016-09-19-TEMArea\Figx-2016-09-19-TEMArea-60485918-002.mxd Date Revised: October 26, 2016 Reviewed By: AM
Paper Size: 11"x17" Scale is referenced to the specified paper size.

About AECOM

AECOM (NYSE: ACM) is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries.

As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges.

From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM companies had revenue of approximately US$19 billion during the 12 months ended June 30, 2015.

See how we deliver what others can only imagine at aecom.com and @AECOM.

Contact
Brett deWynter, P.Eng.
Project Manager
AECOM
201 – 3275 Lakeshore Road
Kelowna, BC, Canada V1W 3S9
D:+1-250-980-7104
M +1-250.869.7126
Brett.dewynter@aecom.com

Bruce Ford, MRM, R.P.Bio.
Senior Environmental Biologist,
Environment, Western Canada
AECOM
3292 Production Way, Floor 4
Burnaby, BC, Canada V5A 4R4
www.aecom.com
D +1-604-444-6449
M +1-604-787-3011
bruce.ford@aecom.com

aecom.com

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – February 16, 2017

AUTHOR: Raphael Shay, Sustainability & Education Coordinator

SUBJECT: **WATER DEMAND MANAGEMENT REBATE PROGRAM**

RECOMMENDATION(S)

THAT the report titled "Water Demand Management Rebate Program" be received;

AND THAT notice of the Toilet Rebate Program's expiry at the end of 2017 be approved and communicated with the community.

AND FURTHER THAT a Washing Machine Rebate Program be developed and begin in 2018;

AND FURTHER THAT a Rainwater Harvesting Rebate Program be developed and begin in 2018.

BACKGROUND

The purpose of this report is to present options for a program to replace the Toilet Rebate Program as per the following resolution, adopted at the January 28, 2016 Regular Board Meeting:

027/16 **Recommendation No. 13** *Water Demand Management Program Options*

THAT the Toilet Rebate Program be phased out at the end of 2017;
AND FURTHER THAT additional water demand management programs be developed in 2017 for implementation in 2018/2019.

DISCUSSION

Toilet Rebate Program Success

3669 toilet rebates have been issued since the program started in 2001. Approximately another 100 rebates are expected during 2017 before the program ends. This will represent water savings of approximately 155,000 litres per day, or 155 cubic meters of water per day.

Options and Analysis

Three rebate program options were outlined in the Water Demand Management Program Options report to the Infrastructure Services Committee of January 14, 2016. These are a Rainwater Harvesting Rebate, a Washing Machine Rebate, and a Xeriscaping and Low Impact

Development Landscaping Rebate. The 2016 report outlined potential programs and the SCRD costs per cubic meter of water saved.

This report will evaluate programs based on the quantity of potential water savings, the seasonality of these savings, the potential for market transformation.

1. Rainwater Harvesting Program

Summer precipitation patterns on the Sunshine Coast are such that rainwater harvesting requires a large storage capacity in order to be impactful. For this reason, larger cisterns are more effective than barrels in supplying water during periods of drought.

A 1,000 gallon cistern would save an estimated 13.41m^3 of water per year with average precipitation. The potential for water savings from rainwater harvesting is smaller than the Toilet Rebate Program because of its seasonality. An efficient toilet saves water year round while a cistern will only be used during the summer. Cisterns are also more expensive than efficient toilets. Combined, these factors result in higher costs per cubic meter of water saved. These costs could be made to more closely match SCRD costs to treat and distribute water by offering a smaller rebate.

While seasonality limits overall water saving potential, it proves advantageous by making water available when it is most needed, most scarce, and therefore most valuable. Sunshine Coast water consumption doubles in the summer, principally for outdoor uses such as gardens and lawns. Increasing available water during summer months contributes to the community's resilience and mitigates against the outdoor water use restrictions of the Drought Management Plan.

There are a few local businesses that provide rainwater harvesting material and services on the Sunshine Coast but cisterns are not yet common. A rebate program could help property owners who have summer water use needs to develop rainwater harvesting infrastructure.

Finally, a rainwater harvesting program is difficult to estimate and measure. Not all properties have the space for a cistern and not all citizens have the resources to pay for the equipment and installation.

Considering the role cisterns play in increasing water availability when it is needed most, a rainwater harvesting rebate program could be developed and launched for 2018.

2. Washing Machine Rebate Program

Washing machines are the second largest indoor water use after toilets. The potential water savings from an efficient washing machine are almost the same as those of an efficient toilet. An efficient washing machine can cut water use by 40% to 50% compared to an inefficient model. This would result in approximately 11.4m^3 of water saved per washing machine per year. Since the costs of washing machines are lower than those of cisterns, the costs per unit of water saved end up being lower.

Unlike toilets, it is still possible to purchase inefficient washing machines. Most properties have a washing machine and therefore, most properties could be interested in an efficient washing machine. Program implementation could also be relatively quick since it can follow a similar model as the Toilet Rebate Program. The community is already familiar with this model and staff can anticipate a high demand in initial years much like the Toilet Rebate Program.

Finally, there is a possibility to collaborate with BC Hydro on a washing machine rebate. BC Hydro has an appliance rebate program and would be interested in co-sponsoring a program with the SCRD.

Given the water saving potential, broad reach, and possibility to collaborate with BC Hydro, a washing machine rebate program could be developed and launched in 2018.

3. Xeriscaping and Low Impact Development Landscaping Rebate Program

Xeriscaping and low impact development landscaping can help reduce water use during the dry summer months. Potential water savings are unknown at this time and are highly dependent on adoption from properties that sprinkle. Participation from properties that let their lawns go dormant would not result in savings.

In terms of reach, a xeriscaping and low impact development landscaping could be of interest to a variety of properties. The coastal area of the Sunshine Coast is predominantly a dry biogeoclimatic zone and this area is where the population resides.

Xeriscaping and low impact development landscaping could be promoted as part of the Water Conservation Program via educational work rather than a rebate program at this time. Once water meters are installed, it would be possible to conduct a pilot program that would quantify water savings and help inform the design of a rebate program.

Financial Implications

In 2006, $700,000 was expended on the Toilet Rebate Program, which also had a fixture replacement component. Program expenditures have gradually decreased with $290,000 expended in 2008 and $130,000 in 2011.

For 2017, $28,500 is budgeted for rebates for the Toilet Rebate Program. Reallocating these funds to a cistern rebate program and a washing machine rebate program in the 2018 budget would allow both programs to move forward but would cap the amount of rebates available.

Timeline for next steps or estimated completion date

The Toilet Rebate Program will be phased out at the end of the year. Celebrating the program's success and notifying the community of the phase out will occur in the summer of 2017 to provide sufficient time for people who would like to participate. New rebate programs will be developed in 2017 and be ready for implementation in 2018.

STRATEGIC PLAN AND RELATED POLICIES

The We Envision Regional Sustainability Plan (2012) has a water consumption reduction target of 33% relative to 2010 levels by 2020 (p.38).

The SCRD Strategic Plan has a priority to Embed Environmental Leadership.

The CRWP describes the 2012 SCRD Strategic Plan policy objective of reducing water consumption by 33% relative to 2010 levels by 2020 (CRWP, p. 1-2, p. 3-16).

The CRWP also describes the need for additional demand management programs beyond universal metering.

The SCRD Agricultural Area Plan has the strategic goal to secure a sustainable water supply for agriculture.

CONCLUSION

The Toilet Rebate Program has been successful and will be phased out at the end of 2017. Staff recommend the program be replaced with a rainwater harvesting rebate program that will increase water availability during summer months and a washing machine rebate program that will save indoor water throughout the year.

These programs will be designed in 2017 for launch and alignment in 2018.

Reviewed by:			
Manager	X-SW	Finance	X-TP
GM		Legislative	
CAO	X-JL	Other	

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – February 16, 2017

AUTHOR: Robyn Cooper, Manager, Solid Waste Services

SUBJECT: **WASTE REDUCTION INITIATIVES PROGRAM UPDATE**

RECOMMENDATION(S)

THAT the report titled Waste Reduction Initiatives Program Update be received.

BACKGROUND

The SCRD launched the Waste Reduction Initiatives Program (WRIP) in the fall of 2015.

The aim of the program is to provide seed funding to community groups, non-profit societies, charitable organizations and school groups to implement projects that contribute to waste reduction or diversion in the region. The WRIP is open to eligible organizations throughout the Sunshine Coast Regional District.

The WRIP has been funded in 2015 and 2016 from the Eco-Fee Reserve in the amount of $5,000.

In 2015, five applications were received and the WRIP partially funded all five projects. The organizations had one year to implement their projects with a completion date by December 31, 2016.

In 2016, five applications were received and the WRIP provided funding for three projects. The organizations have until December 15, 2017 to complete the projects.

The purpose of this report is to provide a summary of the projects.

DISCUSSION

2015 WRIP Project Summary

In total, the projects directly engaged close to 470 residents in waste reduction and diversion initiatives. The projects ranged from backyard composting and community recycling to education about food preservation and fruit tree picking to help reduce food waste as well as workshops on how to stop illegal green waste dumping. A summary of projects awarded is included in Table 1.

Table 1 – 2015 WRIP Recipients

Organization	Project Name	Area Served	Funds Received
Coast Canning Cooperative	Community Canning Kitchen to teach food preservation skills and help reduce food waste.	Coast-wide	$1,940
One Straw Society	Fruit Tree Project to harvest fruit that may otherwise go to waste.	Coast-wide	$1,290
Roberts Creek Community Association	Recycling signage update at Library and Community Hall.	Roberts Creek	$200
Sargeant Bay Society	Green Cone Backyard Composter Pilot Program.	Halfmoon Bay to Pender Harbour	$1,120
Transition Streets Langdale	Anti-green waste dumping education and backyard composting alternatives initiative.	Langdale	$450
		Total	$5,000

Key project highlights:

- Coast Canning Cooperative educated 80 residents about food waste reduction practices at 12 canning workshops in 2016. The project reused over one hundred canning jars and over two dozen pieces of canning equipment and supplies.

- Roberts Creek Community Association – improvements to the recycling signage at the community's library and hall to increase recycling. Observations on recycling behaviour concluded that organics is the biggest opportunity as residents are placing food and pet waste in the recycling and garbage bins.

- The Sargeant Bay Society's Green Cone Pilot Project installed 10 Green Cones at various locations in Pender Harbour including a small café/catering company, the Iris Griffith Centre, Madeira Park Elementary School and a few residential households. The project diverted a total average of 207 kg of food scraps from the landfill per month over a six month period, totaling 1,242 kg.

- Transition Streets Langdale hosted two workshops in Langdale on illegal dumping of green waste and green waste composting options, cleaned one illegal green waste dump site and conducted a door-to-door neighbourhood survey to 225 households on residents' composting behaviours and green waste disposal. Since this project began, Transition Streets Langdale reports a decrease or halt in illegal green waste dumping at common illegal dump site locations in Langdale, based on visual observation.

2016 WRIP Recipients

For 2016, the WRIP was strengthened and required that projects tangibly demonstrate and track the amount of waste reduced or diverted from landfill. A project that relied solely on qualitative data or that was indirectly related to waste reduction and diversion was not considered.

Five applications were received and the WRIP partially funded three projects. The organizations have one year to implement their projects with a completion date by December 15, 2017. A summary of projects awarded is included in Table 2.

Table 2 – 2016 WRIP Recipients

Organization	Project Name	Area Served	Funds Received
Gibsons Curling Club	Establish a new recycling program.	Gibsons and Area	$175
Gibsons Elementary	Establish recycling & composting program.	Gibsons	$2,095
Coast Canning Cooperative	Community Canning Kitchen – enhance ability to accept & reuse fruit donations.	Coast-wide	$1,500
		Total	$3,770

Financial Implications

As part of the 2016 budget process, the WRIP was approved in the amount of $5,000 funded from Eco-Fee Reserve.

The WRIP is included in the 2017 budget for consideration.

Timeline for next steps or estimated completion date

The 2016 WRIP recipients have until December 15, 2017 to complete their projects.

Should the WRIP budget for 2017 be approved, the call for applications will begin in April.

Communications Strategy

The WRIP was posted on the SCRD website, newspaper advertising and social media. The WRIP has a dedicated webpage on the SCRD website. http://www.scrd.ca/wrip

STRATEGIC PLAN AND RELATED POLICIES

The 2015 WRIP projects supported four of the twenty-four Solid Waste Management Plan initiatives: residential waste reduction education, grasscycling and backyard composting, business waste diversion and yard waste composting.

CONCLUSION

The SCRD launched the Waste Reduction Initiatives Program in 2015 to assist community organizations in implementing projects that contribute to waste reduction or diversion in the region, supporting the Solid Waste Management Plan.

For the 2015 WRIP, five applications were received and all five projects were partially funded. Tangible, measurable impacts were seen in two of the five projects. Whereas, the remaining three projects anecdotally recorded waste diversion, recycling and education activities.

For the 2016 WRIP, five applications were received and three projects were funded. The project completion date is December 15, 2017.

Reviewed by:			
Manager		Finance	
GM		Legislative	
CAO	X-JL	Other	

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – February 16, 2017

AUTHOR: Robyn Cooper, Manager, Solid Waste Services and Janette Loveys, CAO

SUBJECT: **SCRD SOLID WASTE – PROPOSED NEXT STEPS**

RECOMMENDATION(S)

THAT the report titled SCRD Solid Waste – Proposed Next Steps be received;

AND THAT a Special Infrastructure Services Committee meeting be scheduled for March 2, 2017.

BACKGROUND

All Regional Districts in British Columbia are required to have a regional solid waste plan approved by the Ministry of Environment. The most recent SCRD Solid Waste Management Plan (SWMP) was adopted by the Board on September 22, 2011. The plan is approved by the Ministry of Environment.

The SWMP includes a target of 65%-69% waste reduction.

To help achieve the waste reduction target, the SWMP includes twenty-four initiatives categorized into reduce, reuse, recycling and residuals management. The initiatives are at various stages of completion.

With a focus on the extending the lifespan of the Sechelt Landfill, the SWMP initiatives were prioritized into a 2016-2020 Implementation Schedule that was adopted by the Board on December 10, 2015.

DISCUSSION

As part of that commitment, a Special Infrastructure Services Committee (ISC) meeting is proposed for March 2, 2017. A workshop format style will be utilized.

Staff are preparing comprehensive materials for the Special ISC meeting. A thorough review of the SWMP prior to the meeting is recommended.

STRATEGIC PLAN AND RELATED POLICIES

This report is in support of the SCRD's Solid Waste Management Plan.

CONCLUSION

Work on the SCRD's Solid Waste Management Plan is continuing as per the implementation schedule adopted in December 2015.

A Special Infrastructure Services Committee is proposed for March 2, 2017.

Reviewed by:			
Manager		Finance	
GM		Legislative	
CAO	X-JL	Other	

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – February 16, 2017

AUTHOR: Angie Legault, Senior Manager, Administration & Legislative Services
Ian Hall, General Manager, Planning & Community Development

SUBJECT: **SUNSHINE COAST REGIONAL DISTRICT 50TH ANNIVERSARY COMMITTEE**

RECOMMENDATION(S)

THAT the report titled Sunshine Coast Regional District 50th Anniversary Committee be received;

AND THAT:

- **The Terms of Reference for the Sunshine Coast Regional District 50th Anniversary Committee as presented in Attachment 1 be approved;**
- **Advertisements seeking expressions of interest from the community to serve on the Committee be placed;**
- **The Board Chair and Chief Administrative Officer review the expressions of interest and select the community members for the Committee;**
- **The Committee designate a Director to participate on the Committee;**

AND THAT staff be authorized to apply to the Community Fund for Canada's 150th for a grant to support the celebration;

AND FURTHER THAT, the 50th Anniversary Committee report to a future meeting on a plan to conduct the anniversary celebration in a cost effective manner.

BACKGROUND

The purpose of this report is to provide the Committee with updated information about the celebration and recognition of the 50th anniversary of the Sunshine Coast Regional District (SCRD).

The SCRD has been serving the residents of the Sunshine Coast since it was formed 1967. The Minister of Municipal Affairs signed Letters Patent deeming that the first meeting of the Regional Board be held on January 12, 1967 in the Hospital Cottage at Sechelt BC. Coincidentally, Canadians will be also celebrating our country's 150 anniversary in 2017.

On October 13, 2016, the Board of the Sunshine Coast Regional District adopted the following resolution:

388/16 **Recommendation No. 9** *Sunshine Coast Regional District 50th Anniversary in 2017*

THAT the report titled Sunshine Coast Regional District 50th Anniversary– 2017 be received;

AND THAT Option 1 – A Special 50th Anniversary Committee be struck to lead the celebrations, including community leaders, a designated elected official, and staff to collaborate and develop a plan for the 2017 celebrations be approved;

AND THAT staff be authorized to apply to the Canada 150 Community Infrastructure Program for a grant to support the celebration;

AND FURTHER THAT staff report to a future Corporate and Administrative Services Committee meeting regarding Terms of Reference for a Special 50th Anniversary Committee.

DISCUSSION

Sunshine Coast Regional District 50th Anniversary Committee

Recommended terms of reference for the 50th Anniversary Committee are provided as Attachment 1. Membership is recommended to represent the entire region and to include intergenerational participation, knowledge of social and economic community partnerships, and a sense of Sunshine Coast arts, culture and heritage. It is recommended that staff conduct public advertising seeking expressions of interest from the community to serve on the 50th Anniversary Committee. It is also recommended that the Chair and Chief Administrative Officer select committee members based on response to advertisements.

The Committee is requested to designate an elected official to serve on the 50th Anniversary Committee.

The 50th Anniversary Committee will be supported by staff participants that have been identified via an internal canvass of SCRD Divisions using a communications, engagement and community development lens. A balance of representation from across the organization has been achieved with commitment from Senior Leadership, Corporate/Administration & Legislative Services, Planning and Community Development and Infrastructure Services. Staff will begin pre-planning and resource gathering in preparation for the 50th Anniversary Committee.

50th Anniversary Resources Update

SCRD was not successful with an application to the Canada 150 Community Infrastructure grant program (program funds were depleted prior to application). Staff continue to seek grant support through all avenues and will look to sponsorships, donations and internal program areas where activities can be streamed/themed as “50th Anniversary” as cost-effective ways to deliver a meaningful celebration. As a follow-on to the celebration or in support of a strategically-aligned legacy project, authorization to apply to the Community Fund for Canada’s 150th, a matching grant program administered by the Sunshine Coast Community Foundation, is requested.

STRATEGIC PLAN AND RELATED POLICIES

This report is supported by the Key Strategic Priority: Facilitate Community Development.

CONCLUSION

The SCRD has been serving the residents of the Sunshine Coast since it was formed 1967. In 2017, the SCRD will be celebrating the 50th anniversary of the Regional District. It will also be Canada's 150 anniversary in 2017.

Staff recommend that the 50th Anniversary Committee Terms of Reference be approved, that advertisements be placed seeking expressions of interest for community participants, the Chair and Chief Administrative Officer select committee members, and that an elected official be designated to participate on the 50th Anniversary Committee.

A cost-effective approach to resourcing the 50th Anniversary celebration is recommended.

Finally, it is recommended that once the 50th Anniversary Committee is appointed and has met, they report to the Board with a plan for a cost-effective anniversary celebration.

Attachments:

Attachment 1: Sunshine Coast Regional District 50th Anniversary Committee Terms of Reference

Reviewed by:			
Manager		Finance	
GM	X-IH	Legislative	X-AL
CAO	X-JL	Other	

Attachment 1

TERMS OF REFERENCE

SCRD 50th Anniversary Committee

1. Purpose

1.1 The purpose of the "SCRD 50th Anniversary Committee" is to:

a. Lead celebration and recognition initiatives and events with respect to the SCRD 50th anniversary.
b. Develop, create, inspire and foster creative and cost effective ways to celebrate the history and achievements of the SCRD throughout 2017.

2. Duties

2.1 The "SCRD 50th Anniversary Committee" will:

a. Provide advice, guidance and leadership for SCRD 50th anniversary community celebrations across the Sunshine Coast
b. Develop creative and cost effective ways to create awareness, fun and recognition of the history and achievements of the SCRD
c. Search out ways to integrate with existing community events to promote the anniversary
d. Serve as ambassadors alongside SCRD Directors at community events
e. Work with SCRD Directors and staff to promote and foster the anniversary.

2.2 The "SCRD 50th Anniversary Committee" will keep the whole SCRD Board apprised of the plans and periodically report to the Board.

2.3 The "SCRD 50th Anniversary Committee" will be dissolved upon the conclusion of the events and final debriefing session in the fall of 2017.

3. Membership

3.1 The "SCRD 50th Anniversary Committee" will be comprised of the following members:

a. No more than eight (8) community members with a goal of balanced, intergenerational representation from rural areas and member municipalities as well as knowledge of:

   i. Sunshine Coast arts and culture
   ii. Sunshine Coast history
   iii. social and economic community partnerships to help integrate and foster the events and initiatives.

b. No more than six (6) SCRD staff members with representation from across the organization, as follows:

i. Senior Leadership
ii. Corporate / Administration and Legislative Services
iii. Infrastructure Services
iv. Planning and Community Development

c. One SCRD Board Director.

3.2 Members are appointed for 2017.

3.3 The role of staff may also include:

a. Participating in and supporting the various events and initiatives as appropriate
b. providing information and professional advice;
c. facilitating and/or co-chairing meetings;
d. writing reports and recommendations to the Board as requested by the committee;
e. bringing such matters to the committee's attention as are appropriate for it to consider in support of Regional District Board direction;
f. serving as one of the communication channels to and from the Board; and
g. providing advice to the Board that is at variance to a committee recommendation.

3.4 The Chair and Vice Chair will be appointed by the Committee. It is recommended to have one community member act in a chair or vice chair role.

4. Operations

4.1 A majority of the voting members of the committee, as listed in section 3 will constitute a quorum.

4.2 The "SCRD 50th Anniversary Committee" will meet approximately 8 times in 2017, but may meet more or less frequently at the call of the Chair.

4.3 All Committee meetings must be open to the public except where the committee resolves to close a portion of it pursuant to Section 90 of the *Community Charter*.

4.4 Committee members are encouraged to:

a. attend and participate in meetings of the Committee
b. share experiences and ideas while maintaining an open mind to others' perspectives
c. report back to the appropriate Regional District staff and/or Committee

4.5 In carrying out its mandate, the Committee will work towards conducting operations in a way that:

a. improves the economic, environmental and social well-being for present and future generations;
b. encourages and fosters community involvement;
c. enhances the friendly, caring character of the community;
d. maintains an open, accountable and effective operation;

e. preserves and enhances the unique mix of natural ecosystems and green spaces in the SCRD;
f. is consistent with the goals and objectives of the SCRD's strategic plan; and
g. Recognizes advisory committees are one of many channels that the Regional Board may utilize to obtain opinions and advice when making decisions.

4.6 The SCRD will provide support which will include:

a. preparing meeting agendas and distributing them to the Committee members in advance of the meeting
b. preparing minutes of all meetings using SCRD standard practices
c. forwarding the minutes to the Committee Chair for review prior to the distribution to the entire Committee membership

4.7 Unless otherwise provided for, meetings shall be conducted in accordance with the rules of procedure set out in the Board Procedure Bylaw.

4.8 Committee members are subject to the Conflict of Interest legislation outlined in Section 100 – 109 of the *Community Charter*. The terms "Council" and "Committee" shall be interchangeable for the purpose of interpretation of these sections.

4.9 Committee members must respect and maintain the confidentiality of the issues brought before them.

4.10 Committee members serve without remuneration but may be eligible to have reasonable expenses reimbursed in accordance with the SCRD Policy on Committee Volunteer Meeting Expenses.

5. Reference Documents

5.1 SCRD Procedure Bylaw No. 474
5.2 *Community Charter*, Section 100 – 109 – Conflict of Interest
5.3 *Community Charter*, Section 90 – Open/Closed Meetings

Approval Date:		Resolution No.	
Amendment Date:		Resolution No.	
Amendment Date:		Resolution No.	

Annex F

SUNSHINE COAST REGIONAL DISTRICT
TRANSPORTATION ADVISORY COMMITTEE
January 19, 2017

RECOMMENDATIONS FROM THE TRANSPORTATION ADVISORY COMMITTEE MEETING HELD IN THE CEDAR ROOM OF THE SUNSHINE COAST REGIONAL DISTRICT AT 1975 FIELD ROAD, SECHELT, BC

PRESENT: (Voting Members)	Director, Electoral Area E, Chair	Lorne Lewis
	Director, Electoral Area A	Frank Mauro
	Director, Electoral Area B	Garry Nohr
	Director, Electoral Area F	Ian Winn
	Director, Electoral Area D	Michelle Morton (Alt.)
	Director, District of Sechelt	Doug Wright
	School District No. 46	Christine Younghusband
	BC Ferries, Langdale Terminal Manager	Hanna Josephson
	Transportation Choices (TraC)	Alun Woolliams
	Insurance Corporation of BC	Harvey Kooner
ALSO PRESENT: (Non-Voting)	Manager, Transit and Fleet	Gordon Dykstra
	General Manager, Planning and Community Development	Ian Hall
	Operations Manager, Ministry of Transportation and Infrastructure	Don Legault
	Chair, Southern Sunshine Coast Ferry Advisory Committee	Diana Mumford
	RCMP	S/Sgt Vishal Mathura
	Recorder	Susan Fernandez
	Media	2

CALL TO ORDER 2:45 p.m.

AGENDA The agenda was adopted as amended:

- Correction: ***NEXT MEETING***, April 20, 2017 at 2:45 pm

MINUTES

Recommendation No. 1 *Transportation Advisory Committee Recommendations*

The Transportation Advisory Committee recommended the recommendations of the Oct 20, 2016 Transportation Advisory Committee meeting be received for information.

COMMUNICATIONS

<u>Recommendation No. 2</u> *Communications*

The Transportation Advisory Committee recommended that the following communications be received:

- Diana Mumford, Southern Sunshine Coast Ferry Advisory Committee, regarding BC Ferries Updates, Traffic Statistics and Schedule

- Todd G. Stone, Minister of Transportation and Infrastructure, regarding Highway 101 at Oceanview Drive

- Transportation Choices (TraC), regarding TraC Survey Results and Cycling Community Infrastructure Comment

<u>Ferries Updates, Traffic Statistics and Schedule</u>

Diana Mumford reviewed the documents she had submitted for the Committee, and discussion followed around several items.

- *Langdale, Berth 1 is now closed for refurbishment; two smaller ferries will be used for hourly service from Berth 2. Hourly ferry service has less capacity per sailing, but slightly more capacity over two hours than previous service, until the smaller Island Sky is introduced at Spring Break. Ticket sales cut-off still occurs approximately 10 minutes prior to sailing, as this is a safety issue.*
- *BC Ferries is considering the idea of passengers not being able to stay in their vehicles and must go to the passenger levels, as a response to Provincial regulations. Comments were made in support of following Provincial requirements in not forcing open deck car passengers on Route 3 to go upstairs.*
- *Experience Card discounts vary by route, and the Route 3 discount is lower than several others; Diana Mumford to inquire with BC Ferries as to the rationale behind their discount structure.*
- *A copy of the new hourly schedule was distributed.*

<u>Highway 101 at Oceanview Drive</u>

- *Don Legault commented that they talked with BC Hydro and an overhead luminaire on the north side of this intersection will be installed in the next couple of weeks; lowering of the speed limit is not planned at this time.*

<u>TRaC 2016 Cycling Survey</u>

- *TRaC had received 160 completed survey responses, both online and at the 2016 Biking and Walking Open House. The resulting list of priorities were:*
    - *Bike lane clearing (increasing the frequency of sweeping)*
    - *Regular meeting of area planners to meet and coordinate projects and design decisions*
    - *Marine Drive, and ferry to ferry bike routes.*
- *Some discussion occurred regarding the priority and cost of Marine Driver bicycle access.*

ROUNDTABLE

- *Gordon Dykstra noted that as requested, a letter was sent to the Vancouver Coastal Health inviting them to regularly attend the Transportation Advisory Committee meetings.*
- *Comments were made regarding the need for pothole repair and road maintenance, along the Port Melon Highway. Don Legault will pass this issue on to Capilano Highways. Specific pothole locations should be reported to Capilano Highways via the 24 hr reporting number on their website.*
- *Christine Younghusband introduced herself as the new representative for the School District #46, which is in the budget process for the 2017-18 school year. She informed the Committee that School District #46 has been granted transportation grant funding of $380,000, which will be ongoing. In the short term,*

they have purchased five activity buses for district use. Input was requested on the most effective way to spend future funds, please submit to Nick Weswick, the S.D.#46 Secretary-Treasurer

- *Frank Mauro reported that new pavement along the highway at Trout Lake reflects light differently, making it difficult to see when combined with darkness and rain. He also noted that at the North end of Halfmoon Bay hydroplaning now seems more prevalent along the uphill passing lane. Don Legault will review the passing lane in regard to the hydroplaning problem.*
- *An erosion problem at Keith Road was noted; some work has been done.*
- *Discussion occurred regarding poor visibility of white fog lines in Roberts Creek.*
- *The ferry schedule for Gambier and Keats has been updated and is available online, along with the shuttle bus schedule in place during the Berth 1 refurbishment as Langdale.*
- *Sunshine Coast Transit has adjusted their bus schedule to match the hourly ferry sailings occurring during Berth 1 refurbishment.*

NEXT MEETING April 20, 2017 at 2:45 p.m.

ADJOURNMENT 3:38 p.m.