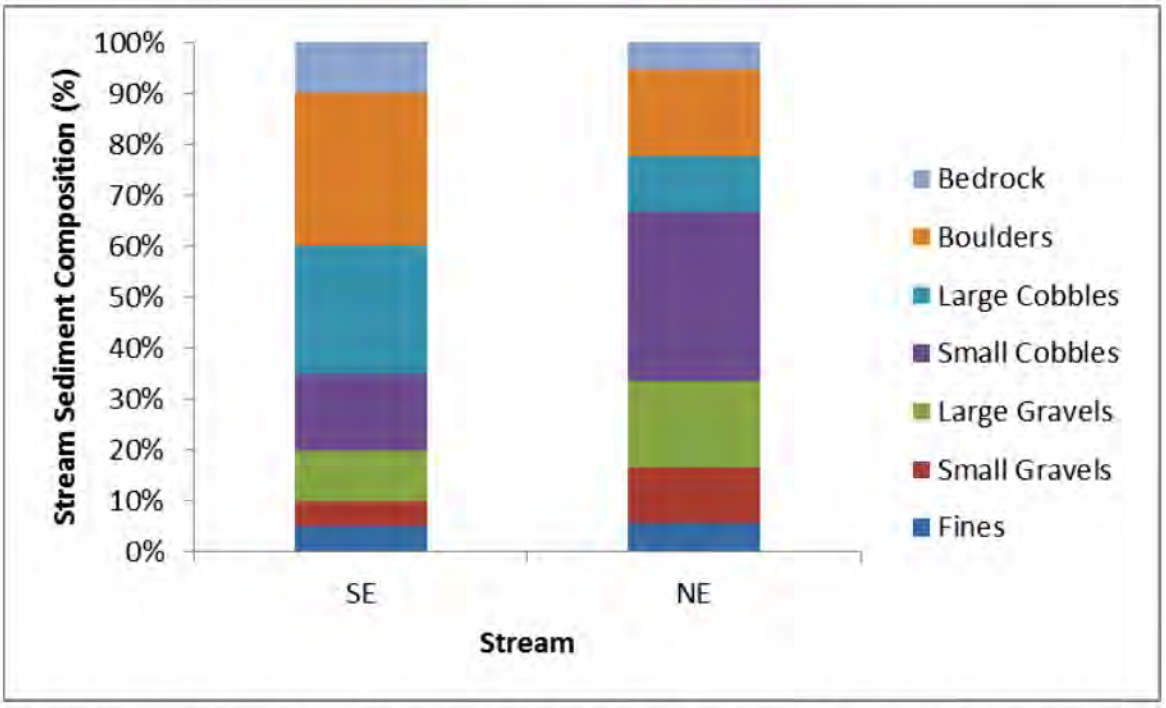

Figure 23: Quantitative Estimate of Eastern Inlet and Stream Sediment Composition, 2016

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				
			Very Poor	Poor	Medium	Rich	Very Rich
	Actual	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 Series 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:\60485818\900-Work\920-928 (GIS)\02_Maps\Vegetation\2016-09-19-TEMArea.Figs-2016-09-19-TEMAreasV2-60485818-002.mxd Date Revised: October 26, 2016 Reviewed By: AM
Paper Size: 11"x17" Scale is referenced to the specified paper size

Spatial Data from SCRD, GeoBC, 2015

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NAD 1983 UTM Zone 10N

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

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)

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	-	-	-	-

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AECOM

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).

AECOM

Drawings

SUNSHINE COAST REGIONAL DISTRICT

NORTH

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

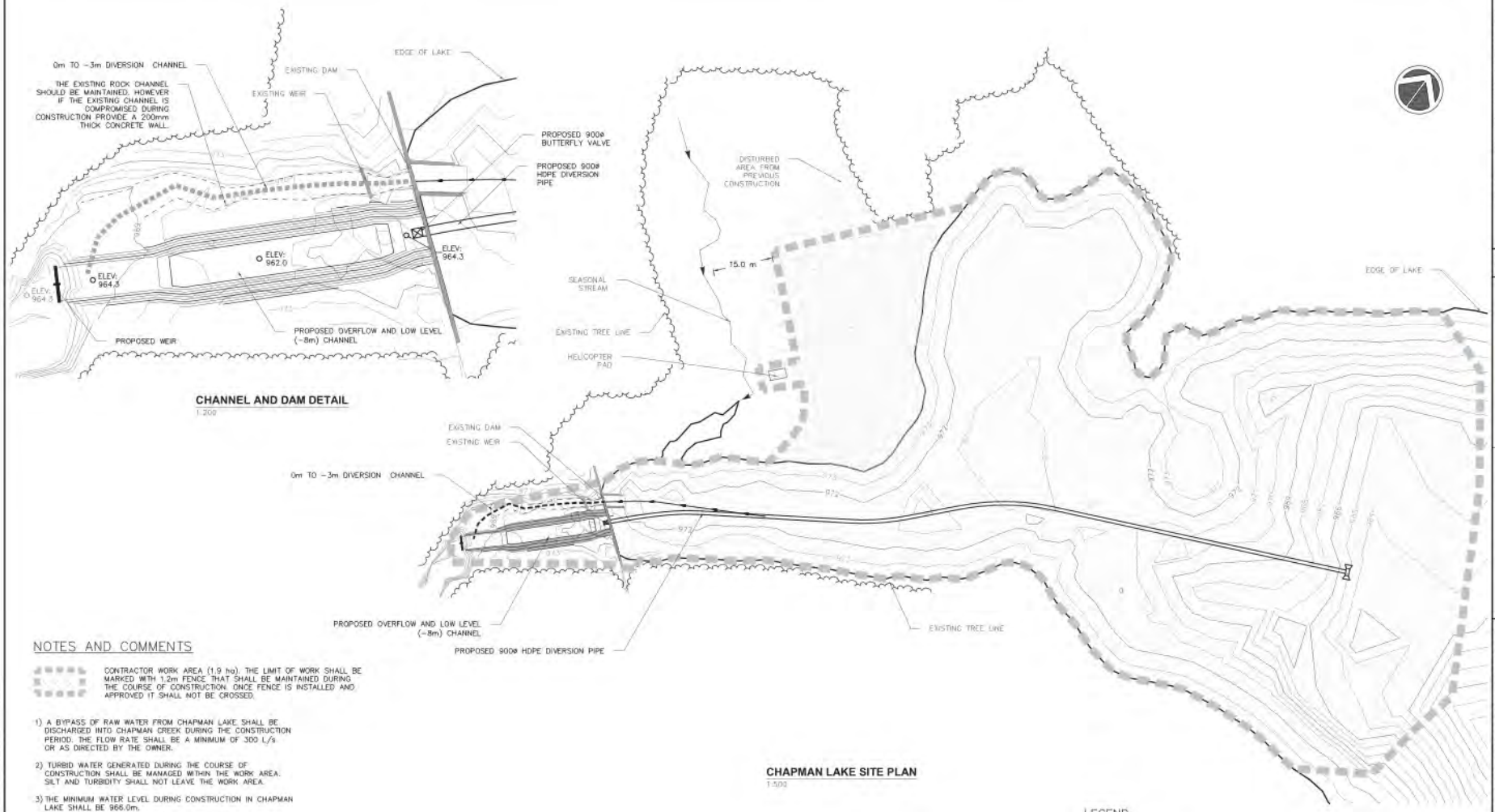
STRUCTURAL
S-100 PLAN AND SECTIONS (NOT IN THIS SUBMISSION)
S-101 DETAILS (NOT IN THIS SUBMISSION)

CHAPMAN LAKE SUPPLY IMPROVEMENTS

AECOM
60485918

NOT FOR CONSTRUCTION
NOVEMBER 2016

ISSUED FOR PERMIT APPLICATION



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

NOT FOR CONSTRUCTION

REV	DESCRIPTION	DRN	CHK	DATE (YMMD)
A	ISSUED FOR PERMIT APPLICATION	RT	BAW	2016/11/08

DRN BY: RT | DES BY: BAW | CHK BY: BAW | APP BY: BAW

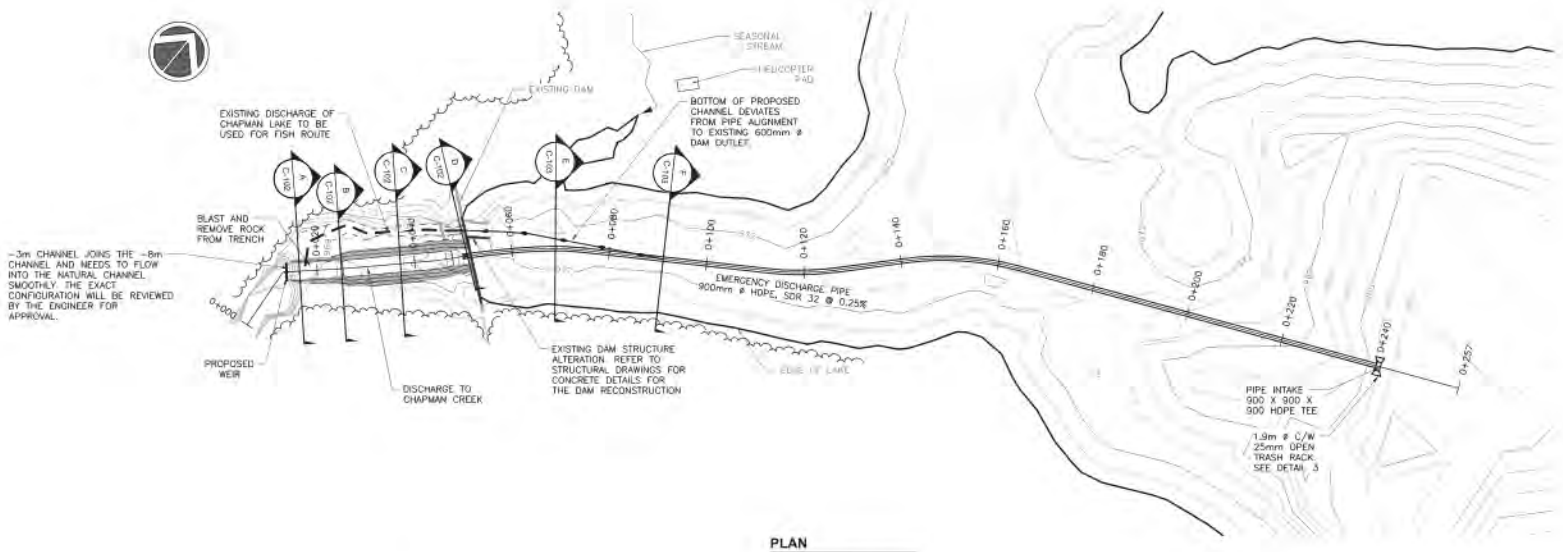
VERIFY SCALE IF PLAN SHEET IS REDUCED

AECOM

SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

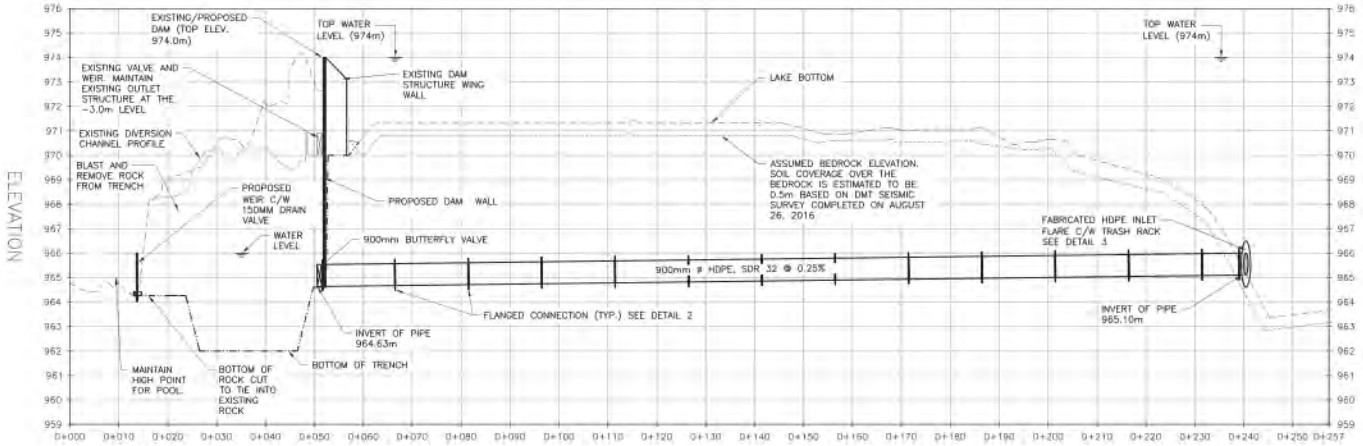
CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
SITE PLAN

PROJECT START DATE (M/Y): Mar 2016
PROJECT NO.: 60465918
FILENAME: 60465918 C-100.dwg
SHEET NO.:
DRAWING NO.: **C-100**



PLAN

1:500



PROFILE

1:500 (I) 1:100

NOT FOR CONSTRUCTION

NO.	DESCRIPTION	DRN	CHK	DATE (YMD)
B.	ISSUED FOR PERMIT APPLICATION	RT	BMV	2016/11/08
A.	ISSUED FOR DISCUSSION	RT	BMV	2016/09/15

VERIFY SCALE IF PLAN SHEET IS RESIZED

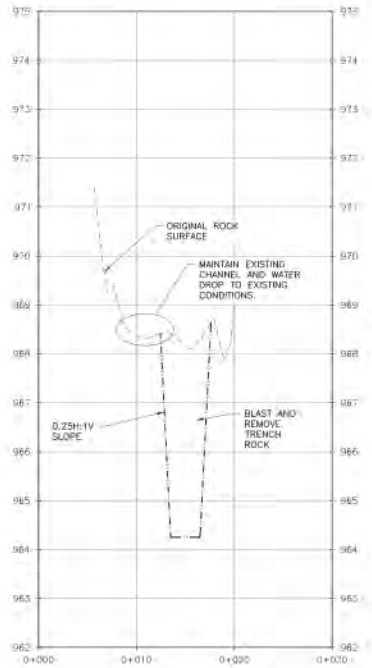
DRN BY: RT
DES: BMV
DES BY: BMV
AUS: BMV
CHK BY: BMV
APP BY: BMV

AECOM

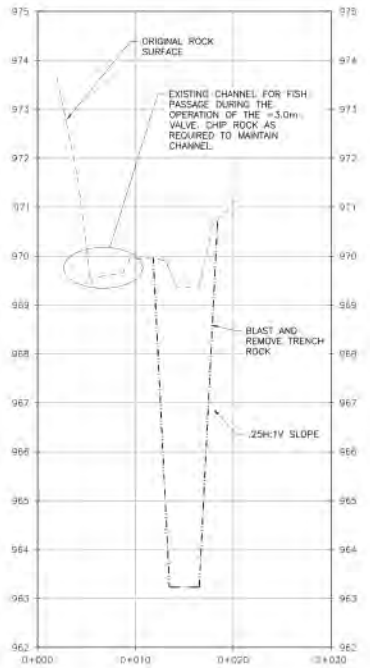
SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
PLAN AND PROFILE

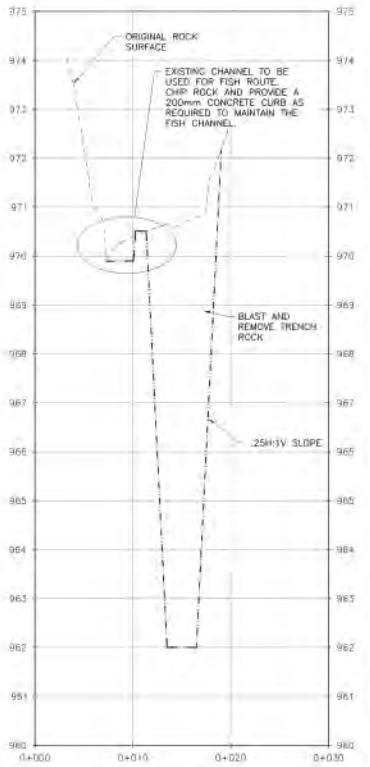
PROJECT START DATE (M/Y): Mai 2016
PROJECT NO.: 60465918
FILENAME: 60465918 C-101.dwg
SHEET NO.
DRAWING NO.: C-101



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



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



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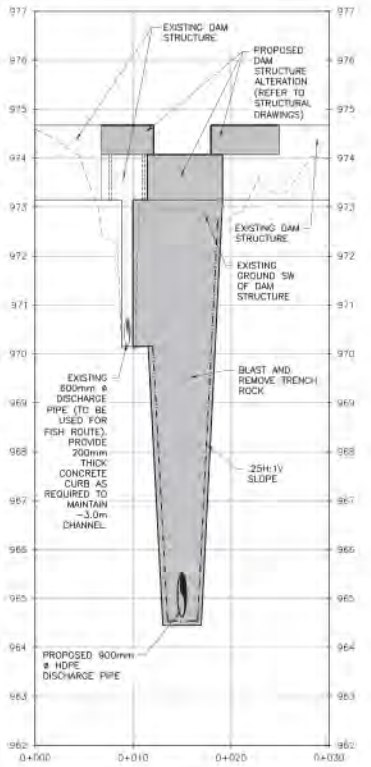
C-101 | H 1:250 V 1:50



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

NOT FOR CONSTRUCTION

VERIFY SCALE IF PLAN SHEET IS RESIZED

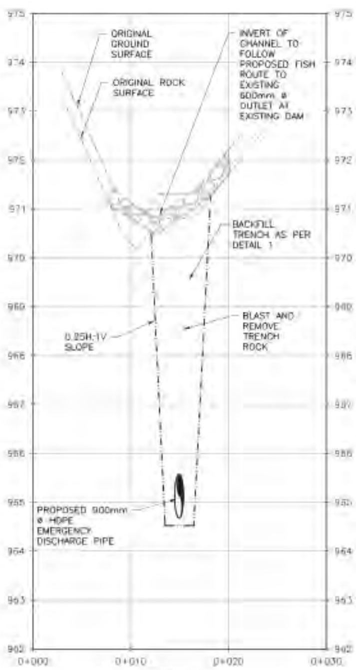
DRN BY	CHK'D BY	APP'D BY	NO.	DESCRIPTION	DES	CHK	DATE (YMD)
RT	BAN	BAN	A	ISSUED FOR PERMIT APPLICATION	RT	BAN	2016/11/08

AECOM

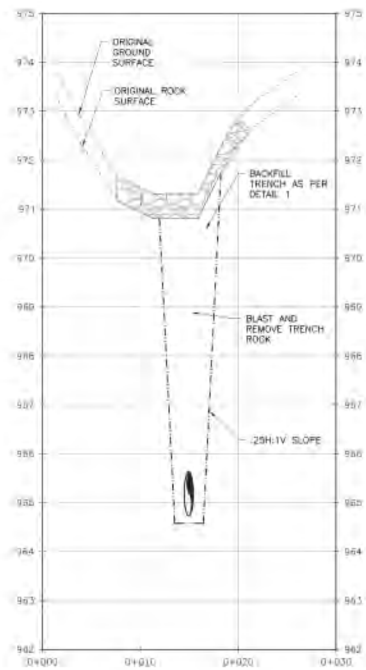
SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
SECTIONS

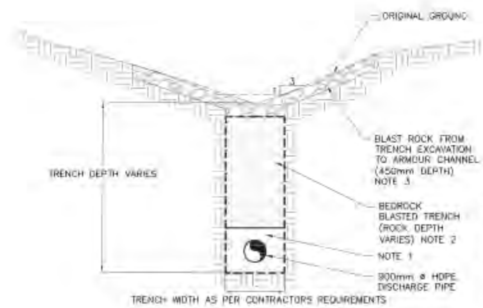
PROJECT START DATE (M / Y): Mai 2016
PROJECT NO.: 60469918
FILENAME: 60469918 C-102.dwg
SHEET NO.:
DRAWING NO.: C-102



E | SECTION

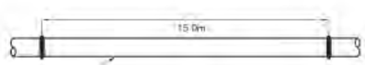


F | SECTION



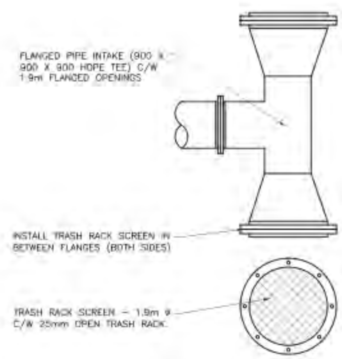
1 | TRENCH BACKFILL DETAIL

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.



FLANGED HDPE 900mm ø PIPE. PROVIDE FUSED VANSTONE FLANGES C/W 125# EPOXY COATED BACKING RING.

2 | FLANGED HDPE PIPE CONNECTON



FLANGED PIPE INTAKE (900 X 900 X 900 HDPE TEE) C/W 1.9m FLANGED OPENINGS

INSTALL TRASH RACK SCREEN IN BETWEEN FLANGES (BOTH SIDES)

TRASH RACK SCREEN – 1.9m ø C/W 25mm OPEN TRASH RACK

3 | FABRICATED SUPPLY PIPE INLET

NOT FOR CONSTRUCTION

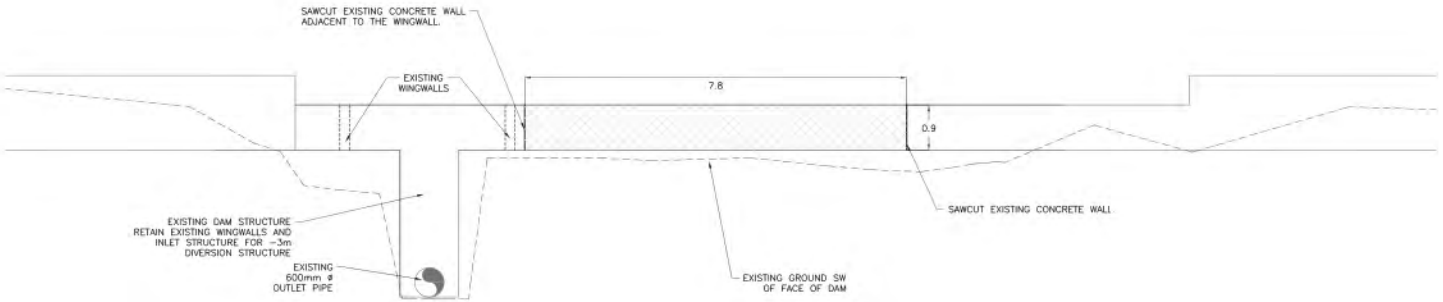
REV	DESCRIPTION	DRN	CHK	DATE
A	ISSUED FOR PERMIT APPLICATION	RT	BWV	2016/11/08

AECOM

SUNSHINE COAST REGIONAL DISTRICT
CHAPMAN LAKE

CIVIL
CHAPMAN LAKE SUPPLY IMPROVEMENTS
SECTIONS AND DETAILS

PROJECT START DATE (M/Y): Mar 2016
PROJECT NO: 60485978
DRAWING NO: C-103



- EXISTING FACE OF DAM
1:50

NOT FOR CONSTRUCTION

VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE (YMMD)
A	ISSUED FOR PERMIT APPLICATION	RT	BAW	2016/11/08

DRN BY: RT
DES BY:
CHK BY: BAW
APP BY: BAW

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

AECOM

Appendices

Appendix A Climate Change Memo

AECOM

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.

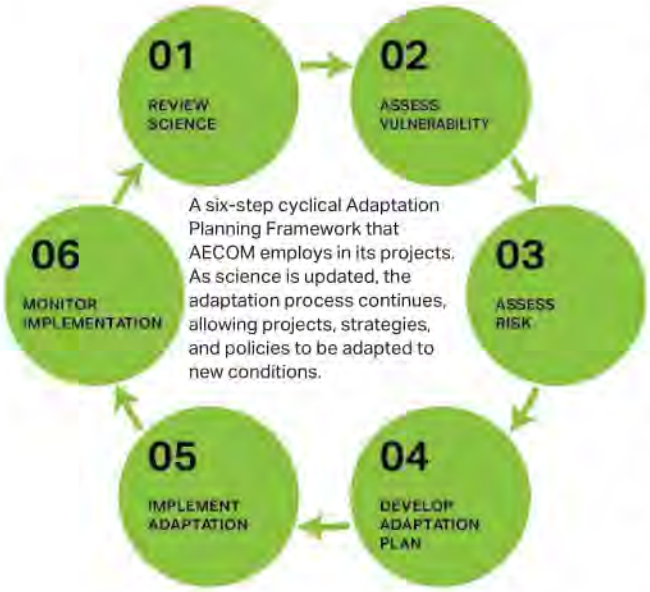
It should be noted that further analysis beyond this memo is required to estimate the thresholds for vulnerability of the Chapman Water System's source waters, and ultimately the longevity of the Project in affording future drought mitigation. Climate projections for temperature and precipitation are 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

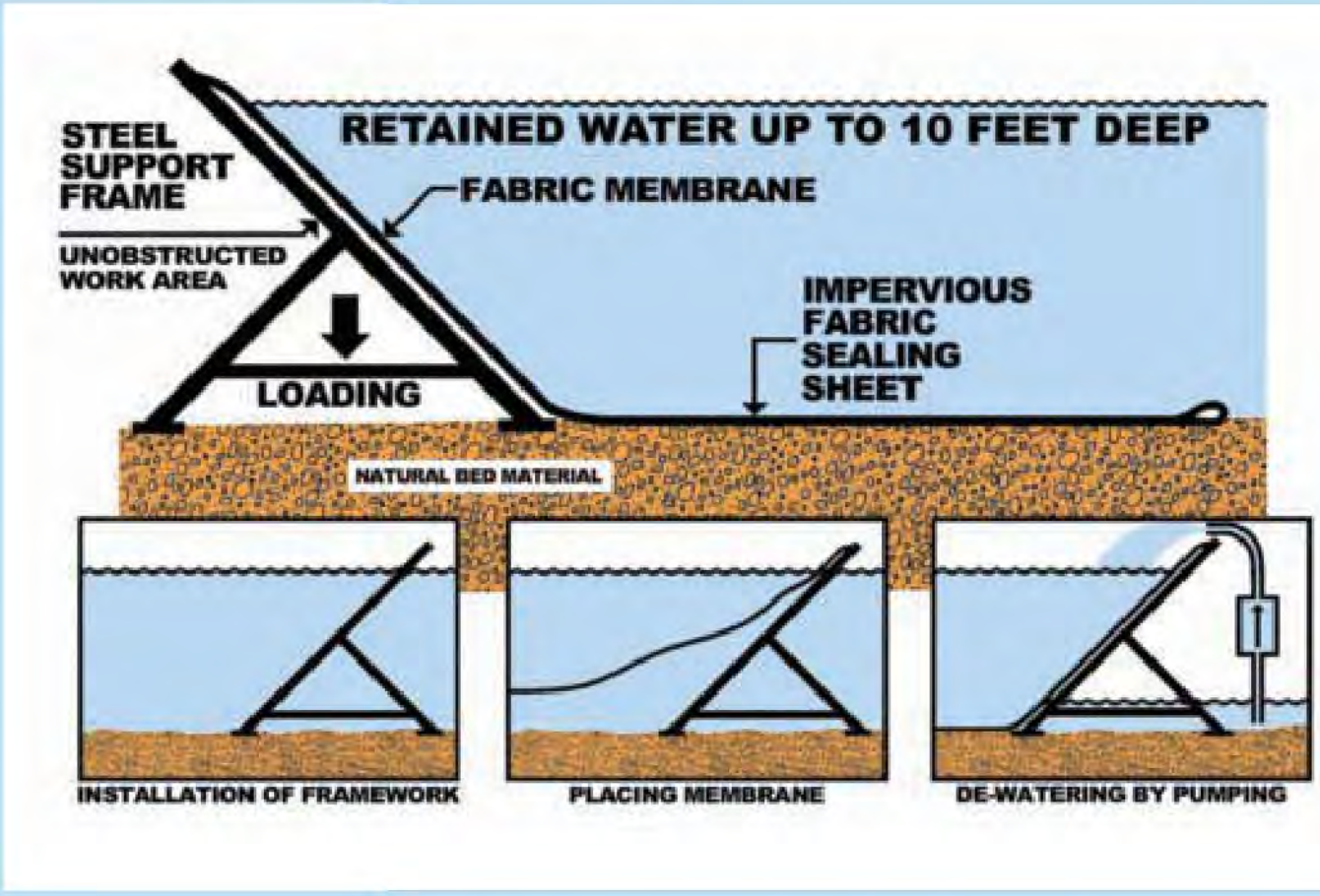
PORTADAM

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

PORTADAM

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.

Dam Rehabilitation

Divert river flow to allow spillway repairs under any conditions.

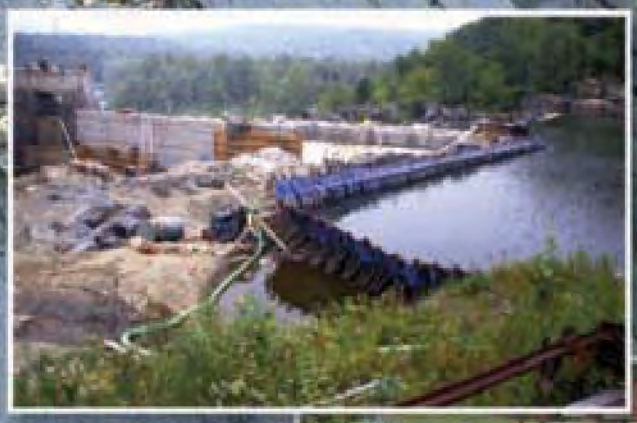
Low head dam rehabilitation and retrofit can easily be accomplished behind a PORTADAM cofferdam system.

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.



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

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

PORTADAM

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.

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.

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.

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

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

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.

Patent Pending

PORTADAM

Pipeline River Crossings & Repairs

Pipeline river crossing in a two-phase operation.

Portadam can be used in most streams and rivers.

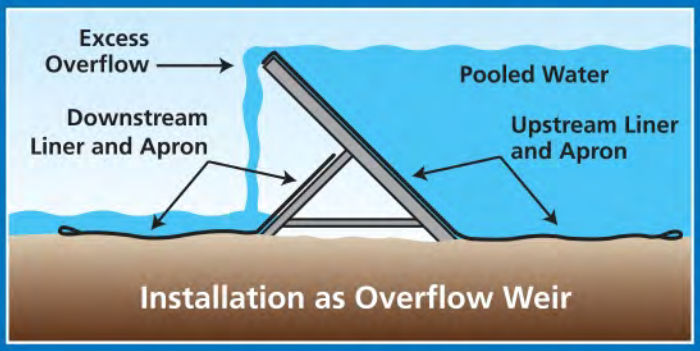
Much less costly than directional drilling.

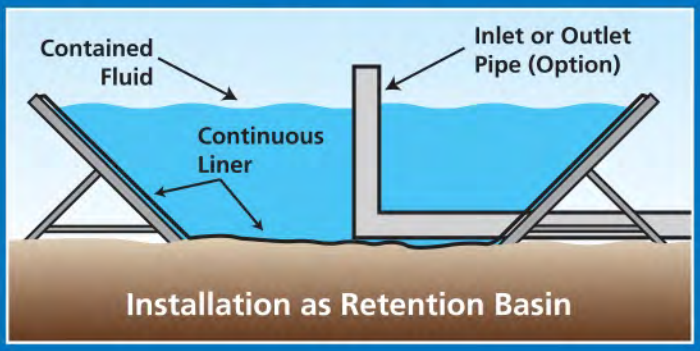
The PORTADAM system has proven to be a clean and effective method of performing open cut construction of pipelines across rivers and streams. A two-phase operation allows for unimpeded flow of water around the work site while offering an environmentally-friendly cofferdam system with no introduction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

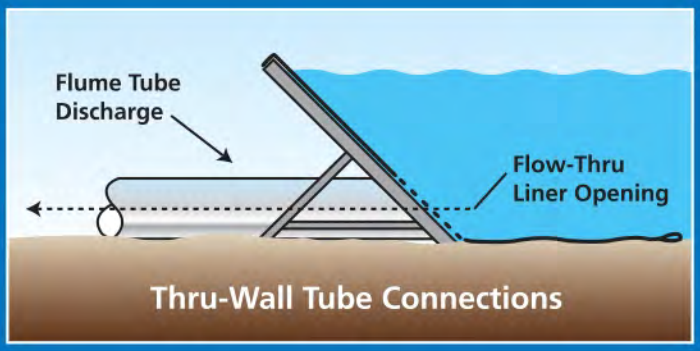
Adjustment of the river or streambed prior to installation is normally not required. Flexibility of the PORTADAM system equipment allows for installation over irregular contours and around obstructions.

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







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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

Appendix C Consultation

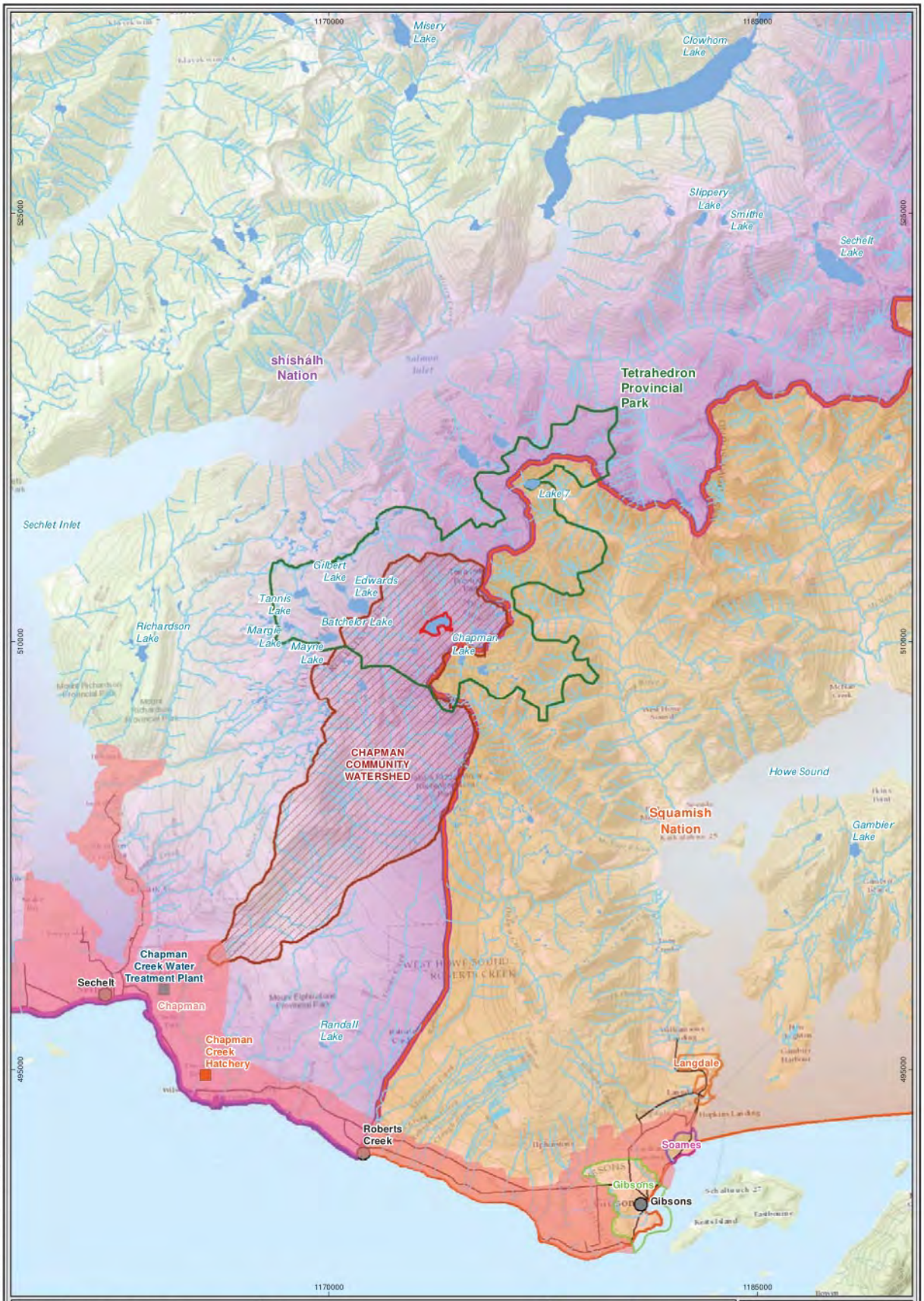
1. Consultation and Stakeholder Engagement Plan

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

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NAD 1983 BC Environment Albers

Legend

- Project Area (Chapman Lake)
- Squamish Nation Territory
- shishálh 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\300-Work\920-929 (GIS)\02_Maps\First Nation\2016-03-01-FNTerritories\Fig2-2016-03-01-FNTerritories\Portrait 60485918 002.mxd Date Revised: March 03, 2016 Reviewed By: AM Paper Size: 11"x17" Scale is referenced to the specified paper size.

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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

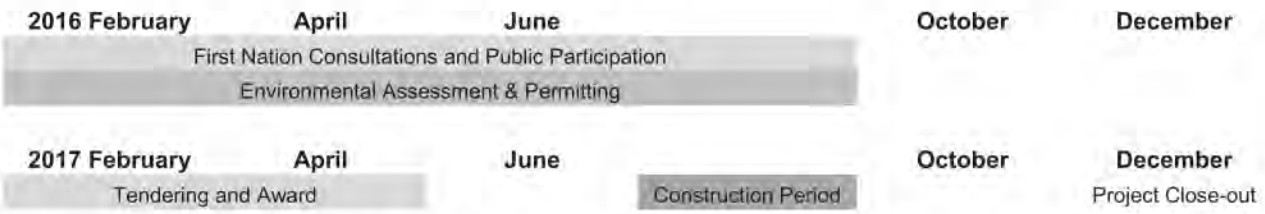
As part of the Comprehensive Regional Water Plan, in addition to the proposed Project, the SCRD is implementing a range of initiatives which aim to conserve, maintain and expand a sustainable water supply. These efforts include:

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.



Aboriginal Consultation and Public Participation

Aboriginal Consultation and public participation is intended to facilitate meaningful consultation with the shishálh 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[c]	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[r]	<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 $10^{(1.016(\log(\text{hardness}))-1.71)}$ 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 $e^{(0.8545[\ln(\text{hardness})]-1.465)}$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 $e^{(1.273[\ln(\text{hardness})]-4.705)}$ 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 $e^{(0.76[\ln(\text{hardness})]+1.06)}$ 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; $e^{(1.273\ln(\text{hardness})-1.465)}$ 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.

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[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.

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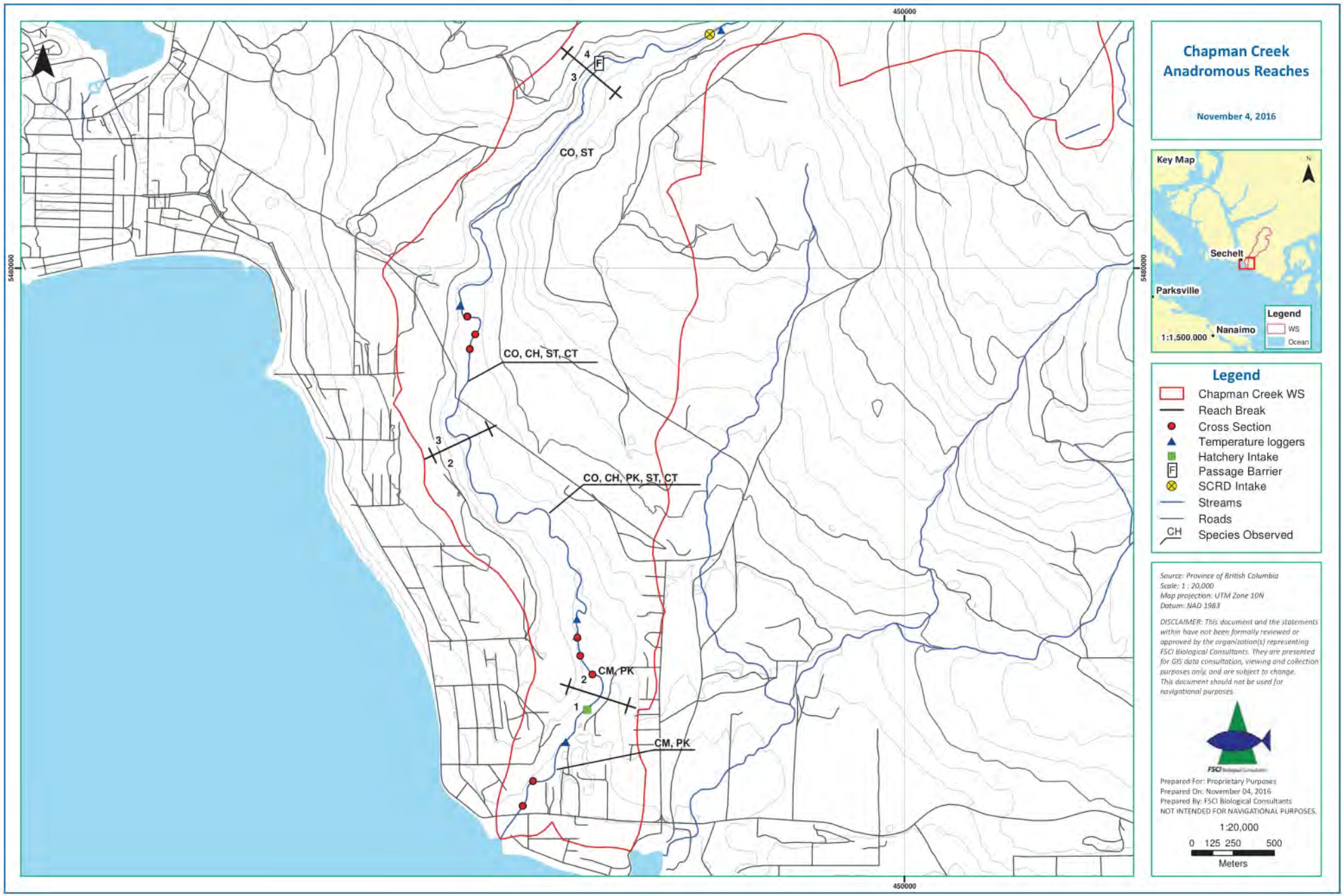
604-740-2637 (tel)
dbates@fsci-biological.ca


450000
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Chapman Creek
Anadromous Reaches
November 4, 2016
Key Map
N
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
CH
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.
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Prepared On: November 04, 2016
Prepared By: FSCI Biological Consultants
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Meters

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.

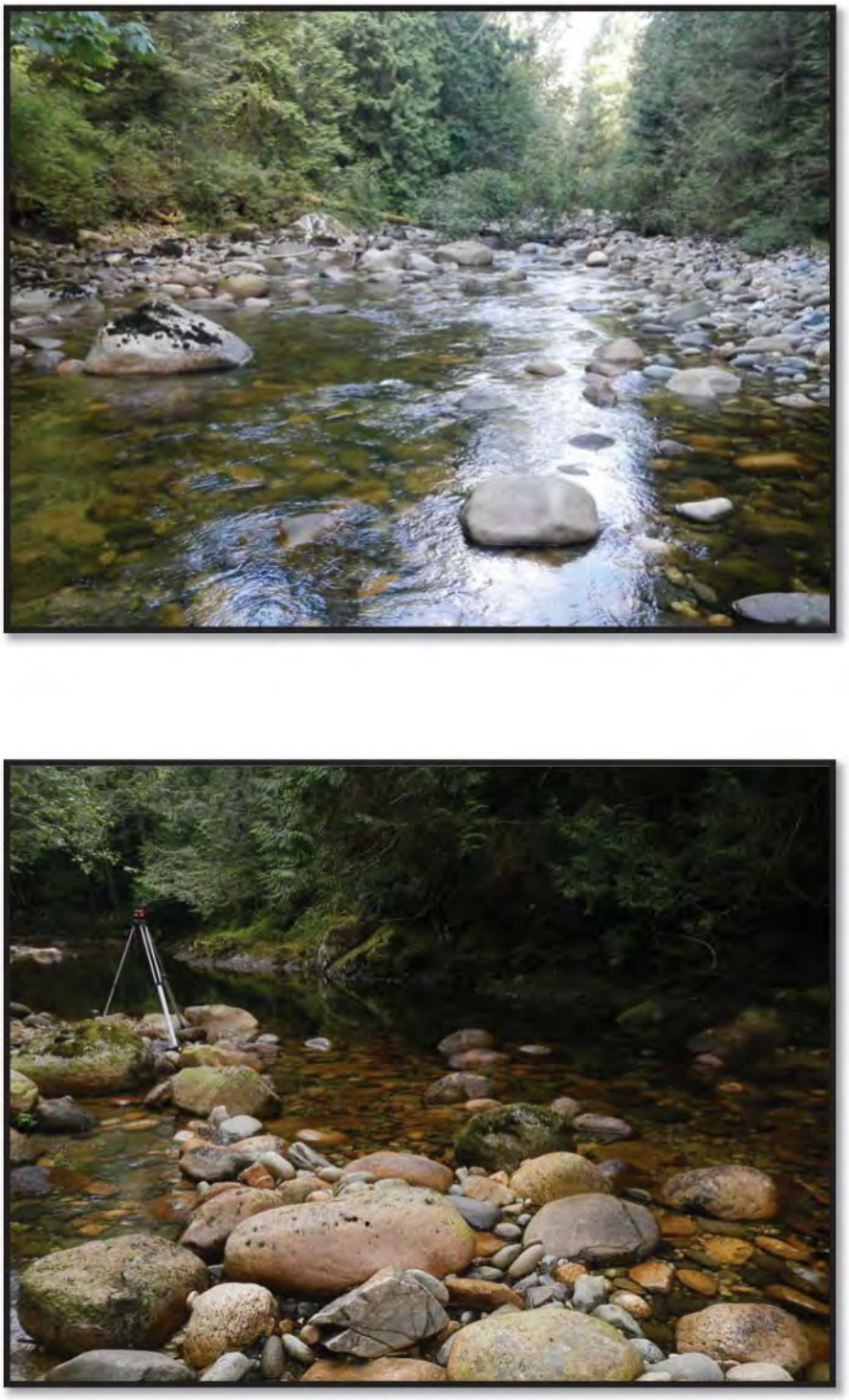


Figure 2: *Example of observed available rearing habitat found in Reach 2 and 3 of the Chapman Creek mainstem. The photos were taken August 10 at an estimated flow of 0.20 -0.22 cms.*

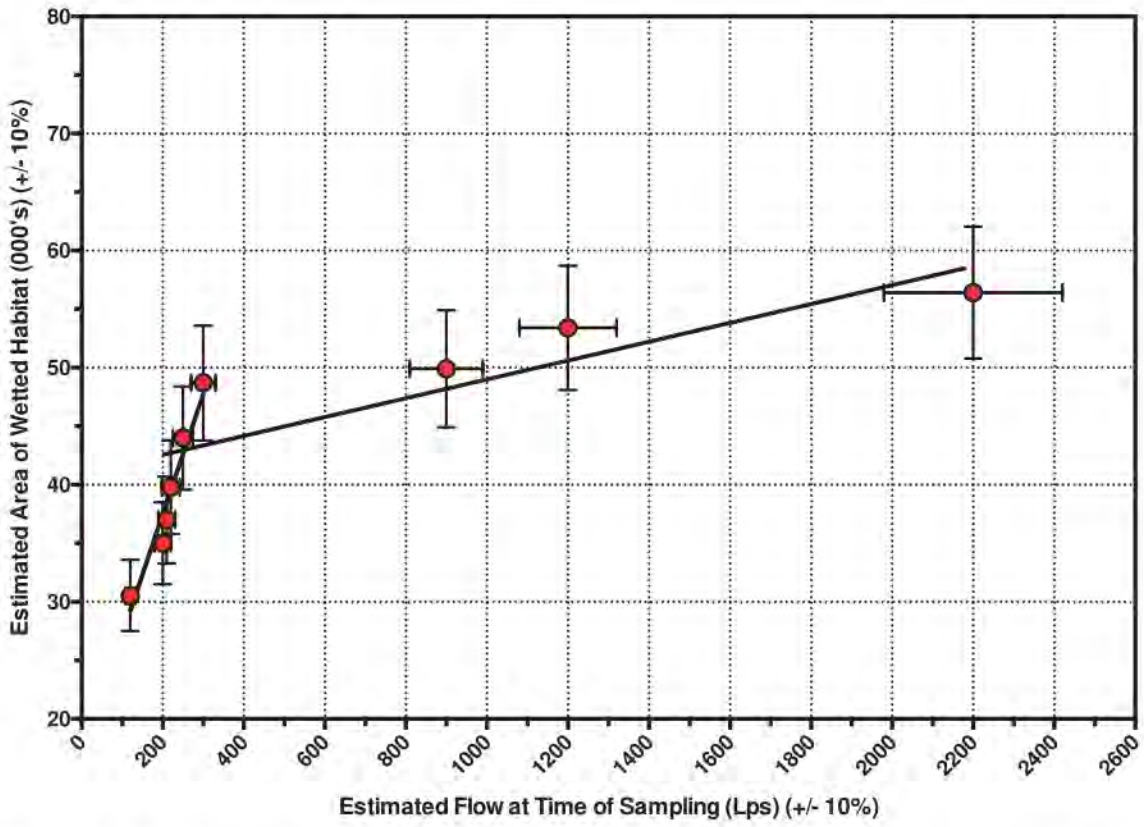


Figure 3: *The measured available wetted habitat versus the estimated flow (lops) documented on the lower anadromous length of Chapman Creek. The intersection or breakpoint of the linear relationships illustrates the point at which quality habitat area increase slows with increasing flow. This is intended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

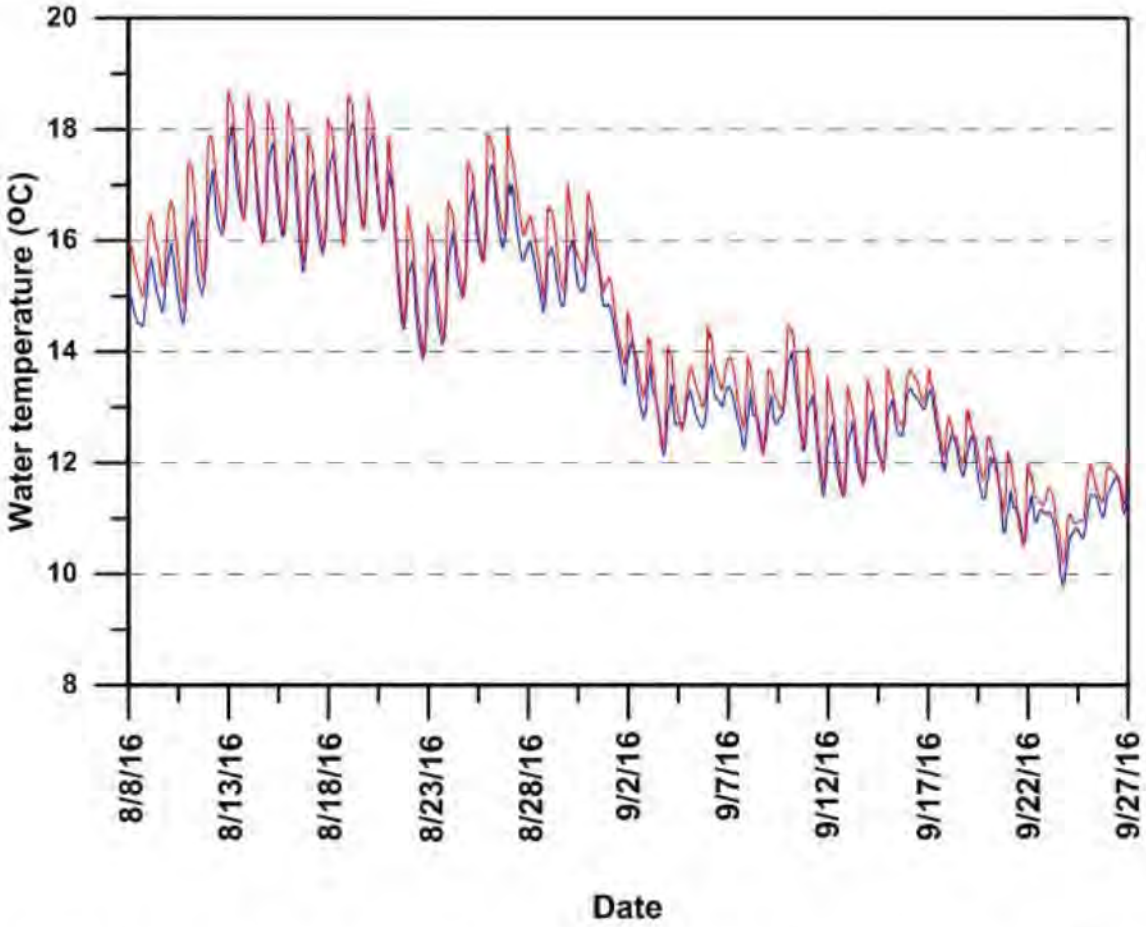


Figure 4: *Water temperatures recorded every 30 minutes from the beginning of August to the end of September 2016. The temperatures were recorded in Reach 2 (Red line) and 3 (Blue line). The temperatures peaked at daily highs greater than 18°C for a 10-day period.*

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.).

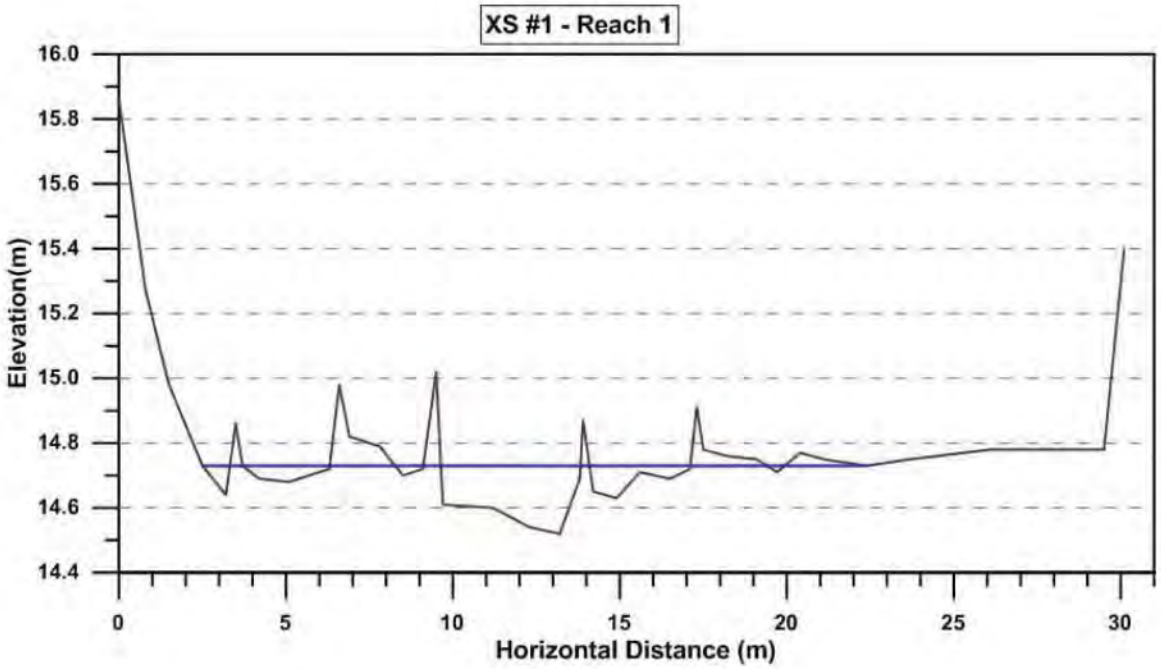
I trust this information is helpful. I welcome the opportunity to discuss in detail either the 2015 mitigation plans or the 2016 sampling results.

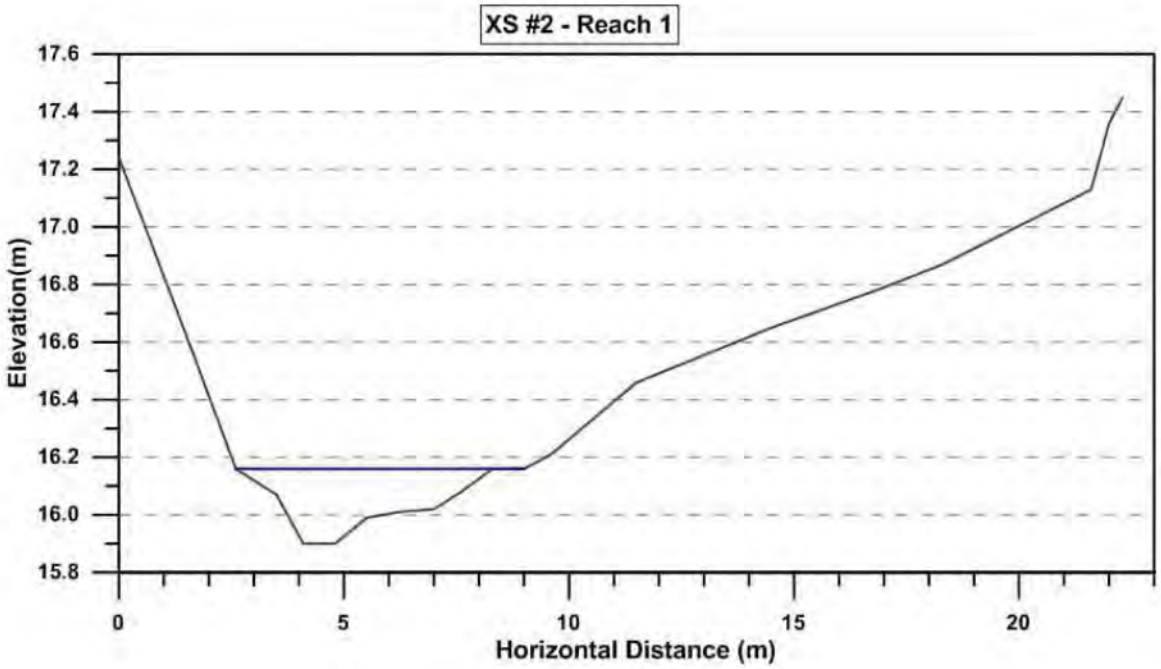
Sincerely

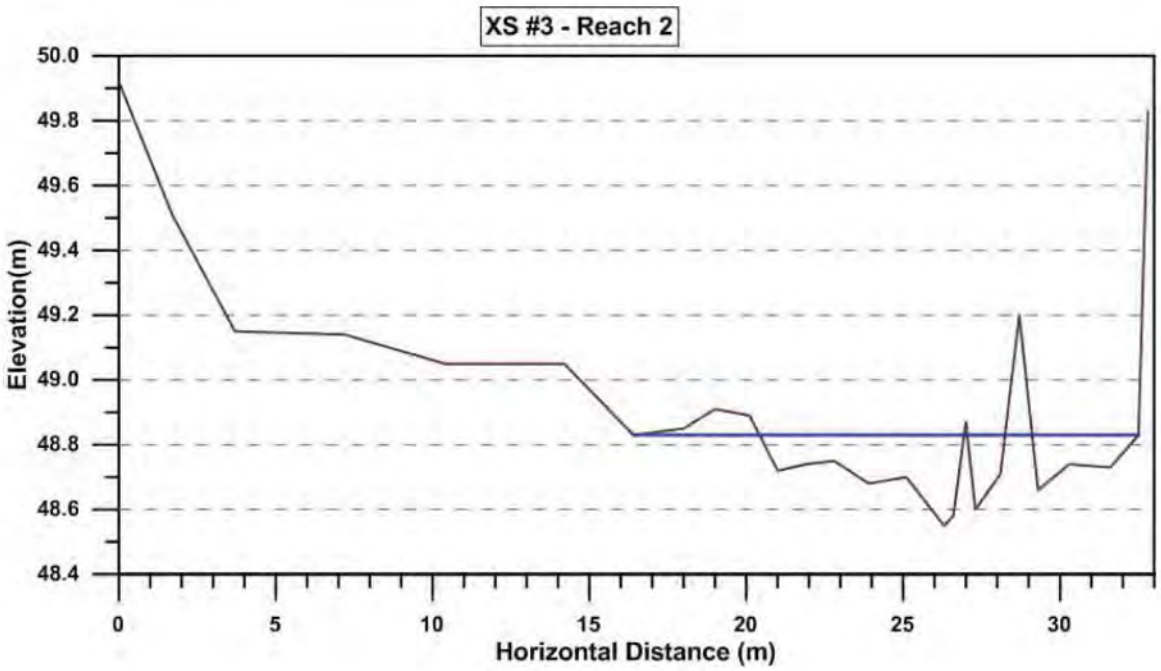
D. Bates, RPBio (#405)
Fisheries Biologist

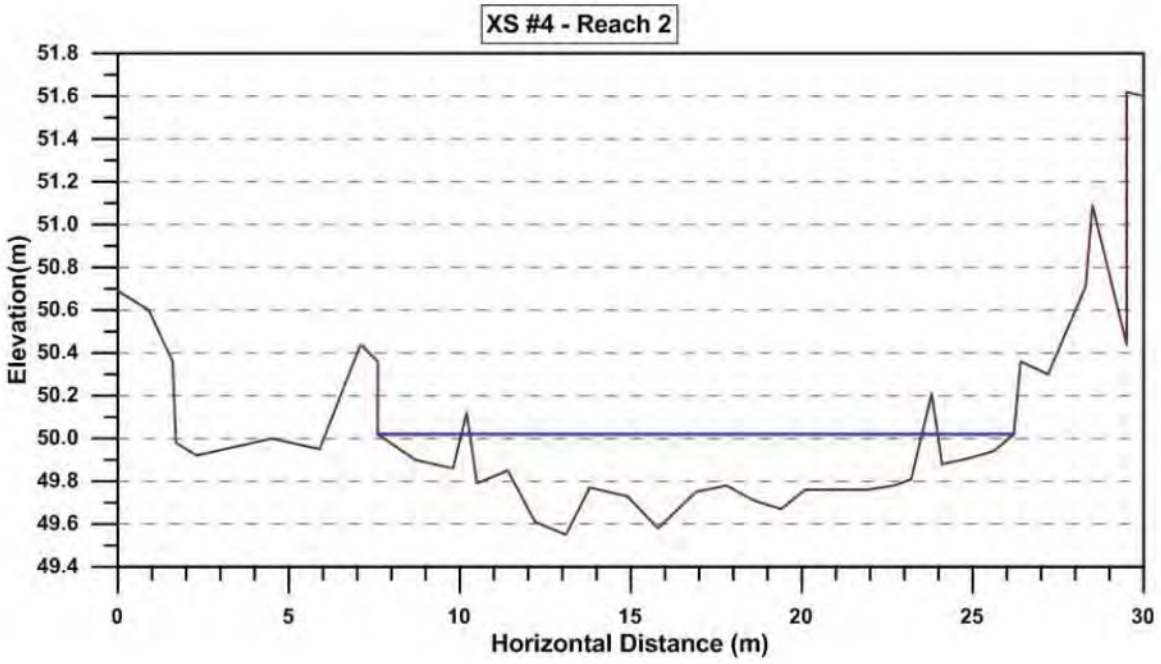
Figure 6: Photos of the first riffle above the high tide mark on lower Chapman Creek. This area is characterized by extensive bedload build-up and in some years presents a migration barrier at low flows. The pool immediately downstream provides the first significant adult holding location.

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
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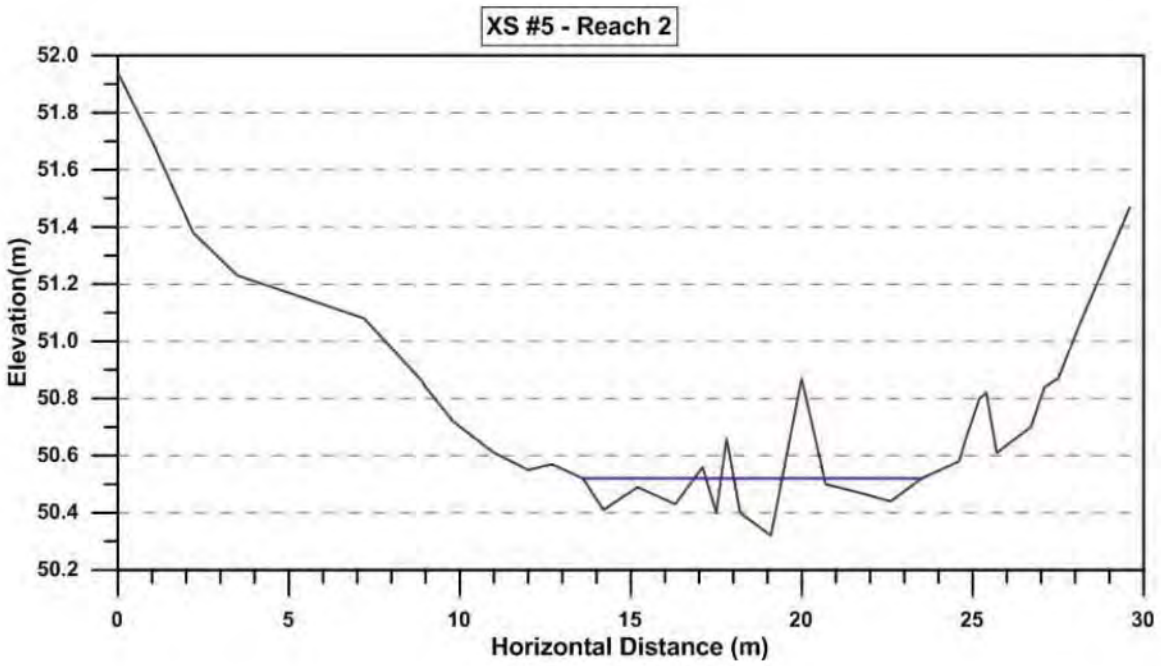
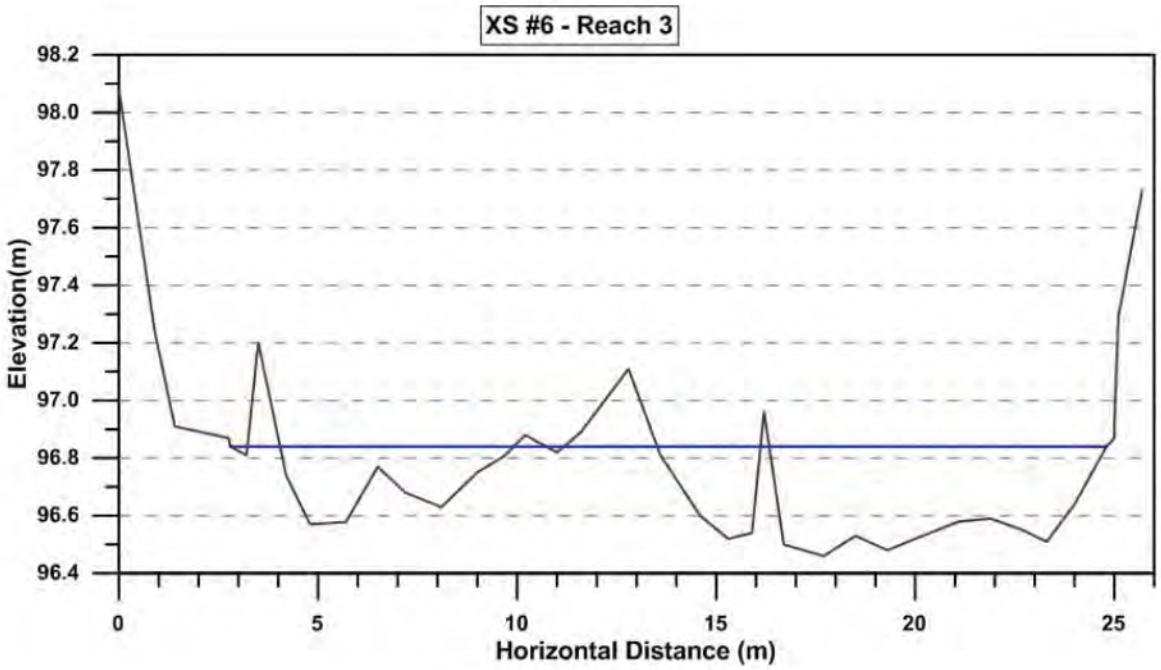
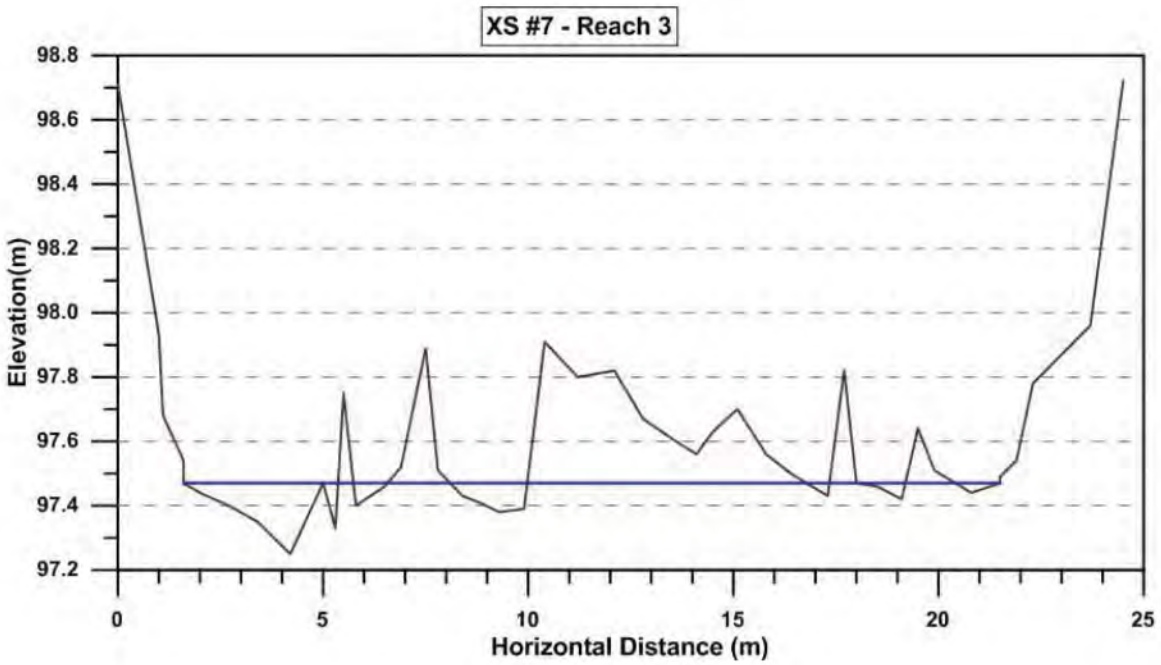
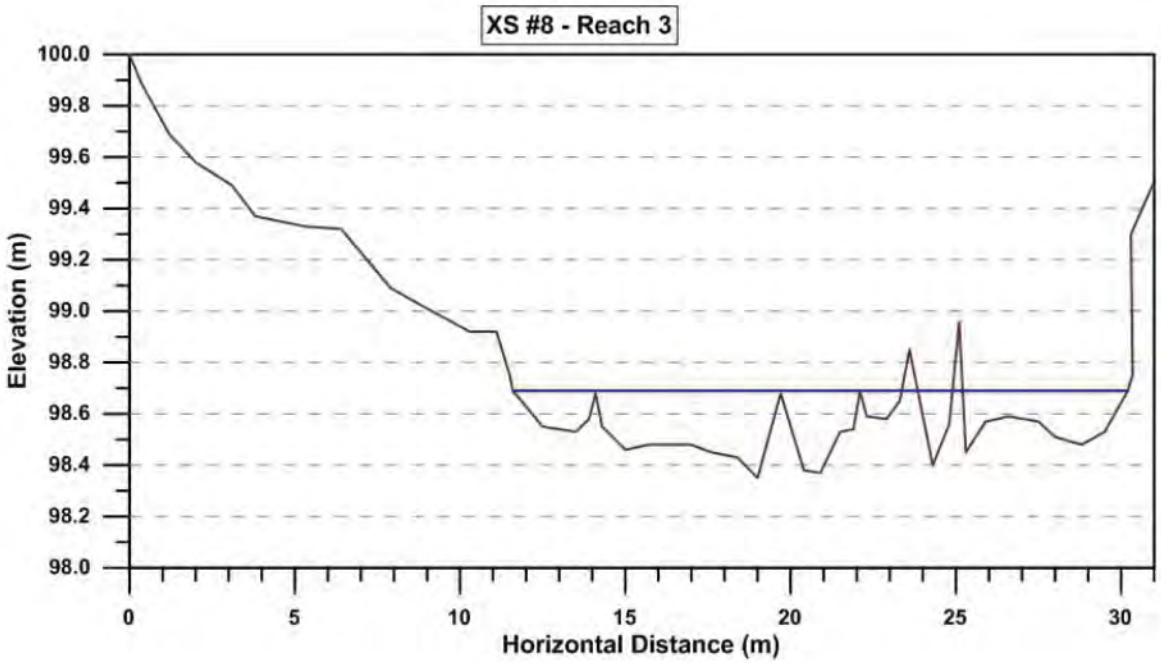
50.0
49.8
49.6
49.4
0
5
10
15
20
25
30
Horizontal Distance (m)


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


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


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


XS #8 - Reach 3
Elevation (m)
100.0
99.8
99.6
99.4
99.2
99.0
98.8
98.6
98.4
98.2
98.0
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							

Spatial Data from SCRD, GeoBC, 2015

N
W E
S
0 90 180 270
Metres
1:10,000

NAD 1983 UTM Zone 10N

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, 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

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

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

TEM Area

02 November 2016

AECOM

DRAFT
Figure x

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BC Parks Comments *Chapman Lake Water Supply Expansion Project Environmental Assessment Report* (AECOM 2016)

Comments prepared by Joanna Hirner, Registered Professional Biologist, Conservation Specialist, South Coast Region, BC Parks
March 24, 2017

In these comments the Water Supply Expansion project is referred to as the 'Chapman Lake Project' and the Environmental Assessment report as the 'Chapman Lake EA':

1. In our June 8, 2016 comments we requested additional information regarding the background and rationale for undertaking the Chapman Lake Project, as well as additional description of other water supply and demand management options considered. Demand management and development of other water sources are of interest because they will reduce future dependence on Chapman Lake water and allow greater flexibility to manage drawdown to protect values at Chapman Lake. Section 1 and 2 of the Chapman Lake EA provide additional details regarding the rationale, but description of other supply and demand management options considered and proposed for the future is still lacking. We assume this type of information is available in the Comprehensive Regional Water Plan (CRWP) (Opus Dayton Knight 2013) but request a summary of the long term source development and demand management projects that are being developed, including timelines, be provided in support of the Park Use Permit application. Also, please address if there any plans to scale back or decommission infrastructure at Chapman Lake once other sources are developed.
2. The following four comments (#3-6) relate to the uncertainties that exist regarding the future frequency, extent and duration of drawdown ("drawdown regime"). Uncertainty regarding drawdown regime is in turn related to uncertainties in future hydrology, climate, and downstream environmental flow needs. In a general sense, the following four comments are meant to demonstrate that important uncertainty exists regarding future drawdown regime, and thus conclusions regarding residual impacts are uncertain. Unless a specific request is made, no response is required to these comments, other than to acknowledge that future drawdown regime is uncertain.
3. Section 2 and Appendix A provide analyses of historical and current hydrology of the Chapman Creek watershed and how climate change may alter hydrology in the future. Our interpretation is that although existing data and climate models can be used to make predictions, important uncertainties remain regarding future hydrology and climate conditions, as outlined below.
    a. The characterization of current hydrology in the Chapman Creek watershed and its capacity to meet future water demands is primarily based on analysis of water gauge data collected in the Chapman Creek watershed 1959 to 1988. More recent data analysis is limited to data collected since 2014 when remote monitoring and management of lake levels was implemented associated with the existing Chapman Lake dam. Thus the analysis may not fully reflect more recent changes in the hydrology of the watershed since the late 1980s.
    b. The analysis presented suggests that uncertainties remain regarding how the Chapman Creek watershed will respond to climate change. For example, the analysis in Appendix A uses model predictions for the Metro Vancouver area extrapolated to the Sunshine Coast. To increase the potential accuracy of climate change predictions for the Chapman Creek watershed, Appendix A recommends a more detailed hydrological and hydraulic assessment of water balance in the watershed based on climate projection information, and comparison of local geographic and climate data to Metro Vancouver data to confirm the relevance of Metro Vancouver projections applied to Chapman Creek, although these analyses have not been done. We request

confirmation of whether or not the more detailed hydrological analyses as recommended in Appendix A will be done.

4. Although there is uncertainty regarding the future hydrology of Chapman Creek, generally the predictions related to climate change are smaller snowpack, longer and drier summers, and dry conditions that will extend further into the fall. In our June 8, 2016 comments we expressed concern about the potential for increased frequency of drought, and the associated increased frequency, extent and duration of drawdown, to cause long-term changes to the water table and recharge rates of Chapman Lake. The Chapman Lake EA does not provide analysis or discussion of this issue, other than to state that the recharge rate is fast, based on the fact that the lake went from almost -3m to full pool over 4.5 days of rainfall in the fall of 2015. However, it is unclear whether rapid recharge would continue with climate change and under repeated and prolonged drought and drawdown conditions. We request further discussion of the risk that the water table could be lowered over the long-term under more frequent drought and more frequent and extended large drawdown, and the associated risk of changes to recharge rates of Chapman Lake.

5. The analysis of fish habitat and environmental flow needs presented in Section 5.3.6 (p. 56) and Appendix G suggests that the current operating procedure of providing a minimum of 0.2 m^3/s during low flows is adequate for rearing salmonids, but not consistently adequate for adult salmonids migrating upstream. The requirement to provide adequate flow for migrating adult salmonids in the future may increase future drawdown requirements and presents a source of uncertainty around predicting the future frequency and severity of drawdown of Chapman Lake. We are not requesting further analysis of this issue at this time other than acknowledgement that drawdowns of Chapman Lake could be larger and more frequent than assumed in the Chapman Lake EA. We are also interested in responses to additional questions raised by FLNRO regarding environmental flow needs.

6. Most of the conclusions regarding the residual effects of the operation of the Chapman Lake Project (as summarized in the Executive Summary and Table 28) are based on the assumption that drawdown below -3 m would be relatively infrequent and of short duration. However, our interpretation is that important uncertainties remain around the assumption of low frequency and short duration of large drawdowns, especially in the long-term. For example, if increased drawdown is required in the future to provide adequate flows for fish, large drawdowns may be more frequent and longer lasting than predicted, leading to larger than expected residual effects on environmental components in and around Chapman Lake. This in turn suggests that the conclusions of low to moderate residual effects associated with operation of the Chapman Lake project are also uncertain, and residual effects may be larger than predicted. Monitoring during operation will be required to detect impacts and develop mitigation/adaptive management, and a plan for monitoring during operation will need to be developed (see comment #28).

7. Section 6.3.1.2 (p. 69) provides assessment of residual effects on soil and vegetation during operation. The assessment considers the following potential impacts: exposure of shoreline and associated increased risk of erosion and sedimentation, and additional hydrological drawdown of wetlands during drought conditions. The Chapman Lake EA concludes that long term effects are not expected "given that these events are relatively infrequent and of short duration". However, large drawdowns and associated impacts may be more frequent and longer in duration than suggested, especially in the longer-term. In addition, it is unknown whether or not multiple years of drought and large and extended drawdowns could lead to a long term lowering of the water table, which could have important impacts on vegetation. Thus it should be acknowledged that impacts are uncertain and may be greater than suggested in the Chapman Lake EA. We also request that wetland water levels and wetland vegetation be monitored during operation to detect potential impacts of drawdown and possible changes in water table.

8. The issue of sedimentation and potential for erosion, instability or bank failure of shoreline during large drawdown has not been clearly considered. For example, the analysis of sediment quality in Section 5.2.3 (p. 41) does not appear to include an analysis of sediment depth, which could influence bank stability. Section 6.5.1.2 (p. 77) states that concern has been expressed regarding instability of the deltas around major tributaries that flow into Chapman Lake, but concludes that a major movement of lake sediments is unlikely because the bathymetry of the lake is not steep in these areas. However, the potential for slope failures in other steeper areas of the lake bed does not appear to have been considered. The potential for rapid refilling of the lake during rain events to cause slope failures also does not appear to have been considered. We request additional analysis of the potential for sloughing of sediments during large or extended drawdown throughout all areas of the lake, and suggest involvement of a Geotechnical Engineer in this analysis.

9. Section 6.5.2.2 (p. 79-80) suggests that Dolly Varden in Chapman Lake will be resilient to potential impacts of operational drawdown on spawning because there are multiple age classes in the lake, i.e. if spawning is restricted in one year due to drought, there will be a cohort of spawners available to spawn the next year. However, drought events (even a 1:25 year drought) can occur more than one year in a row and drought events may become more frequent in the future due to climate change. Thus the potential for drawdown to negatively affect spawning may be greater than assumed in the Chapman Lake EA report. No response is required to this comment other than to acknowledge that risks of impacts to Dolly Varden are likely greater than expected and thus monitoring of Dolly Varden during operation will be required (see next comment).

10. Monitoring of the Dolly Varden population in Chapman Lake is required during operation to detect negative changes that could result from more frequent, longer and deeper drawdowns. It is not clear from the Chapman Lake EA if the data collected to date are sufficient to provide baseline to monitor changes in population over time. A monitoring plan will need to be developed prior to construction, and designed with appropriate methods and measurements that allow for detection of changes in the Dolly Varden population. The monitoring plan will identify if additional information needs to be collected pre and/or during construction. Monitoring will need to continue during operation to detect impacts and develop and implement mitigation as needed.

11. Section 6.5.2.1 (p. 79) states that full drawdown during construction is unlikely to negatively affect Dolly Varden because 2016 observations suggest that even a full -8m drawdown will not cause complete blockage of access to spawning creeks. In addition, the assessment assumes that Dolly Varden will spawn later in the fall when construction will be complete and Chapman Lake will be refilling. These assumptions regarding access to spawning streams and spawning timing need to be tested through additional life history study to determine when Dolly Varden spawn relative to lake re-filling, and how timing may influence impacts from drawdown. For example, if spawner migration to stream spawning locations occurs prior to lake refilling, fish may have to migrate through channels in open mud flats exposing them to possible sedimentation and predation. At a minimum, monitoring of spawning access and timing should be initiated during the drawdown associated with the construction period. Better understanding of life history will help reduce uncertainty around potential impacts of drawdown during operation and will be useful for developing mitigation during operation.

12. Note that the Dolly Varden population at Chapman Lake is likely of high conservation value because it is a mono-culture headwater population of genetically isolated Dolly Varden. This type of population may be rare or even unique (additional review of existing information could determine how rare this type of population is). In addition, Dolly Varden are associated with cold water and may be at increased risk of population declines through climate change and more frequent drought events, even in the absence of artificial reservoir drawdowns. The Chapman Lake population may be particularly vulnerable as an isolated population with no incoming gene flow. All of the above increases the importance of monitoring to better understand and mitigate potential impacts of increasing frequency, duration and extent of drawdown during operation.

13. Section 6.4.4.2 (p. 73-74) discusses potential residual effects on Western Toad, even though there are no known observations of Western Toads in the Chapman Lake area. However, the presented analysis can be extrapolated to aquatic breeding amphibians generally, which are common and important in the wetlands surrounding Chapman Lake. The Chapman Lake EA suggests that potential residual effects on toads during operation will be minimal even under increased drawdown because lowest water levels will occur in late summer once the majority of tadpoles have gone through metamorphosis. This will not be true for neotenous Northwestern Salamanders which spend their entire lives in the aquatic environment. Neotenous salamanders have been observed in Chapman Lake tributaries and may occur in adjacent wetlands. Northern Pacific Treefrog tadpoles and Long-toed Salamander larvae were abundant in wetlands at the east end of the lake during late August 2016 field surveys, suggesting that tadpoles remain late in the season during typical low water periods. Also, there is the outstanding question regarding the potential for multiple years of drought and large drawdowns to lead to a long term lowering of the water table in the area, which could reduce suitable habitat for amphibians. Thus uncertainty remains regarding the extent of residual effects on amphibians.

14. Mercury and formation of methylmercury (Sections 5.3.1.4, 6.5.1.2):

    a. Fish tissue sample results reported in Section 5.3.1.4 (p. 47-48) show total mercury in fish tissue was above the CCME and BC Tissue Residue Guidelines to Protect Wildlife from Mercury Toxicity in four of the five fish sampled. However, Section 5.3.1.4 states "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." We request more details explaining why the Chapman Lake EA came to this conclusion.

    b. Tissue sampling for mercury was conducted to establish a baseline for comparison to samples collected in the future because of concern that increasing drawdown may lead to elevated levels of methylmercury in the food web. High levels of methylmercury are known to be generated in newly created reservoirs, but evidence also suggests that large drawdown in established reservoirs may also lead to increases in methylmercury formation (see Azimuth 2015, cited in the Chapman Lake EA). Discussion presented in Section 6.5.1.2 (p. 76-77) suggests that methylmercury formation related to drawdown is not a problem at Chapman Lake because it is much smaller, experiences less drawdown, and has less inundation of vegetation than Carpenter Lake, the reservoir studied in Azimuth (2015). However, Carpenter Lake is only one reservoir where elevated mercury levels have been potentially linked to water level fluctuations. References in Azimuth (2015) and elsewhere (e.g. Willacker *et al.* 2016 http://dx.doi.org/10.1016/j.scitotenv.2016.03.050) document studies that included a range of waterbody sizes and conditions (including smaller reservoirs and a range of drawdown regimes). These studies repeatedly showed relationships between water level fluctuations and increased mercury in fish. The 2016 tissue sample results for Chapman Lake combined with evidence in the literature suggests to us a possible link between elevated mercury levels in fish tissue and the existing drawdown regime in Chapman Lake. In addition, increasing drawdown in the future may exacerbate this problem. We recommend that fish tissue sampling be included in the monitoring program during operation.

    c. Total mercury in the water column (which includes methylmercury) was well below water quality criteria (as reported in Section 6.5.1.2 and Appendix D). However, mercury accumulates in the sediment and this is primarily where methylmercury formation occurs. The sediments may be the source of higher than criteria levels of mercury observed in fish tissue. Analysis of metals (including mercury) in sediment should be included in future monitoring, including during the summer of construction to provide a baseline pre-operation.

15. The executive summary states that the intake for the pipe will have an invert elevation of 965.1 m but the April 2016 permit application identified an invert elevation of 966 m. Please explain the change.
16. Section 3.2 (p. 15): This section states that "in order to install the intake end of the pipe the lake may have to be drawn down below the -8m level depending on the type of coffer dam used." Has consideration been given to a possible situation where drought conditions are experienced at this time when lake is already below -8 m? The schedule for construction and choice of coffer dam used must be designed to minimize the duration of deep and maximum (-8 m) drawdown as much as possible.
17. Section 5.0: The data collected during the 2016 field assessment and the details of sampling methods and sampling locations will be required to allow for comparison with future field assessments and data (i.e. to monitor environmental change and impacts). Most of this information appears to be included in the Chapman Lake EA and its appendices. Digital versions of spatial data files for sampling locations, occurrence records, Terrestrial Ecosystem Mapping (TEM), etc. will also be needed. Please confirm that SCRD has been or will be provided with digital spatial data (including TEM polygons) and any other raw data/sampling information required for future monitoring.
18. In Section 5.3.4 (p. 54) fish habitat in south eastern stream was rated low to moderate in part due to no fish captured. Note that on August 24th Joanna Hirner observed a small fish (assumed to be Dolly Varden) in a pool associated with this stream.
19. Section 5.4.5 (p. 60-61) presents the results of Terrestrial Ecosystem Mapping (TEM). The red-listed Sitka sedge/peat-mosses Fen community was identified in some polygons that overlap or are adjacent to the permit area and construction temporary use area as shown in Figure 6 (p. 14). Protecting this plant community is a priority that must be reflected in the Construction Environmental Management Plan (EMP) still to be developed as described in Section 7.0. Monitoring for changes in the Sitka sedge/peat mosses Fen community that may result from more frequent and extended large drawdowns is also a priority during the operation phase.
20. Section 6.4.4.3 Coastal Tailed Frogs: It appears no targeted surveys were conducted for Coastal Tailed Frog in Chapman Creek downstream of the Chapman Lake dam. Although not described in this report, we assume that mitigation will be designed and implemented for fish during construction at the dam outlet and immediately downstream (i.e. isolation of construction areas and salvage of fish). These mitigation measures for fish should be adapted to also protect Coastal Tailed Frog (e.g. survey efforts and methods designed to salvage tailed frog tadpoles).
21. Section 6.5.1.1 (p. 76) includes the following statement: "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." This statement does not acknowledge likely impacts of sediment release on aquatic life (fish, invertebrates, Coastal Tailed Frogs) in Chapman Creek. Prevention of any sediment releases should be a priority for environmental management during construction.
22. Section 6.5.2.1 (p. 78-79) discusses de-stratification of the water column (and associated changes in temperature and dissolved oxygen) as a potential impact of full draw down to -8 m during construction. A slow rate of drawdown is presented as a measure to prevent de-stratification. De-stratification presumably could also occur during operation, especially during large drawdown events or if drawdown occurs quickly. Impacts of drawdown on stratification, temperature, and dissolved oxygen should be closely monitored during construction to help understand potential impacts and design mitigation for operation including measures to prevent rapid drawdown.
23. Section 6.5.2.2 (p. 80) states that the proposed 2 m plunge pool will prevent impacts to fish that drop 8 m from dam crest to the channel below. A fisheries biologist from FLNRO consulted during our review made additional suggestions regarding design of the plunge pool:

- Engineer the pool with the objective that fish enter and exit the pool safely;
- Design the pool so that fish are easily directed into the deepest part of the plunge pool and are not bouncing off of the bedrock
- Size and locate pool so that it contains refuge areas for fish to recover after their fall.

24. Section 6.5.2.2 (p. 80) states that intakes of the new pipe will be fitted with a trash screen with 25 mm openings, and concludes that there is a low risk of fish being negatively affected by use of this screen. Is it feasible to have a screen with hole sizes smaller than 25 mm to reduce the risk as much as possible? If it is not feasible and a 25 mm screen is used, the passage of fish through the intake pipe should be monitored. If a problem is detected (e.g. too many fish passing through the pipe into the creek below), then adaptive management procedures should be applied.

25. Section 7.0 (p. 85-86) describes the Environmental Management Plans (EMPs) that will be developed for the construction and operation phases. These plans will need to be developed in detail in advance of construction/operation, and BC Parks will require review and approval of these plans as part of the Park Use Permit. The construction plan will need to include mitigation measures as listed in Section 7.0, but some additional mitigation not listed in Section 7.0 needs to be added to the plans. This includes prevention and management of invasive plants, fuel and spill management, archaeological resource management, and socio-cultural impact management.

26. Given that the rock sample used for determining the potential for Acid Rock Drainage and Metal Leaching was weathered, the recommendations regarding further testing in Section 7.0 (p. 85-86) should be implemented.

27. Under 'Air Quality' in Table 28 (p. 88) 'apply dust suppression' is listed as a mitigation measure. Please provide details on what product would be used and if the proposed product poses any risks to environmental values or water quality.

28. Monitoring (sections including 6.5.2.4 [p. 81-82] and 7.0 [operation EMP, p. 86]): Monitoring for effects on key values during construction and operation is proposed several times in the Chapman Lake EA. We support these recommendations. A detailed monitoring plan will need to be developed prior to construction, and BC Parks will require review and approval of these plans as part of the Park Use Permit. As stated previously in these comments, the future frequency, extent and duration of drawdowns are uncertain, which means residual effects are also uncertain. Monitoring will allow for testing of assumptions regarding residual effects, detection of negative impacts, and implementation of mitigation and adaptive management to reduce negative impacts. Key effects and values to be monitored include:
    - Dolly Varden: spawning timing and access; population condition; tissue sampling; changes to habitat quality and quantity
    - Effects of drawdown on the water table and wetlands, including wetland vegetation (Sitka sedge/peat mosses [Fen]) and amphibians
    - Water and sediment quality, including monitoring for sloughing of exposed sediments
    - Aquatic vegetation

29. Also related to monitoring, it is not clear that the data collected in 2016 is suitable and sufficient to allow for future comparative monitoring relative to pre-construction conditions. For example, sampling of aquatic vegetation as described in Section 5.3.5 (p. 55-56) is qualitative. Qualitative assessments tend to be hard to repeat and detect only major changes. Monitoring must be designed to be quantitative and repeatable to allow for detection of changes during operation. Using the aquatic vegetation example, long-term monitoring of cover and species composition on transects or plots would provide quantitative data. Monitoring during the construction year must be designed to provide data that can be used for the long-term monitoring plan.

BRITISH COLUMBIA | Ministry of Environment

Land Use / Occupancy Park Use Permit Application

Only applications that are considered by BC Parks to be compatible with the conservation and recreation objectives identified for the park(s), protected area(s), conservancy(ies) and recreation area(s) (collectively 'parks') involved in the proposal will be evaluated.

All applications must include completed application form, map, attachments (as indicated below) and non-refundable application fee (plus applicable taxes). Please make payment by VISA/MasterCard/American Express or by cheque, made payable to the Minister of Finance.

INFORMATION REGARDING APPLYING FOR A PARK USE PERMIT AVAILABLE AT:
http://www.frontcounterbc.gov.bc.ca/Start/parks/

Application Type:

- ☐ New
- ☐ Renewal (Authorization #) _____
- ☒ Amendment (Authorization #) __102714__

Requested Period of Use (inclusive): From 08/09/2017 (mm/dd/yy) to 11/30/2018 (mm/dd/yy)

PART 1. NAME(S) AND MAILING ADDRESS

Applicant Name:

FULL LEGAL NAME of Individual(s), Company or Society, Ministry or Government Agency:

_SUNSHINE COAST REGIONAL DISTRICT_____

Contact Name for Company or Ministry Applicants: Michael Day, P.Eng_____

☐ **BC Incorporation** ☐ **BC Registration** ☐ ***Society Act*** #_____

Age: 19 or over ☒ Yes ☐ No

Legal Mailing Address:

1975 Field Road

City/Town: Sechelt

Province: BC Postal code: V0N 3A1

Contact Information:

Daytime Phone: 604 885 6810

Cell: s.16

Fax:

Email Address: Michael.Day@scrd.ca

Billing Address (if different from legal mailing add.):

City/Town:

Province: Postal code:

Contact Information:

Daytime Phone:

Cell:

Fax:

Email Address:

Preferred method of contact: ☐ Phone ☐ Cell Phone ☐ Regular mail ☒ Email

Do you hold a Crown Land Tenure: ☐Yes ☐No **If yes, provide file number(s):**_____	**Have you previously held a Park Use Permit or Resource Use Permit:** ☐Yes ☐No **If yes, provide file number(s):** _____

PART 2: PURPOSE, LOCATION, AREA

Name of Park(s):
Tetrehedron Provincial Park

Purpose (Summary of Proposed Activity):
Please select all that apply

- ☐ Aquaculture and mariculture
- ☐ Alternative power project
- ☐ Grazing
- ☐ Meteorological or hydrological station
- ☐ Seismic and gravity station
- ☐ Navigation Aid
- ☐ Trapping
  - ☐ Trapline cabin
- ☐ Forestry Activities
- ☐ Mining, sand and gravel quarry
- ☐ Restoration/habitat enhancement project
- ☐ Roads and Trails
- ☐ Rights-of-way
- ☐ Privately owned structure
  - ☐ Cabin
  - ☐ Private moorage
  - ☐ Other: _____
- ☐ Provincially owned structure
- ☐ Communication sites
- ☐ Hydro transmission/distribution lines
- ☐ Pipelines (gas or oil)
- ☐ Telephone Booths
- ☐ Telephone lines
- ☒ Water impoundment (dam or dyke)
- ☒ Waterline/sewer

Location of Proposed Activities:

1) Is the activity proposed for any frontcountry* areas? ☐Yes ☒No

*"Frontcountry" means an area within one kilometre of either side of the centreline of a park road or a highway.

2) Are the activities selected above the same for all parks listed on the application? ☒Yes ☐No

If 'No', please indicate which park(s) each activity is proposed for (if not enough space, please provide an attachment):

PART 3: DETAILED PROPOSAL

Please attach a detailed proposal description that addresses the following (A-D):

A. Please describe the proposed activity and provide the following information:

a) Purpose of the land use or occupancy;
b) Details of the existing uses, vegetation cover, wildlife present, water resources, geology, and historical/cultural significance of the proposed site and adjacent area;
c) Location and size of all proposed and current improvements (facilities/structures);
d) If applicable, details of the physical changes to the site that would be required to meet the needs of the proposal and the proposed mitigation of such changes;
e) Construction schedule (if applicable) for proposed new permanent and/or temporary facilities;
f) Photographs of the site and area adjacent to the proposed land use/occupancy;
g) Proposed site and adjacent area description and mapping in terms of its current legal status;
h) Type of transportation and access route to the proposed site(s); and
i) The initial 5 year operational plan related to this proposal.

B. List all experiences of the applicant and/or others involved in this proposal in previous park use permits including the name, number, date and location of the permit(s).

C. Describe expected or potential impacts on the park' environmental, cultural, recreational values changes including, but not limited to:

a) Habitat for vegetation and wildlife, particularly listed species or species at risk;
b) Any watercourses or water bodies (diversions, flows, potential siltation, etc.)
c) Special features such as unique geological formations;
d) Access to the park, and the area of the park under consideration;
e) aesthetics and visual values;
f) Cultural values, including traditional use of the area by First Nations;
g) Park visitors and local communities, including public health and safety and recreational use or enjoyment of the park;

and actions that will be taken to mitigate identified impacts on the park(s).

D. Provide maps of the proposed application area, including (if required):

a) General Location Map: A map(s) of the individual protected areas within the application, drawn to 1:50 000 to 1:250 000 (or larger if required to encompass boundaries of permit area) scale that illustrates at a landscape level scale the general location of the area under application, including boundaries of the proposed permit area and major landmarks, travel/access routes.

b) Permit Area Map: Where the land use/occupancy utilizes improvements or structures, a more detailed map(s) of the proposed permit area(s) within each park, drawn to 1:20 000 to 1:50 000 scale showing the exact proposed boundaries of the permit area, including the area (in hectares) as well as any watercourses or other identifying features (trails, facilities, roads, etc.). The permit area map must clearly identify the location of travel/access routes, and specific activity site(s). If applicable, the location and construction description of any temporary facilities or the use of existing facilities within the permit area, as well as the location and size of all proposed improvements must also be included.

c) Detailed Site Map: Where the operation proposes to use any existing or to construct any new improvements, a detailed site map at 1:1 000 to 1:5 000 scale must be submitted identifying the location of all improvements (buildings, structures, roads, power lines, fences, docks, etc.) in relation to the boundaries of the permit area.

PART 4: APPLICATION CERTIFICATION

All applications must be complete. Incomplete applications will not be processed until information is submitted.
All of the following must be attached to or enclosed with this application form:

- **completed application form, including attached management plan;**
- **map(s) to standards detailed in application requirements;**
- **attachments as indicated below; and**
- **non-refundable application fee (plus applicable taxes).**

Upon submission of a complete application and application fee, allow 140 days to evaluate proposals. Applications requiring additional steps, or supplying insufficient information may delay evaluation. BC Parks reserves the right to deny any application. The information you provide will be subject to the *Freedom of Information and Protection of Privacy Act*. The submission of this form does not in any manner convey any rights to use or occupy land within a park, protected area, recreation area or conservancy.

- Businesses must either be licensed to do business in BC, or if licensed/incorporated outside of British Columbia (considered to be 'extra-provincial companies') must be in compliance with section 375 of the *Business Corporations Act* to operate in British Columbia.
- Extraprovincial societies must be registered under the *Society Act* in British Columbia in order to hold a park use permit or resource use permit. An extraprovincial society is a society or association formed outside British Columbia, and includes a branch of that society or association.

Additional costs and requirements:

Upon evaluation of the proposal it may be determined that additional costs and requirements must be provided prior to issuance of the permit, such as financial guarantees, or survey and inspection costs (as per Section 21 of the *Park Act*).

Commercial General Liability (CGL) insurance in the amount of $2 million per occurrence may be required as a minimum for parks, protected areas, conservancies and recreation areas. Applications will be assessed to determine whether additional types of insurance, such as aviation liability or marine liability, may also be required.

Additional information on insurance is available at
http://www.env.gov.bc.ca/pasb/applications/process/park_use.html#insurance

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THE APPLICANT HEREBY CERTIFIES THAT ALL THE INFORMATION PROVIDED IN THIS APPLICATION IS TRUE AND CORRECT.

Signature of Applicant or Authorized Signatory of Applicant: _____

Date: 2017-08-09

Interest will be charge on all overdue accounts, the interest rate charged is 3% + the prime lending rate of the principal banker to the Province as established each 3 month quarter starting Oct 1st.

Send completed application and proposal description to:
Ministry of Forests, Lands, and Natural Resource Operations
FrontCounter BC

For additional information on how or where to submit your application, please call the FrontCounter BC Contact Centre or visit the website to determine an office nearest you:

Call FrontCounter BC toll free at:**1-877-855-3222**
FrontCounter BC Website: http://www.frontcounterbc.ca/locations/index.html

PLEASE RETAIN A COPY OF THIS APPLICATION FOR YOUR RECORDS

First Nations Consultations

Consulting with First Nations

The Province of British Columbia's legal duty to consult with First Nations arises from section 35 of the *Canadian Constitution Act*, which recognizes and affirms aboriginal and treaty rights. The duty to consultarises when the Crown has knowledge, real or constructive, of the potential existence of the Aboriginal right or title and contemplates conduct that might adversely affect it. Consultation with First Nations will be guided by principles of good faith, and meaningful dialogue with the intent to fully understand the nature and scope of the aboriginal right, the potential to adversely affect that aboriginal right, and address those potential impacts to an aboriginal right while balancing societal interests.

Agreements with First Nations

In many locations, the Province has agreements with First Nations. These agreements may be referred to as Collaborative Management Agreements, Reconciliation Protocol Agreements, Memorandum of Understanding or simply Working Agreements. In some cases the Province and Canada have entered into a treaty with a First Nation, which contains certain provisions regarding treaty rights within parks and protected areas. Modern treaties contain provisions to address those treaty rights in the management of parks and protected areas where a treaty right exists.

These agreements apply to a variety of parks and protected areas and conservancies and include obligations by the Province to discuss operational delivery of programs in addition to information associated with applications for park use permits with a First Nation. These discussions provide the First Nation and the Province with an opportunity to raise any questions or concerns associated with a park use permit application and/or the proposed activity in relation to aboriginal rights or title.

Important Considerations for Park Use Permit Applications

Applicants for park use permits should be aware of the Province's consultation obligations with First Nations and associated time requirements to seek meaningful consultation. There may be occasions when BC Parks may require additional, detailed information to allow for the necessary review of an application. It is important that applicants provide the necessary, detailed information as requested on the application form in order to avoid a longer than anticipated period of time to evaluate the application.

Licence Number: C050724
Dist/Prec: 29C VAN - HOWE SOUND
Region: 02 LOWER MAINLAND
Licence Status: C
Process Status: N/A
Lic. Exp. Date: -

File Number: 0309244
Priority Date: 1967/07/13
Lic. Status Date: 1991/05/28
Proc Status Date: -
Balance Owed: 0.00

Appurtenancy:
STOR FOR C 69217 16599 22345 & 107474 ALL ON CHAPMAN CREEK

Licensee No. 1 (Client Last Updated: 1996/07/25 By Region: 00)
Client No: s.17
SUNSHINE COAST REGIONAL DISTRICT
PO BOX 800
SECHELT BC
V0N3A0

Work Phone: ----------
Home Phone: ----------
Other Phone: ----------
Receives Bill: Y

Permits Over Crown Land:

PCL No	PCL Code	Description	Acres	Billed With Lic
11586	06A	DAMS	1.000	Y
11586	06B	PCL	8.000	Y

Total Licence Demand:

PUC	Description	Quantity/Units	From	To	Irrigated Area
08A	STONP	735.000 AF	Jan.01	Dec.31	-

Licence Comments:
STOR IN CHAPMAN LK

POD 1:
Map No: WR 92.G.052
POD: AA
Rediv: N

PUC	Description	Quantity/Units	Qty	Sto	From	To	Irrigated Area
08A	STONP	735.000 A	T		Jan.01	Dec.31	-

POD Comments:
WSC: 900
Source: Chapman Creek
Gaz/Alias: G

Province of
British Columbia
MINISTRY OF
ENVIRONMENT,
LANDS AND PARKS

BC Environment
LOWER MAINLAND REGION

10334 — 152 A Street
Surrey
British Columbia
V3R 7P8
Telephone: (604) 582-5200
Facsimile: (604) 660-6926

File: 0309244

May 16, 1994

Sunshine Coast Regional District
PO Box 800
Sechelt, BC V0N 3A0

Dear Sirs:

Re: Conditional Water Licence 50724

For reasons set out in the enclosed Order, the Assistant Regional Water Manager has deemed it appropriate to amend the above licence.

This new documentation should be attached to your copy of the licence.

The Water Act provides for the appeal of any decision made by an engineer appointed under the Act. Your right of appeal to this decision lies to the Comptroller of Water Rights, Parliament Buildings, Victoria, B.C. V8V 1X4, and must be made within 30 days of the date your licence was issued. Reasons for the appeal must be included with your letter of appeal.

Yours truly,

Robert A. Edwards, P. Eng.
Assistant Regional Water Manager
Lower Mainland Region

Enclosure

c.c. Comptroller of Water Rights

Province of
British Columbia
MINISTRY OF
ENVIRONMENT,
LANDS AND PARKS

BC Environment
LOWER MAINLAND REGION

10334 — 152 A Street
Surrey
British Columbia
V3R 7P8
Telephone: (604) 582-5200
Facsimile: (604) 660-6928

ORDER

WATER ACT

Section 15

File No. 0309244

In the matter of Conditional Water Licence 50724, which authorizes the storage of water from Chapman Creek and the reservoir is Chapman Lake.

Having determined that Conditional Licences 11728 and 50723 have been amended, and being satisfied that no persons rights will be injuriously affected, I hereby amend Clauses (d) and (g) of the said licence to read as follows:

(d) The purpose for which the water is to be used is set out in Conditional Licences 69217, 16599, 22345 and 107474, or any licences issued in substitution thereof.

(g) The land upon which the water is to be used and to which this licence is appurtenant is as set out in Conditional Licences 69217, 16599, 22345 and 107474, or any licences issued in substitution thereof.

Dated at Surrey, British Columbia, this 16th day of May, 1994.

Robert A. Edwards, P. Eng.
Assistant Regional Water Manager

WATER RESOURCES SERVICE
WATER RIGHTS BRANCH
MAILING ADDRESS:
COMPTROLLER OF WATER RIGHTS
PARLIAMENT BUILDINGS
VICTORIA, B.C. V8V 1X5

WHEN REPLYING PLEASE QUOTE FILE NO. 0309244

DEPARTMENT OF ENVIRONMENT

14th October, 1976.

Sunshine Coast Regional District,
Box 600,
Sechelt, B. C.

Dear Sirs:

Water application on Chapman Creek (storage in Chapman Lake)

Your water application on the above-named source has been investigated and we are now preparing two licence/s authorizing:

(1) the diversion and use of 1,000,000 gallons a day of water for waterworks purpose on lands within the District boundaries.

(2) the storage of 735 acre feet a year of water in support of the diversion licence.

S. C. R. D.
OCT 19 1976
RECEIVED

A copy of the licence/s will be forwarded when ready.

Yours truly,

H.D. DeBeck,
Comptroller of Water Rights.

Per: FWF

FWF/ht

Province of
British Columbia

Ministry of the
Environment

Water Rights Branch
Parliament Buildings
Victoria
British Columbia
V8V 1X5

S. C. R. D.
OCT 12 '78
RECEIVED

Sunshine Coast Regional District
Box 800
Sechelt, B.C.
VON 3AO

Our file: 0309244

5th October, 1978

Enclosed please find certified copies of ~~PERMIT~~/Conditional Water Licence No. 50723 and 50724.

A copy of Permit over Crown Land No. 11586 is also enclosed.

Any error in the licence or permit should be brought to my attention immediately.

The 1st annual rental for the licence is $20.90 & $2. and for the Permit over Crown Land is $12.00 . These rentals are paid up to the , and subsequent rentals are due and payable in January of each year, at which time you will receive a statement.

Please remit $21.00, which is the balance owing for 1978 rentals. + app fee (storage)

Water licences do not authorize entry on privately owned land for the construction of works. Consent of the owner must be secured or a right-of-way expropriated. Consent should be in proper form and registered in the Land Registry Office.

Permission for crossing roads or lands under the jurisdiction of any Government Department must be obtained from the Department concerned.

In order to keep a water licence in good standing the following must be observed:

(a) Continued beneficial use of the water, as authorized.
(b) Payment of annual rentals.
(c) Compliance with the terms of the licence.
(d) Compliance with terms of the Water Act.

IMPORTANT: In order to protect your interests kindly notify the Comptroller of Water Rights if:

- any change is made in your mailing address.
- you sell the land to which the licence is appurtenant.
- you propose to subdivide the land to which the licence is appurtenant.
- you propose to alter the works authorized under the licence.

Comptroller of Water Rights.

Encl.

W.R.B. 21

British Columbia

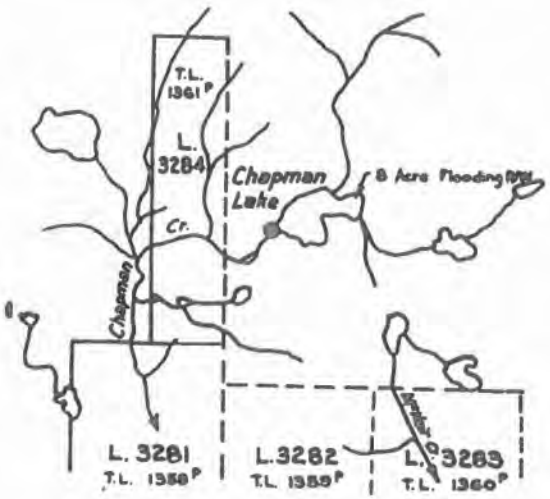
VANCOUVER WATER DISTRICT

G.1, NEW WESTMINSTER DISTRICT

Scale: 80 Chains to 1 Inch

N

TRUE NORTH



LEGEND

Dam ○

Ref. Map 92G/NW (B-3)

Right of Way ●

Signature

Date 1st Aug. 1978

C.L. 50724

File 0309244

R/W Permit No. 11586

Howe Sound Precinct

For Diversion see C.L.'s 11728, 16599, 22345 & 50723

PROVINCE OF BRITISH COLUMBIA

MINISTRY OF THE ENVIRONMENT

PERMIT UNDER THE WATER ACT AUTHORIZING THE OCCUPATION OF CROWN LAND

Sunshine Coast Regional District of Box 800, Sechelt, B.C. V0N 3A0

the holder(s) of Conditional/~~Final~~ Water Licence(s) 50724 authorizing the ~~diversion and use~~ storage of water in Chapman Lake is/are hereby flooding and

authorized to occupy Crown land by constructing, maintaining, and operating thereon the works authorized under the said water licence and any licences which may be issued in substitution thereof.

(*a*) The Crown land which is authorized to be occupied under this permit is a portion of unsurveyed land, Group 1 New Westminster District,

the location of which is shown approximately on the plan attached to the said water licence.

(*b*) The approximate dimensions of the Crown land authorized to be occupied under this permit are

(1) damsite	1 acre
(2) flooded	8 acres
total area	9 acres

(*c*) Subject to the payment of royalty, stumpage, and other compensation, and the obtaining of a licence to cut timber as provided under Condition 5, the permittee may cut and remove from the said land any timber, the removal of which is necessary to permit construction and maintenance of the said works, and clearing of the said land which may be flooded.

(*d*) The annual rental for this permit is $12,00, which is subject to review and revision at any time at the discretion of the Crown.

(*e*) This permit is appurtenant to the land, mine, or undertaking to which the aforesaid water licence is appurtenant.

(*f*) The conditions relative to the rights granted under this permit are printed on the back of this form.

W.R. Redel
Assistant Deputy Minister of the Environment
Land and Water Management

File No. 0309244

Ref. Map 92G/NW(B-3)

W. R. Map ----- Date issued: 1st August,1978 Permit No. 11586

I HEREBY CERTIFY THIS TO BE A TRUE COPY OF A DOCUMENT ON RECORD IN THE WATER RIGHTS BRANCH

W.R.B. 12—5M-477-8133

COMPTROLLER OF WATER RIGHTS

LAND AND WATER MANAGEMENT
WATER RIGHTS BRANCH

MINISTRY OF THE ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sunshine Coast Regional District of Box 800, Sechelt, B.C. VON 3AO

is/are hereby authorized to store water as follows:—

(a) The source(s) of the water-supply is/are Chapman Creek and the reservoir is Chapman Lake.

(b) The point(s) of storage is/are located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 18th July, 1974.

(d) The purpose for which the water is to be used is as set out in Conditional Licences 11728, 16599, 22345 and 50723.

(e) The maximum quantity of water which may be stored is 735 acre feet per annum, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f) The period of the year during which the water may be stored is the whole year.

(g) The land upon which the water is to be used and to which this licence is appurtenant is as set out in Conditional Licences 11728, 16599, 22345 and 50723.

(h) The works authorized to be constructed are dam, which shall be located approximately as shown on the attached plan.

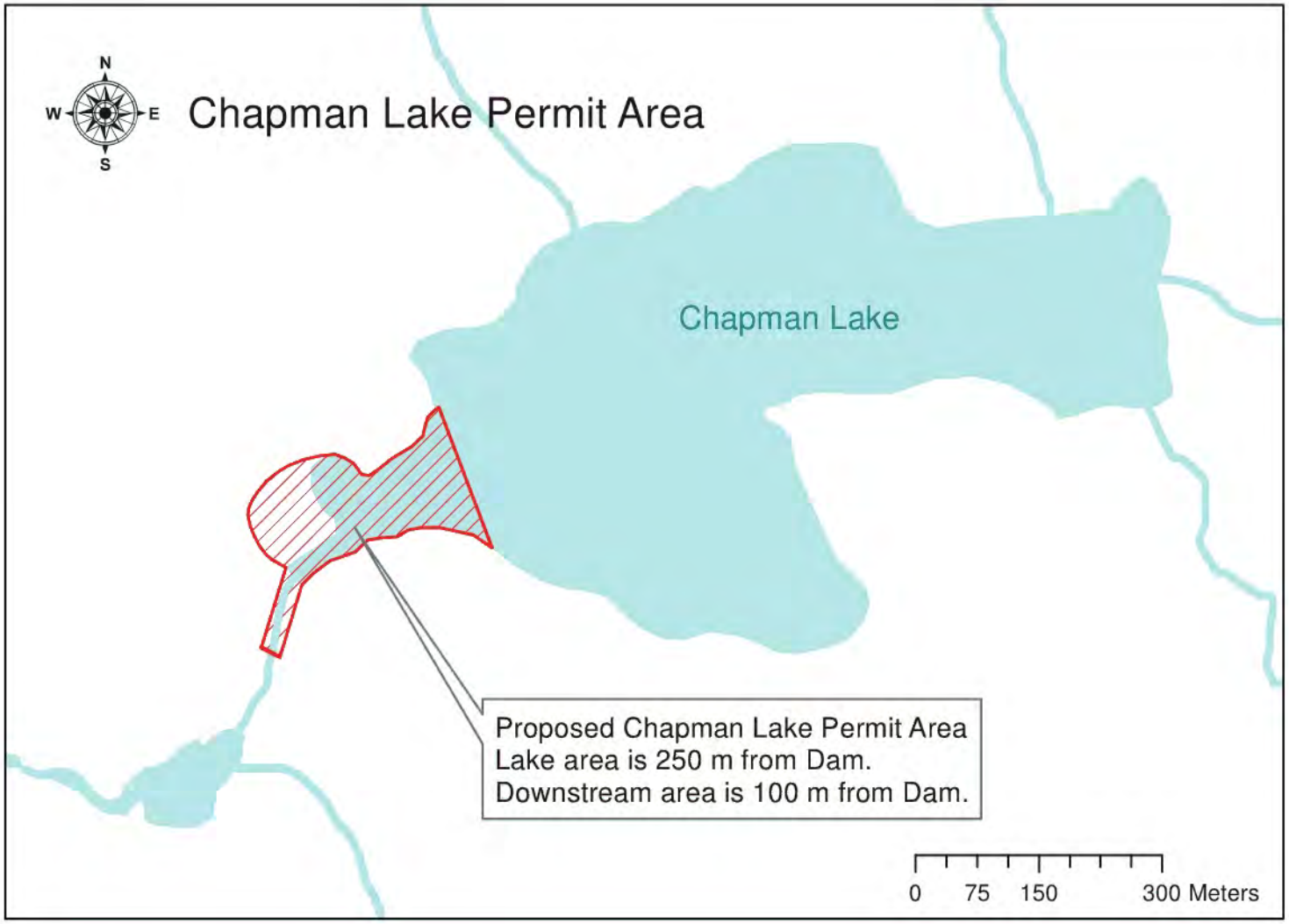
(i) The construction of the said works shall be commenced on or before the 28th day of February, 1979, and shall be completed and the water beneficially used on or before the 31st day of December, 1990..

(j) The rights granted under this licence are subject to a reserve established by Order in Council No. 2277/1967.

(k) The Engineer for the Vancouver Water District may at any time, by an Order in writing, order the release of water from Chapman Lake in order to maintain a minimum flow in Chapman Creek for the preservation of fish life.

H. D. DeBeck,
Comptroller of Water Rights.

File No. 0309244 Date issued: 1st August, 1978 Conditional Licence No. 50724


N
W
E
S
Chapman Lake Permit Area
Chapman Lake
Proposed Chapman Lake Permit Area
Lake area is 250 m from Dam.
Downstream area is 100 m from Dam.
0
75
150
300 Meters

Sunshine Coast Regional District
1975 Field Road
Sechelt, British Columbia
Canada V0N 3A1
P 604.885.6800
F 604.885.7909
Toll free 1.800.687.5753
info@scrd.ca
www.scrd.ca

January 10, 2017

Ministry of Environment
PASB – Park Use Permits
PO Box 9371 Stn Prov Govt
Victoria, BC V8W 9M3
Fax: 250-387-1695

Re: Annual Reporting for Park Use Permit # 102714 (2016)

As a requirement of the Sunshine Coast Regional Districts Park Use Permit (#102714), please see the enclosed Park Use Activity Report for a summary of activities in 2016.

Work completed in the Tetrahedron included valve work at the Edwards Lake control, snow surveys, initial phase of the weather station installation, and an environmental assessment completed by AECOM for the Chapman Lake Supply Expansion Project.

If you have any questions in regards to the information provided the attached report, please contact the undersigned.

Yours Truly,

Lynda Fyfe

Lynda Fyfe, RB Tech
Environmental Technician, Infrastructure Services
SUNSHINE COAST REGIONAL DISTRICT
604-885-6800

Sunshine Coast Regional District
1975 Field Road
Sechelt, British Columbia
Canada V0N 3A1
P 604.885.6800
F 604.885.7909
Toll free 1.800.687.5753
info@scrd.ca
www.scrd.ca

Sunshine Coast Regional District - Tetrahedron Park Use Activity Report

Prepared by: Lynda Fyfe

Year: 2016

Permit no.: 102714

Transportation: Airspan Helicopters

Date	Flight Hours	Location	Activities
3/4/2016	0.7	Chapman Lake, Edwards Lake	Snow surveys
4/4/2016	0.7	Chapman Lake, Edwards Lake	Snow surveys
5/12/2016	0.8	Chapman Lake	Lake control
8/4/2016	0.6	Chapman Lake, Edwards Lake	Lake controls
8/11/2016	1.4	Chapman Lake	SCRD Chapman Lake Project – AECOM environmental assessment?
8/23/2016	1.5	Chapman Lake, Edwards Lake	SCRD Chapman Lake Project – AECOM environmental assessment?
8/24/2016	1.2	Chapman Lake	SCRD Chapman Lake Project – AECOM environmental assessment?
8/25/2016	0.9	Chapman Lake	SCRD Chapman Lake Project – AECOM environmental assessment?
8/30/2016	1.3	Edwards Lake	Lake control valve work
9/8/2016	2.6	Above Chapman Lake	Tetrahedron weather station installation
9/12/2016	0.7	Edwards Lake	Lake control valve work
9/13/2016	1.3	Edwards Lake	Lake control valve work
9/15/2016	0.6	Edwards Lake	Lake control valve work
9/20/2016	0.7	Chapman Lake, Edwards Lake	WHO/WHY? – signed by Bryan
10/6/2016	0.6	Edwards Lake	Lake control upgrade
10/28/2016	0.8	Chapman Lake, Edwards Lake	Chapman Lake, Edwards Lake – lake controls, Chapman Lake – snow survey course locate

BRITISH COLUMBIA | Ministry of Environment

Land Use / Occupancy Park Use Permit Application

Only applications that are considered by BC Parks to be compatible with the conservation and recreation objectives identified for the park(s), protected area(s), conservancy(ies) and recreation area(s) (collectively 'parks') involved in the proposal will be evaluated.

All applications must include completed application form, map, attachments (as indicated below) and non-refundable application fee (plus applicable taxes). Please make payment by VISA/MasterCard/American Express or by cheque, made payable to the Minister of Finance.

INFORMATION REGARDING APPLYING FOR A PARK USE PERMIT AVAILABLE AT:
http://www.frontcounterbc.ca/index.html

Application Type:

- ☐ New
- ☐ Renewal (Authorization #) _____ Are you requesting changes to your authorization? ☐ Yes ☐ No
- ☒ Amendment (Authorization #) _____

If you are requesting changes to your authorization, please clearly indicate the changes under **Part 2: List of Proposed Changes**.

Requested Period of Use (inclusive): From 08/24/2015 (mm/dd/yy) to 08/24/2017 (mm/dd/yy)

PART 1. NAME(S) AND MAILING ADDRESS

Applicant Name:

FULL LEGAL NAME (ENTITY):
Sunshine Coast Regional District

Contact Name(s): Monte Staats **Age:** 19 or over ☒ Yes ☐ No

☐ **BC Incorporation #**_____ ☐ **BC Registration #**_____ ☐ ***Society Act #***_____

- ☐ Individual(s)
- ☐ Company
- ☐ Registered Society or Association
- ☐ Federal Government
- ☐ Provincial Government
- ☒ Municipal Government/Regional District
- ☐ First Nation/Indian Band
- ☐ University, College or Museum
- ☐ Private School or Public School (K-12)

Legal Mailing Address:
1975 Field Rd.

City/Town: Sechelt
Province: BC Postal code: V0N 3A1

Contact Information:
Daytime Phone: 604 885 6800
Cell: s.16
Fax:
Email Address: monte.staats@scrd.ca

Billing Address (if different from legal mailing add.):

City/Town:
Province: Postal code:

Contact Information:
Daytime Phone:
Cell:
Fax:
Email Address:

Preferred method of contact: ☐ Phone ☐ Cell Phone ☐ Regular mail ☒ Email

Do you hold a Crown Land Tenure: ☐Yes ☐No	Have you previously held a Park Use Permit or Resource Use Permit: ☒Yes ☐No
If yes, provide file number(s): _____	If yes, provide file number(s): 102714

PART 2: PURPOSE, LOCATION, AREA

Name of Park(s):

Tetrahedron Provincial Park

Purpose (Summary of Proposed Activity:
Please select all that apply

- ☐ Aquaculture and mariculture
- ☐ Alternative power project
- ☐ Grazing
- ☐ Meteorological or hydrological station
- ☐ Seismic and gravity station
- ☐ Navigation Aid
- ☐ Trapping
  - ☐ Trapline cabin
- ☐ Forestry Activities
- ☐ Mining, sand and gravel quarry
- ☐ Restoration/habitat enhancement project
- ☐ Roads and Trails
- ☐ Rights-of-way
- ☐ Privately owned structure
  - ☐ Cabin
  - ☐ Private moorage
  - ☐ Other: _____
- ☐ Provincially owned structure
- ☐ Communication sites
- ☐ Hydro transmission/distribution lines
- ☐ Pipelines (gas or oil)
- ☐ Telephone Booths
- ☐ Telephone lines
- ☐ Water impoundment (dam or dyke)
- ☒ Waterline/sewer

Location of Proposed Activities:

1) Is the activity proposed for any frontcountry* areas? ☐Yes ☒No

***"Frontcountry" means an area within one kilometre of either side of the centreline of a park road or a highway.

2) Are the activities selected above the same for all parks listed on the application? ☒Yes ☐No

***If 'No', please indicate which park(s) each activity is proposed for (if not enough space, please provide an attachment):

List of Proposed Changes (Renewal and/or Amendment Application Types):

- Increase Permit Area at Chapman Lake (refer to attached Map)

PART 3: DETAILED PROPOSAL

Please attach a detailed proposal description that addresses the following (A-D):

A. Please describe the proposed activity and provide the following information:

a) Purpose of the land use or occupancy;
b) Details of the existing uses, vegetation cover, wildlife present, water resources, geology, and historical/cultural significance of the proposed site and adjacent area;
c) Location and size of all proposed and current improvements (facilities/structures);
d) If applicable, details of the physical changes to the site that would be required to meet the needs of the proposal and the proposed mitigation of such changes;
e) Construction schedule (if applicable) for proposed new permanent and/or temporary facilities;
f) Photographs of the site and area adjacent to the proposed land use/occupancy;
g) Proposed site and adjacent area description and mapping in terms of its current legal status;
h) Type of transportation and access route to the proposed site(s); and
i) The initial 5 year operational plan related to this proposal.

B. List all experiences of the applicant and/or others involved in this proposal in previous park use permits including the name, number, date and location of the permit(s).

C. Describe expected or potential impacts on the park' environmental, cultural, recreational values changes including, but not limited to:

a) Habitat for vegetation and wildlife, particularly listed species or species at risk;
b) Any watercourses or water bodies (diversions, flows, potential siltation, etc.)
c) Special features such as unique geological formations;
d) Access to the park, and the area of the park under consideration;
e) aesthetics and visual values;
f) Cultural values, including traditional use of the area by First Nations;
g) Park visitors and local communities, including public health and safety and recreational use or enjoyment of the park; and
h) Actions that will be taken to mitigate identified impacts on the park(s).

D. Provide maps of the proposed application area, including (if required):

a) General Location Map: A map(s) of the individual protected areas within the application, drawn to 1:50 000 to 1:250 000 (or larger if required to encompass boundaries of permit area) scale that illustrates at a landscape level scale the general location of the area under application, including boundaries of the proposed permit area and major landmarks, travel/access routes.

b) Permit Area Map: Where the land use/occupancy utilizes improvements or structures, a more detailed map(s) of the proposed permit area(s) within each park, drawn to 1:20 000 to 1:50 000 scale showing the exact proposed boundaries of the permit area, including the area (in hectares) as well as any watercourses or other identifying features (trails, facilities, roads, etc.). The permit area map must clearly identify the location of travel/access routes, and specific activity site(s). If applicable, the location and construction description of any temporary facilities or the use of existing facilities within the permit area, as well as the location and size of all proposed improvements must also be included.

c) Detailed Site Map: Where the operation proposes to use any existing or to construct any new improvements, a detailed site map at 1:1 000 to 1:5 000 scale must be submitted identifying the location of all improvements (buildings, structures, roads, power lines, fences, docks, etc.) in relation to the boundaries of the permit area.

PART 4: APPLICATION CERTIFICATION

All applications must be complete. Incomplete applications will not be processed until information is submitted.
All of the following must be attached to or enclosed with this application form:

- **completed application form, including attached management plan;**
- **map(s) to standards detailed in application requirements;**
- **attachments as indicated below; and**
- **non-refundable application fee (plus applicable taxes).**

Upon submission of a complete application and application fee, allow 140 days to evaluate proposals. Applications requiring additional steps, or supplying insufficient information may delay evaluation. BC Parks reserves the right to deny any application. The information you provide will be subject to the *Freedom of Information and Protection of Privacy Act*. The submission of this form does not in any manner convey any rights to use or occupy land within a park, protected area, recreation area or conservancy.

- Businesses must either be licensed to do business in BC, or if licensed/incorporated outside of British Columbia (considered to be 'extra-provincial companies') must be in compliance with section 375 of the *Business Corporations Act* to operate in British Columbia.
- Extraprovincial societies must be registered under the *Society Act* in British Columbia in order to hold a park use permit or resource use permit. An extraprovincial society is a society or association formed outside British Columbia, and includes a branch of that society or association.

Additional costs and requirements:

Upon evaluation of the proposal it may be determined that additional costs and requirements must be provided prior to issuance of the permit, such as financial guarantees, or survey and inspection costs (as per Section 21 of the *Park Act*).

Commercial General Liability (CGL) insurance in the amount of $2 million per occurrence may be required as a minimum for in parks, protected areas, conservancies and recreation areas. Applications will be assessed to determine whether additional types of insurance, such as aviation liability or marine liability, may also be required. Insurers must be licensed to do business in British Columbia or Canada.

Additional information on insurance is available at
http://www.env.gov.bc.ca/pasb/applications/process/park_use.html#insurance

THE APPLICANT HEREBY CERTIFIES THAT ALL THE INFORMATION PROVIDED IN THIS APPLICATION IS TRUE AND CORRECT.

Signature of Applicant or Authorized Signatory of Applicant: _____

Date: August 19, 2015

Interest will be charge on all overdue accounts, the interest rate charged is 3% + the prime lending rate of the principal banker to the Province as established each 3 month quarter starting Oct 1st.

Send completed application and proposal description to:

Ministry of Forests, Lands,
and Natural Resource Operations
FrontCounter BC

For additional information on how or where to submit your application, please call the FrontCounter BC Contact Centre or visit the website to determine an office nearest you:

Call FrontCounter BC toll free at: **1-877-855-3222**
FrontCounter BC Website: http://www.frontcounterbc.ca/locations/index.html

PLEASE RETAIN A COPY OF THIS APPLICATION FOR YOUR RECORDS

First Nations Consultations

Consulting with First Nations

The Province of British Columbia's legal duty to consult with First Nations arises from section 35 of the *Canadian Constitution Act*, which recognizes and affirms aboriginal and treaty rights. The duty to consult arises when the Crown has knowledge, real or constructive, of the potential existence of the Aboriginal right or title and contemplates conduct that might adversely affect it. Consultation with First Nations will be guided by principles of good faith, and meaningful dialogue with the intent to fully understand the nature and scope of the aboriginal right, the potential to adversely affect that aboriginal right, and address those potential impacts to an aboriginal right while balancing societal interests.

Agreements with First Nations

In many locations, the Province has agreements with First Nations. These agreements may be referred to as Collaborative Management Agreements, Reconciliation Protocol Agreements, Memorandum of Understanding or simply Working Agreements. In some cases the Province and Canada have entered into a treaty with a First Nation, which contains certain provisions regarding treaty rights within parks and protected areas. Modern treaties contain provisions to address those treaty rights in the management of parks and protected areas where a treaty right exists.

These agreements apply to a variety of parks and protected areas and conservancies and include obligations by the Province to discuss operational delivery of programs in addition to information associated with applications for park use permits with a First Nation. These discussions provide the First Nation and the Province with an opportunity to raise any questions or concerns associated with a park use permit application and/or the proposed activity in relation to aboriginal rights or title.

Important Considerations for Park Use Permit Applications

Applicants for park use permits should be aware of the Province's consultation obligations with First Nations and associated time requirements to seek meaningful consultation. There may be occasions when BC Parks may require additional, detailed information to allow for the necessary review of an application. It is important that applicants provide the necessary, detailed information as requested on the application form in order to avoid a longer than anticipated period of time to evaluate the application.

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

PARK USE PERMIT

LAND USE / OCCUPANCY

This Park Use Permit No. **102714** (the "Permit") is issued under the authority of the *Park Act*	(the "Park") **See "Management Plan Schedule, Permit Area Description" for a complete list of Parks and Protected Areas**

FROM:
HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, represented by the Minister responsible for the *Park Act* (the "Province") at the following address:

Ministry of Environment and Climate Change Strategy
BC Parks
South Coast Region
200 - 10470 - 152nd Street
Surrey BC V3R 0Y3

TO:

Sunshine Coast Regional District

(the "Permittee") at the following address:

1975 Field Road
Sechelt, BC V0N 3A1

THE PROVINCE AND THE PERMITTEE AGREE AS FOLLOWS:

ARTICLE I - GRANT OF PERMIT

1.01 The Province, on the terms and conditions of this Permit, grants to the Permittee permission to enter upon and use that part of the Park (the "Permit Area") described, and for the purposes described, in the Management Plan Schedule.

ARTICLE II - TERM

2.01 The duration of this Permit is for a term of **10 years** commencing on **February 1, 2014** (the "Commencement Date") and ending on **January 31, 2024** (the "Expiration Date"), unless cancelled, terminated or renewed in accordance with the terms and conditions of this Permit.

ARTICLE III - FEES

3.01 The Permittee must pay to the Province a minimum fee (the "Permit Fee") of **$500.00 (plus applicable taxes)** prior to Commencement date and on each anniversary of the commencement date during the term of this Permit.

3.02 The Province may, by notice to the Permittee not less than 30 days prior to each anniversary of the Commencement Date, increase the Permit Fee to an amount solely determined by the Province at its discretion, and the Permittee must pay the increased amount.

3.03 The Permittee must pay interest to the Province on money payable by the Permittee and owing to the Province under this Permit, at the rate of interest prescribed by the *Financial Administration Act* in respect of money owing to the Province, which interest will be calculated from the date that the money becomes payable to the Province.

ARTICLE IV - INDEMNITY

4.01 The Permittee will indemnify and save harmless the Province, its servants, employees and agents against all losses, claims, damages, actions, costs and expenses that the Province, its servants, employees and agents may sustain, incur, suffer or be put to at any time arising, directly or indirectly, from any act or omission of the Permittee, its employees, agents, contractors and licensees under this Permit, except for any liability arising from any independent, negligent act of the Province.

ARTICLE V – SECURITY AND INSURANCE

5.01 On the Commencement Date, you will deliver to us Security in the amount of $0.00 which will: **Not Required**

(a) guarantee the performance of your obligations under this Permit;

(b) be in the form required by us; and

(c) remain in effect until we certify, in writing, that you have fully performed your obligations under this Permit.

5.02 Despite section 5.01, your obligations under that section are suspended for so long as you maintain in good standing other security acceptable to us to guarantee the performance of your obligations under this Permit and all other Dispositions held by you.

5.03 We may use the Security for the payment of any costs and expenses incurred by us to perform any of your obligations under this Permit that are not performed by you and, if such event occurs, you will, within 30 days of that event, deliver further Security to us in an amount equal to the amount drawn down by us.

5.04 After we certify, in writing, that you have fully performed your obligations under this Permit, we will return to you the Security maintained under section 5.01, less all amounts drawn down by us under section 5.03.

5.05 You acknowledge that we may, from time to time, notify you to

(a) change the form or amount of the Security; and

(b) provide and maintain another form of Security in replacement of or in addition to the Security posted by you under this Permit;

and you will, within 60 days of receiving such notice, deliver to us written confirmation that the change has been made or the replacement or additional form of Security has been provided by you.

5.06 You must

(a) without limiting your obligations or liabilities under this Permit, at your expense, effect and keep in force during the Term the following insurance with insurers licensed to do business in Canada:

(i) **Commercial General Liability** insurance in an amount of not less than two million dollars **$2,000,000.00 inclusive per occurrence** insuring against liability for personal injury, bodily injury (including death) and property damage, including coverage for all accidents or occurrences on the Permit Area or any improvements. Such policy will include cross liability, liability assumed under contract, provision to provide 30 days advance notice to us of material change or cancellation, and include us as an additional insured;

(b) ensure that all insurance required to be maintained by you under this Permit is primary and does not require the sharing of any loss by any of our insurers;

(c) within 10 working days of the Commencement Date of this Permit, provide to us evidence of all required insurance in the form of a completed "Province of British Columbia Certificate of Insurance";

(d) if the required insurance policy or policies expire or are cancelled before the end of the Term of this Permit, provide within 10 working days of the cancellation or expiration, evidence of new or renewal policy or policies of all required insurance in the form of a completed "Province of British Columbia Certificate of Insurance";

(e) notwithstanding subsections (c) or (d) above, if requested by us, provide to us certified copies of the required insurance policies to be maintained by you under this Permit.

5.07 We may, acting reasonably, from time to time, require you to

(a) change the amount of insurance set out in subsection 5.06(a); and

(b) provide and maintain another type or types of insurance in replacement of or in addition to the insurance previously required to be maintained by you under this Permit;

and you will, within 60 days of receiving such notice, cause the amounts and types to be changed and deliver to us a completed "Province of British Columbia Certificate of Insurance" for all insurance then required to be maintained by you under this Permit.

5.08 You shall provide, maintain, and pay for any additional insurance which you are required by law to carry, or which you consider necessary to insure risks not otherwise covered by the insurance specified in this Permit in your sole discretion.

5.09 You waive all rights of recourse against us with regard to damage to your own property.

ARTICLE VI - COVENANTS OF THE PERMITTEE

6.01 The Permittee must:

(a) pay the Permit Fee and other money payable under this Permit when due at the address of the Province first written above or at such place as the Province may specify from time to time;

(b) pay when due all taxes, levies, charges and assessments that relate to operations of the Permittee under this Permit;

(c) comply with all laws, bylaws, orders, directions, ordinances and regulations of any competent governmental authority in any way affecting the Permit Area, the Park, its use and occupation or the Permittee's operations under this Permit;

(d) advise its employees, contractors, licensees, and agents of the laws and regulations respecting provincial parks and recreation areas and the conditions of this Permit respecting conduct in the permit Area;

(e) keep the Permit Area in a safe, clean and sanitary condition to the satisfaction of the Province and make safe, clean and sanitary any portion of the Permit Area that the Province may direct by notice in writing to the Permittee;

(f) remove from the Permit Area and the Park all garbage, debris and effluent resulting from its use of the Park and Permit Area under this Permit, except as otherwise permitted in the Management Plan Schedule;

(g) comply with all orders and directions made, verbally or in writing, by a park officer (as defined in the *Park Act*) relating to the Park, this Permit or the Permit Area;

(h) not construct, erect, place, repair, maintain or alter any building, fixture, equipment, structure or improvement in the Permit Area except as may be permitted by this Permit or with the prior written consent of the Province;

(i) take all reasonable precautions to prevent and suppress fires in the Permit Area;

(j) not interfere with free public access through, across and upon the Permit Area, unless otherwise specified in the Management Plan Schedule;

(k) not interfere with or disrupt the activities and operations of other Permittee's or users in the Park;

(l) use and occupy the Permit Area only in accordance with the provisions of this Permit;

(m) not remove, destroy, damage, disturb or exploit any natural resource (as that term is defined in the *Park Act*) or any archaeological or cultural artefact found in or on the Permit Area except as may be permitted by this Permit, and only then in accordance with the *Park Act* and all other applicable laws;

(n) not commit or allow any wilful or voluntary waste, damage or destruction in or upon the Permit Area;

(o) pay for or repair, as determined by the Province, any damage caused to the property of the Province by the Permittee, its employees, agents, contractors, or licensees;

(p) upon the expiration, cancellation or termination of this Permit:

(i) peaceably quit and deliver up possession of the Permit Area to the Province,

(ii) remove all chattels and improvements of the Permittee from the Permit Area within 30 days of the expiration, cancellation or sooner termination of this Permit, unless otherwise advised in writing, by the Province,

(iii) deliver to the Province possession of all equipment, furnishings, fixtures, chattels and improvements owned by the Province in a state of good repair and working order, and

(iv) restore the Permit Area to the satisfaction of the Province;

(v) and to the extent necessary, this covenant will survive the expiration, cancellation or termination of this Permit; and

(q) comply with all provisions of the schedules to this Permit.

ARTICLE VII - RIGHTS OF THE PROVINCE

7.01 The Province retains all rights in respect of the Park and Permit Area which are not expressly granted to the Permittee under this permit, including, without limitation:

(a) the right at all times for the Province, its authorized representatives, employees, and agents to have unimpeded access over and along all portions of the Permit Area and to inspect any portions of the Permit Area;

(b) the right at all times to construct, repair, alter and maintain buildings, equipment, structures and improvements upon the Permit Area; and

(c) the right to grant further rights in respect of the Park and Permit Area, provided that such rights do not unreasonably impede, obstruct or compete with the rights of the Permittee under this Permit.

ARTICLE VIII - NOTICE

8.01 Any notice required to be given by either party to the other will be deemed to be given if it is in writing and is delivered by hand or prepaid registered mail to the address first written above or any other address that may be specified in writing by a party and a notice will be deemed to be delivered, if mailed, eight days after the time of mailing except, in the case of a postal interruption, actual receipt is required.

8.02 Notwithstanding section 8.01, any written notice to be given by the Province to the Permittee under this Permit will be effectively given if it is posted in a conspicuous place on the Permit Area.

ARTICLE IX - RENEWAL

9.01 Not later than 140 days prior to the Expiration Date, the Permittee may, by notice in writing delivered to the Province, apply to the Province for a renewal of this Permit.

9.02 Provided that the Permittee is not in default under this Permit and subject to the terms of the *Park Act*, the Province may renew this Permit upon the terms and conditions determined by the Province.

9.03 The Permittee acknowledges that nothing in this Permit obligates the Province to renew this Permit and the Province's decision in that respect is entirely within its discretion

ARTICLE X - TRANSFER

10.01 The Permittee must not assign, transfer, sublicence or grant any of the rights or privileges granted by this Permit without the prior written consent of, and on the terms and conditions determined by, the Province.

10.02 If the Permittee is a corporation then a change in the control (as that term is defined in subsection 2(3) of the *Business Corporations Act*) of the Permittee without the prior written consent of the Province is deemed to be a breach of section 10.01.

ARTICLE XI - CANCELLATION

11.01 In the event that

(a) the Permittee defaults in the payment of the Permit Fee or other money payable under this Permit, and the default continues for 7 days after the giving of written notice of the default by the Province to the Permittee;

(b) the Permittee fails to perform or observe any of the terms or conditions of this Permit, other than the payment of money, and the failure is not remedied within a period specified by the Province;

(c) the Permittee has wilfully misrepresented information:

(I) on the application form which led to the granting of this Permit, or

(ii) required to be provided under the terms and conditions of this Permit;

(d) the Permit Area is damaged or destroyed by any cause whatsoever;

(e) the Park is closed by the Province;

(f) the Permittee files a petition in bankruptcy, is adjudged bankrupt, is petitioned into bankruptcy, makes an assignment for the benefit of its creditors, becomes insolvent or takes the benefit or protection of any statute for bankrupt or insolvent debtors;

(g) any of the Permittee's assets is seized in execution from the Permit Area;

(h) the Permittee, its employees, agents, contractors or licensees performs any act which in the opinion of the Province, affects the good standing or reputation of the Park, or adversely affects any other permit holder or park user within the Park;

the Province may cancel this Permit immediately by written notice to the Permittee.

11.02 In the event that the Permittee and the Province mutually agree in writing to terminate this Permit, the parties will be released and discharged from their obligations under this Permit, except as otherwise provided in this Permit.

11.03 The obligation of the Permittee

(a) to pay the Permit Fee and other money payable under this Permit; and

(b) to comply with Sections 4.01, 6.01(e), 6.01(o) and 6.01(p);

will survive the expiration, cancellation or termination of this Permit.

11.04 The Permittee will not be entitled to any compensation from the Province, in damages or otherwise, in respect of a cancellation or termination of this Permit.

ARTICLE XII - MISCELLANEOUS

12.01 This Permit may be inspected by the public at such times and at such places as the Province may determine.

12.02 Time is of the essence in this Permit.

12.03 Nothing in this Permit will be considered to have been waived by the Province unless such waiver is in writing.

12.04 During the term of this Permit, the Permittee will be an independent contractor and not the agent, employee or partner of the Province.

12.05 The Province will not be liable for any loss, damage, cost or expense resulting from the destruction of or damage to the Permittee's property or a disruption of the Permittee's operations under this Permit which result from strikes, flooding or other acts of God, vandalism, or any other interference to the Permittee's operation or property.

ARTICLE XIII- INTERPRETATION

13.01 In this Permit, unless the context otherwise requires, the singular includes the plural and the masculine includes the feminine, a corporation and body politic.

13.02 The captions and headings contained in the Permit are for convenience only and are not to be construed as defining or in any way limiting the scope or intent of the provisions of this Permit.

13.03 In this Permit, a reference to an enactment of the Province of British Columbia or of Canada includes a reference to any subsequent enactment of like effect, and unless the context otherwise requires, all statutes referred to in this Permit are enactments of the Province of British Columbia.

13.04 If any part of this Permit is found to be illegal or unenforceable, that part will be considered separate and severable and the remaining parts will be enforceable to the fullest extent permitted by law.

13.05 If all or part of the Permit Area is in a recreation area established or continued under the *Park Act*, this Permit is deemed to be a resource use permit as that term is defined in the *Park Act*.

13.06 All schedules to this Permit form an integral part of this Permit.

IN WITNESS WHEREOF the parties have duly executed this Permit.

SIGNED and **DELIVERED** on behalf of the **Province** by a duly authorized representative of the Province.

Duly Authorized Representative

Jennie Aikman
Print Name

Regional Director
Print Title

September 26, 2017
Date

MANAGEMENT PLAN SCHEDULE

PERMIT AREA DESCRIPTION

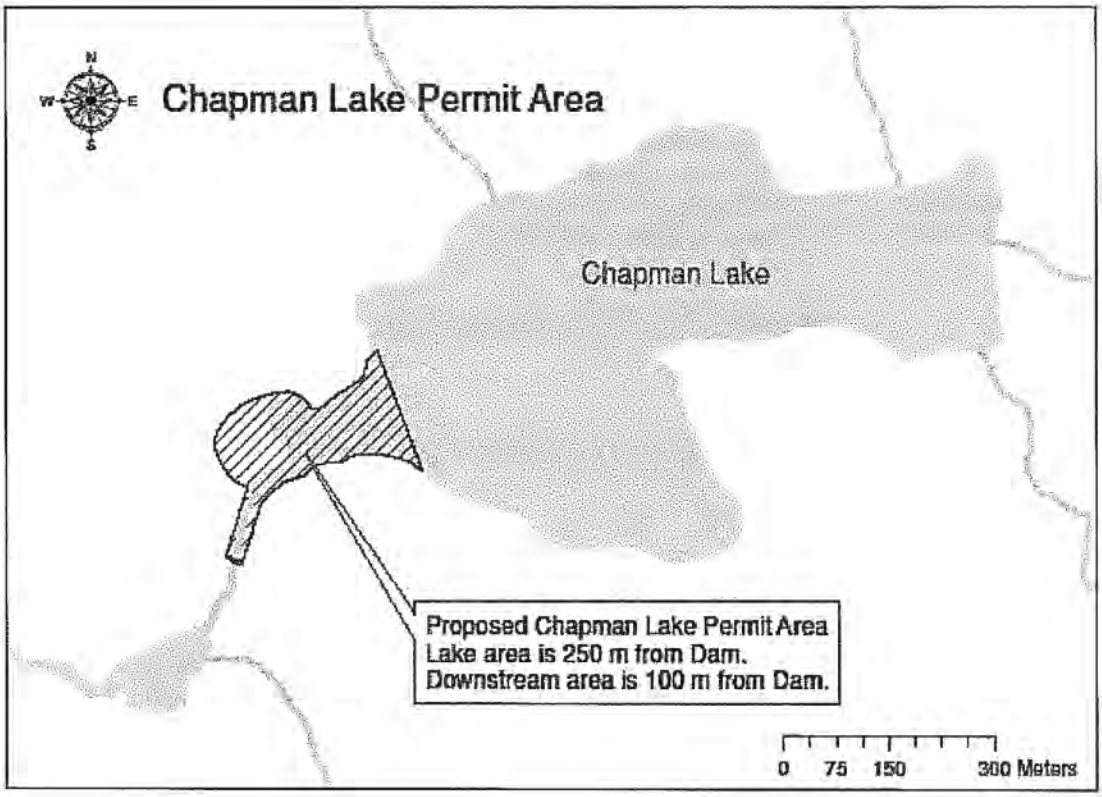
The Permittee is authorized to enter the Permit Area described below and outlined on the attached map.

Permit Area Overview Map

- **Tetrahedron Park**
- **Area adjacent to the outlet of Chapman Lake**
- **Area adjacent to the outlet of Edwards Lake**

Chapman Lake Permit Area

Temporary Chapman Lake Permit Area (valid until 30 October 2018)



FEE(s)

Protected Land: **Tetrahedron Park**

Activities: Water Impoundments (dams and dykes)
Purpose: Rights of way and miscellaneous land use without structures - The use of a defined area for a powerline, telephone line, pipeline or other service or utility right of way and other miscellaneous land use without structures - Company or local government. Fee charged for this purpose is for each protected land.
Fee Description: $500 or $60 per hectare whichever is greater
Schedule K Ref: Part 3, Column 2, Item 4(b)

Fees:

Item	Number	Rate	Total
Minimum Fee	1	$500.00	$500.00
Hectares	1	$60.00	$60.00

Sub Total (based on Fee Description above): $500.00

Sub Total: **$500.00**

Minimum Fee Required: **$500.00**
(plus applicable taxes)

SPECIAL PROVISIONS

1. Purpose

This Permit is issued to the Permittee for the purpose of **for the purpose of maintaining water impoundment infrastructure at Chapman and Edwards Lake and helicopter pad at Chapman Lake in Tetrahedron Park.**

2. Permittee Designated Representative

The Permittee appoints the following representative to be responsible for liaison between BC Parks and the Permittee:

Name: Michael Day
Address: 1975 Field Road Sechelt, BC V0N 3A1
Telephone: 604-885-6810 office s.16 :ell
Email: Michael.Day@scrd.ca

3. BC Parks Contact Information

The Designated Representative must contact the Area Supervisor with any requirements or questions regarding this Park Use Permit. To determine the Area Supervisor responsible for the protected land(s) listed below, contact the associated regional office for this information.

Park, Protected Area or Conservancy Name	Contact Information
Tetrahedron Park	Ministry of Environment and Climate Change Strategy, BC Parks South Coast Region 200 - 10470 - 152nd Street Surrey BC V3R 0Y3 *Regional Office:* (604) 582-5200 *Fax:* (604) 930-7119

4. Conditions of Term

This permit shall be deemed valid until such time that it has expired under Article 2.01 and that the associated water licences are valid and in good standing and that activities carried out are permitted under:

(a) the conditional water licences and;

(b) this permit.

5. Water Regulations

All activities relating to maintaining water impoundment structures and regulating water levels must be in accordance with the *Water Act.*

6. Flight Access

(a) The use of a helicopter for access to the structures is acceptable. The Permittee shall notify BC Parks as early as feasibly possible prior to any flights into Tetrahedron Park so that BC Parks may utilize available space or service of the helicopter for park operation purposes.

(b) Recognizing that wildlife are sensitive to disturbance from helicopters, maintain an appropriate separation distance from animals (500 m line-of-sight is a recommended default) and take immediate action to increase separation distances if animals react to the helicopter.

(c) If the Permittee chooses to use a helicopter company to access the structure the Permittee will cause any Person/Sub-licensee providing aviation services related to the Permittee' s performance of this Permit to carry, and to provide evidence to the Province of their compliance with this requirement, Aviation Liability insurance on all aircraft operated or used in the performance of this Permit insuring against bodily injury, property damage, and passenger liability, in an amount not less than the limits of liability imposed by any *Canadian Aviation Regulation* and in any event not less than a per occurrence combined single limit of:

(i) $3,000,000 for aircraft up to 5 passenger seats, or

(ii) $3,000,000 plus $1,000,000 for each additional passenger seat for aircraft up to 10 passenger seats, or

(iii) $10,000,000 for aircraft over 10 passenger seats;

and this insurance must:

(i) include the Province and the Permittee as additional insureds;

(ii) be endorsed to provide the Province and the Permittee with 30 days advance written notice of cancellation or material change; and

(iii) include a cross liability clause;

7. Report Requirements

The Permittee shall provide the Province with a report, due upon the anniversary date of the Permit, describing all activities undertaken as a result of this Permit for the previous year. Please submit this report to the following address:

Ministry of Forests, Lands
and Natural Resource Operations
FrontCounter BC – Surrey
200 – 10428 153rd Street
Surrey BC V3R 1E1
Toll Free: 1-877-855-3222
Website: http://www.frontcounterbc.gov.bc.ca/locations/index.html

8. Safety Regulations

The Permittee shall be responsible for all WorkSafe BC regulations and staff safety program and plans for all its staff and sub-contractors utilizing the Park to conduct activities authorized by this permit.

9. Renewal

It is understood by BC Parks and the Sunshine Coast Regional District that this permit shall be renewed pending a review of the terms of this Management Plan Schedule and providing the Sunshine Coast Regional District continues to require water management and structures outlined in this permit and the conditional water licences.

10. Temporary Permit Amendment Conditions

(a) **Term**

(i) The conditions of the temporary permit amendment will be valid during the period from permit approval until **30 October 2018**.

(ii) This temporary permit is subject to approval of the "Water Sustainability Act, Section 10 application - 100220141 – Short Term Water Use on Chapman Lake – Use Approval 2005641".