Upper Lillooet Hydro Project

Operational Environmental Monitoring Year 5




Prepared for:

Upper Lillooet River Power Limited Partnership,
Boulder Creek Power Limited Partnership,
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EXECUTIVE SUMMARY

Ecofish Research Ltd. (Ecofish) was retained by the Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership (collectively, the Partnerships) to conduct Year 5 of the operational environmental monitoring program (OEMP) for the Upper Lillooet Hydro Project (ULHP) (the Project). The Project is comprised of two run-of-river hydroelectric facilities (HEFs) located in the Upper Lillooet watershed northwest of Pemberton, British Columbia (BC). The largest of which is located on the mainstem of the Upper Lillooet River (ULR; Watershed Code (WC): 119). The other facility is located on Boulder Creek (WC: 119-848100). The OEMP (Harwood *et al.* 2021) addresses the operational monitoring conditions identified during the environmental assessments (Hedberg and Associates 2011; Lacroix *et al.* 2011a, 2011b, 2011c, 2011d; NHC 2011; Lewis *et al.* 2012; Leigh-Spencer *et al.* 2012) and conditions outlined in the Environmental Assessment Certificate (EAC) E13-01 (BC EAO 2013), the *Fisheries Act* Authorization (09-HPAC-PA2-00303), and water licences (C130613 and C129969).

This report documents the methods and results for Year 5 of operational monitoring following requirements of the revised OEMP (Harwood *et al.* 2021). Year 5 monitoring was split over 2022 and 2023 because some of the aquatic and terrestrial monitoring was postponed due to access restrictions to the Project caused by landslide risk in 2022. The work postponed until 2023 has been considered Year 5 in this report.

Aquatic and Riparian Habitat

Riparian Revegetation Assessment

The objective of riparian revegetation effectiveness monitoring is to evaluate whether efforts to revegetate temporarily cleared riparian areas meet the performance measures prescribed in the OEMP (Harwood *et al.* 2021). The performance measures (80% survival of planted stock, tree density at or above 1,200 stems/ha, and shrub density at or above 2,000 stems/ha) were based on the DFO and MELP (1998) revegetation guidelines, as recommended by the Long-term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects (Lewis *et al.* 2013). Riparian vegetation restoration monitoring also contributed to Coastal Tailed Frog (*Ascaphus truei*) habitat compliance monitoring at disturbed riparian areas along the Coastal Tailed Frog tributary crossed by the ULR HEF penstock. Revegetation monitoring occurred in Years 1, 3, and 5 of operations.

Overall, the results of Year 5 of revegetation monitoring indicate that riparian revegetation continues to be successful, and vegetation is on track to provide key riparian functions. The average estimated vegetation stem density targets were met for both trees and woody shrubs, and established individuals appeared healthy and continued to grow. Survival of planted stock could not be assessed because tracking of individual stems was not a requirement of the OEMP, and therefore planted stock could not be differentiated from natural revegetation. However, overall high stem densities and low observed mortalities indicate sufficient survival to achieve target densities. Although there were areas of exposed soils in most plots, percent vegetation cover consistently increased over the monitoring period, and the high stem densities of woody vegetation and lack of observed erosion suggest that the established riparian vegetation provides sufficient soil stabilization and other riparian functions.

The continued natural development of riparian vegetation is expected to be sufficient to provide riparian functions, and the riparian revegetation effectiveness monitoring component of the OEMP is therefore considered complete.

Water Temperature and Air Temperature

The objective of monitoring water temperature is to determine Project effects on stream temperature and assess whether any Project-related effects are biologically significant and affect the growth, survival, or reproductive success of ULR and Boulder Creek fish populations. To achieve this, water temperature was monitored continuously for the first five years of operation and will be compared to the baseline data using a Before-After-Control-Impact (BACI) design in a final program summary report to be completed following the completion of remaining OEMP components . Water temperature metrics that were compared to BC Water Quality Guidelines (BC WQG; BC ENV 2023) and fish species and life-history specific optimum temperature ranges included daily and monthly temperatures, length of the growing season, number of extreme temperature days, rate of temperature change, and mean weekly maximum temperature (MWMxT). Air temperature monitoring was also conducted given its influence on water temperature and ice formation.

Prior to start of operation for both facilities, the baseline thermal regime in the ULR and Boulder Creek was characterized between 2008 and 2013 using water temperature data from two monitoring sites in each watercourse: one upstream control site and one impact site located in the (then future) lower diversion reach. Operational monitoring for both facilities began in March 2018 and included data from two new locations for each facility: one at the tailrace and one downstream of the tailrace. In addition, a site was established in nearby North Creek (NTH-USWQ1) to provide replacement data for the Boulder Creek upstream control site that is influenced by warm groundwater inflow during the late fall to early spring period. The upstream control site in the ULR has been re-established twice (currently ULL-USWQ04, which has also been found to be influenced by warm groundwater in the winter). The current operational record for both facilities span from March 2018 to October 2023.

Baseline and operational monitoring of water temperatures in the ULR and Boulder Creek indicate that both are cold-water streams characterized by:

- Daily average temperatures are frequently <1°C during the winter and remain well below 18°C (the recommended maximum temperature guideline for stream salmonids in BC; BC ENV 2023) throughout summer.
- The growing season in the ULR was similar at the upstream site during both baseline and operational monitoring (644-degree days to 861-degree days), with the diversion reach falling within this range during the one year of baseline monitoring conducted in 2012 (825-degree days). However, during operations there were typically more growing season degree days at

both the diversion and downstream sites compared to the upstream sites (858 to 1,214-degree days).

- The length of the growing season in Boulder Creek during baseline (280-degree days at the North Creek upstream control site to 898-degree days in the Boulder Creek future diversion reach site) was generally lower than during operations (613-degree days at the upstream site to 1,185-degree days at the diversion reach site). The ULR and Boulder Creek diversion reaches experienced their longest growing seasons in 2022 and 2019, respectively.
- The Mean Weekly Maximum Temperature (MWMxT) was most frequently sub-optimally cool for salmonids in the ULR and in Boulder Creek during both baseline and operations.

Water and air temperature have been monitored for 5.5 calendar years of operations (March 2018 to October 2023) which meets the monitoring requirements prescribed in the OEMP (Harwood *et al.* 2021). Therefore, the ULR and Boulder Creek water and air temperature monitoring program is considered complete. No additional monitoring requirements are recommended at this time, although this will be confirmed following a BACI analysis that will be completed as part of the final program summary report.

Frazil Ice

Air temperature at Environment Canada's Callaghan Valley and Pemberton Airport weather stations was monitored by Ecofish from October 2017 to December 2023. As per the frazil ice monitoring protocol, site photographs were collected by operations staff for ULR and Boulder Creek if three consecutive days of <-5°C occurred at either weather station. From March 2022 to December 2023, the temperature threshold of three consecutive days at <-5°C was updated to three consecutive days <-12°C, as recommended in the OEM Year 4 report. Based on a review of photographs of occurrences during Year 5 (March 2022 – December 2023), no frazil ice was identified in the diversion reaches of the ULR or Boulder Creek. In 2022 there was one exceedance of -12°C five days in length, at both the Callaghan Valley and Pemberton Airport weather stations; however, based on photographic review, no frazil ice was detected. In 2023, temperatures did not reach threshold levels to trigger frazil ice alarms or response.

Frazil ice monitoring associated with the OEMP is considered complete; however, Innergex will continue to monitor temperature and frazil ice for the life of the Project as required in Schedule B of the Project's EAC. Given observations and monitoring to date, we recommend this continued monitoring in the ULR and Boulder Creek diversions reflects the updated protocol with a threshold of three consecutive days of -12°C average daily temperature recorded at the Callaghan Valley or Pemberton Airport weather stations. Use of the updated thresholds will ensure detection and associated monitoring of extreme events to ensure mitigation can be applied if adverse effects associated with frazil ice are observed.

Stream Channel Morphology

Channel morphology monitoring was completed for baseline conditions during 2016 and for post-operations in 2023 on both Boulder Creek and ULR. Landslide risks (personnel safety) along the Upper Lillooet Forest Service Road in 2022 delayed the operational monitoring assessment by one year past the specified time in the OEMP (Harwood *et al.* 2021). A large forest fire occurred in the watershed during 2015, and a 10-to-20-year return period peak flow occurred approximately one month after the 2016 baseline survey, which together could be expected to contribute to substantial geomorphic changes in both the ULR and Boulder Creek. The OEMP mandated that occurrence of a >10-year return period flow event, in either ULR or Boulder Creek, would be the trigger to conduct a post-operational survey; however, the survey was delayed until after Year 5 in an attempt to detect potential project effects that may have been masked by the 2015 and 2016 natural events.

The potential Project effects on stream channel morphology were assessed by evaluating the natural geomorphic processes and background disturbances, sluicing and operational history, and qualitative observation of geomorphic change using imagery from a Remotely Piloted Aircraft System (RPAS). During baseline sampling (2016), a detailed channel morphology survey was completed on the ground, which included pebble counts, transects, and spawning gravel surveys. The OEMP (Harwood *et al.* 2021) specified that RPAS imagery be collected during the post-operation period for comparison to the baseline period to determine whether major Projects effects had occurred, and the ground-based survey would only be repeated if effects were either apparent or inconclusive in the imagery comparison.

Observations were made in the context of potential Project-effect pathways, including: spawning gravel transport re-establishment through the headpond; substrate coarsening and loss of spawning gravel downstream of the ULR headpond; aggradation of spawning gravel in diversion reach; incision and channel narrowing downstream of the headponds; and reduction in large wood present below the headponds. Monitoring results determined that no major geomorphological effects from the Project had occurred, both due to a lack of changes observed in the RPAS imagery comparison and because spawning gravel and large woody debris were clearly being transported through both headponds and downstream.

Fish Community

The objective of the fish community monitoring program is to assess fish community response during operations and identify any changes in abundance, density, condition, distribution, or timing of migration. This report presents data from Year 5 of operational monitoring (2022/2023) on measures of fish abundance, condition, and distribution of juvenile and adult Cutthroat Trout (*Oncorhynchus clarkii*) and Bull Trout (*Salvelinus confluentus*) populations within the diversion (impact) reach of the ULR as well as the diversion (impact) and downstream (control) reaches of Boulder Creek in support of the fish density and biomass component prescribed by the OEMP. It also presents data on the migration and distribution of spawning adult Bull Trout in both the HEF diversion and downstream reaches and on Cutthroat Trout abundance in a tributary that enters the ULR HEF headpond in support of an assessment of potential fish entrainment.

Juvenile Density and Biomass

Upper Lillooet

In Year 5, Cutthroat Trout fry, juveniles, and adults were captured in the diversion reach. Cutthroat Trout density for all age classes combined in the diversion reach was 1.24 fish/100 m^2, similar to the previous years' (2018 and 2019) operational average of 1.22 fish/100 m^2 and the baseline average of 1.04 fish/100 m^2. Bull Trout fry, juveniles, and adults were captured within the diversion reach in Year 5. Bull Trout density for all age classes combined in the diversion reach was 0.52 fish/100 m^2, lower than the previous years' operational average of 1.77 fish/100 m^2 and lower than the baseline average of 2.37 fish/100 m^2. With all age classes combined, Trout (Cutthroat Trout and Bull Trout) density in Year 5 was 1.76 fish/100 m^2, lower than the previous years' operational average of 2.99 fish/100 m^2 and baseline average of 3.41 fish/100 m^2.

Boulder Creek

Bull Trout fry, juveniles, and adults were captured within the diversion reach in Year 5. Bull Trout density (adjusted for capture efficiency) for all age classes combined in the diversion reach was 2.55 fish/100 m^2, higher than the previous years' operational average of 1.22 fish/100 m^2 and the baseline average of 1.24 fish/100 m^2. Bull Trout density in the downstream reach in Year 5 was 2.88 fish/100 m^2, higher than the previous years' operational average of 1.84 fish/100 m^2 but lower than the baseline average of 3.65 fish/100 m^2.

Cutthroat Trout were not detected during the three baseline monitoring years; however, they were detected at low density in the downstream reach during all three operational monitoring years. Cutthroat Trout density in the downstream reach in Year 5 was 0.06 fish/100 m^2, lower than the previous years' operational average of 0.11 fish/100 m^2. No Cutthroat Trout were detected in the diversion reach in Year 5.

Abundance action thresholds (AAT) were defined in the OEMP for individual age classes and all age classes combined of juvenile Bull Trout within the diversion reach of Boulder Creek. Densities of Bull Trout observed in Years 1, 2, and 5 monitoring (for individual age classes, and all combined) were compared to these AATs, and although variable among years, there were no declines that exceeded AATs.

Factors un-related to Project operations, between baseline and operational years, may also have influenced the fish monitoring results and need to be considered in the assessment. Several stochastic natural events have influenced fish and fish habitat in the Project streams during baseline and operations. These include the Boulder Creek Wildfire (2015) that severely impacted a total of 6,735 ha of terrestrial habitat, including riparian areas along Boulder Creek and the ULR. Natural flood events occurred in November of 2016 and 2017, which caused substantial geomorphic changes in both the ULR and Boulder Creek, including within the sampling reaches. Changes were most apparent at

Boulder Creek, where substantial scouring occurred in the diversion reach, and the downstream reach (below the powerhouse site) now occupies a new channel following floods in fall 2016. These natural events noticeably affected the habitat in these streams and likely affected the fish communities. This potentially confounds the detection of Project effects on fish populations, if effects were to have occurred. Further unprecedented recent weather events (e.g., heat domes, and droughts) may also have had additional influence on the fish community.

Adult Migration and Spawning

Adult fish migration and spawning was assessed within the diversion and downstream reaches of both the ULR HEF and Boulder Creek HEF, the tailrace of each HEF, and a section on North Creek (a reference stream) through angling surveys in 2023. These surveys were conducted to determine if access to the two diversion reaches was impacted by water diversion. At both HEFs, the absence of Bull Trout observed holding downstream of the two powerhouses, coupled with positive detection in the diversion reaches, suggests that movement into the two diversion reaches is not inhibited by flow reductions associated with either facility's operations. All assessed lower portions of the diversion reaches (lowermost 300 m on Boulder Creek and 500 m on ULR) were also deemed to be accessible to fish, with no barriers to migration identified.

Tributary bank walk spawner surveys were conducted in two reference streams located downstream of the ULR and Boulder hydro facilities: a tributary at km 29.2 of the ULR (29.2 km Tributary) and Alena Creek. These reference tributaries were monitored to help assess the potential confounding effects of the Capricorn/Meager slide in August 2010 on the results of the monitoring program in the ULR and Boulder Creek. The peak numbers of spawning adult Bull Trout observed in 29.2 km Tributary were higher in 2023 (five individuals) than in previous years under operation (2018 (two), 2019 (zero), 2020 (one), and 2023 (three)) but lower than in baseline surveys in 2011 (eight). In Alena Creek, peak numbers of spawning adult Bull Trout in 2023 (three) were within the range of previous operational years (2018 (two), 2019 (one), 2020 (zero), and 2021 (five)), but lower than during baseline surveys in 2011 (nine).

Assessment of Entrainment at the Upper Lillooet River Intake

The assessment of fish entrainment included examining densities and biomass of Cutthroat Trout in a tributary to the headpond (at river km 87.0). Densities of Cutthroat Trout in the tributary in 2023 were higher than in 2013, 2018, and 2019 for all age classes combined. Biomass of Cutthroat Trout in the tributary in 2023 were slightly higher than in 2018 and 2019, but lower than 2013 for all age classes combined. Fry densities in 2023 were more than double in previous years. Parr 1+ and 2+ density in 2023 was slightly lower than in 2018 and 2019 but higher than in 2013. Adult density was similar to 2018 and 2019 values but lower than 2013.

The removal of sampling in the upstream reach following Year 2 does not allow comparisons to the upstream control to be made. Continued monitoring of the headpond tributary has allowed for an ongoing assessment of this population to infer potential Project effects. Overall, there is no evidence indicating a decline in Cutthroat Trout in the tributary after four years of monitoring and the risk of entrainment in the ULR HEF intake is therefore considered low. Accordingly, we recommend the removal of this component in subsequent monitoring years.

Wildlife Species Monitoring

Harlequin Ducks

The objective of Harlequin Duck (*Histrionicus histrionicus*) response monitoring, which is a requirement of the Project's EAC (Condition #3 of the TOC), is to confirm that Harlequin Ducks continue to use the ULR HEF area post-construction. Spot checks were conducted in Year 5 (2022) at the intake and the powerhouse on May 1, 6, and 14 (pair surveys), and on August 10, 15, and 21 (brood surveys). No Harlequin Ducks were observed in Year 5 of the monitoring program, either during surveys or incidentally. The species was also not observed in monitoring Years 2 to 4, although they were observed in Year 1 and during two of the three baseline years. Thus, continued use could not be confirmed for the last four years of operational monitoring although lack of detection does not necessarily indicate lack of presence.

Species at Risk & Regional Concern

Wildlife species at risk and of regional concern are being monitored through the recording of incidental observations during the first five years of Project operations to contribute to the provincial database and to inform Project operations on situations that may require consideration of wildlife species likely to be present. Most wildlife species incidentally observed in Year 5 have also been recorded in previous monitoring years, except for a Red Fox (*Vulpes vulpes*), which has not been recorded previously. To reduce the potential for human-wildlife conflict, it is recommended that Project personnel continue to record and share wildlife sightings with other Project personnel, especially of Grizzly Bear (*Ursus arctos*), Moose (*Alces americanus*), and Elk (*Cervus elaphus*), particularly along the Project access roads.

Wildlife Habitat Monitoring

Habitat restoration monitoring for Harlequin Ducks and Peregrine Falcons (*Falco peregrinus*) was completed and reported on in the OEM Year 1 report (Regehr *et al.* 2019).

Habitat Restoration - Amphibian Habitat

The objective of amphibian habitat restoration compliance monitoring is to confirm that key habitat restoration prescriptions were implemented post-construction for Coastal Tailed Frog (*Ascaphus truei*) terrestrial (riparian) and instream habitat. Compliance monitoring was completed at transmission line crossings and the penstock crossing in Year 1; however, geotextile had become exposed at the penstock crossing (ULL-ASTR04) within the riparian area and stream channel. Work was completed in the fall of 2019 to cover the exposed geotextile with additional rocky substrate, and spot checks were conducted in 2020 and 2023. The spot check in Year 3 (2020) indicated that the majority of the geotextile that had been exposed in 2018 remained covered, but that a small portion (~ 0.8 m long) of geotextile had become exposed at the edge of river right, which was re-covered with cobble by hand.

During the Year 5 (2023) spot check, the same small portion (~ 0.7 m long) of geotextile that was uncovered in 2020 had again become exposed at the edge of river right, which was re-covered by hand. Given that repeated exposure of covered geotextile has been observed in a specific problem area, it is recommended that inspections, with maintenance implemented as needed, be conducted on a regular basis at ULL-ASTR04 (e.g., every three years).

Habitat Restoration - Mammal Habitat

The objective of mammal habitat compliance monitoring in 2023 was to confirm that habitat restoration measures prescribed to minimize sensory disturbance and visibility of the transmission line corridor from adjacent Project roads had been implemented for Grizzly Bear, Moose, and Mule Deer (*Odocoileus hemionus*) habitat. Year 5 monitoring involved confirming presence and adequacy (width and height) of vegetated screens between the transmission line RoW and active FSRs, where the transmission line RoW is within 10 m of an active FSR and passes through legislated protected habitat (Ungulate Winter Range (UWR) or Wildlife Habitat Area (WHA)) or high value Grizzly Bear habitat). Vegetated screens at 18 of 29 restoration monitoring sites had not attained the required height (5 m) and/or width (5 m) in Year 3, and reassessment in Year 5 (2023) was required. Other monitoring requirements (to confirm access roads in WHA 2-399 were deactivated, garbage and food waste were being disposed of properly, and plant composition requirements of vegetated screens were met) were completed in Year 1.

Results of mammal habitat restoration compliance monitoring for Grizzly Bear, Moose, and Mule Deer at restoration monitoring sites indicated that vegetated screens at 6 of 18 restoration monitoring sites reassessed in Year 5 did not meet required dimensions. However, five of these sites have reached width requirements and are expected to achieve height requirements naturally given that all have heights of at least 3 m and have had improvements in growth since Year 3. One of the six sites is in an area burned by the 2015 Boulder Creek wildfire and is correspondingly slow to recover; however, it is anticipated to revegetate naturally over time and is not considered a critical screen given its location high above the road. Given these results, no further action or monitoring is recommended.

Vegetation Monitoring

The objectives of vegetation monitoring are to qualify and quantify the re-growth of vegetation in terrestrial areas disturbed through the construction of the Project, to mitigate short-term habitat loss, and to prevent the introduction of invasive species that may occur through site disturbance. All long-term revegetation monitoring areas in the ULHP Project area that were assessed in 2023 (Year 5) showed continual development of revegetation processes throughout the monitoring period: the sites are increasing in cover and number of stems of woody vegetation, percent ground cover has increased on all sites, the plants that were present on most sites are vigorous and healthy, and no major erosion issues were observed. Slope shaping, soil decompaction, and/or other soil treatments have helped to revegetate the sites. The sites assessed in 2023 met Project requirements, and no further revegetation actions are required. Detailed methods and results are presented in the Year 5 Upper Lillooet Hydro Project Revegetation Assessment Report (Appendix A).

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1. INTRODUCTION

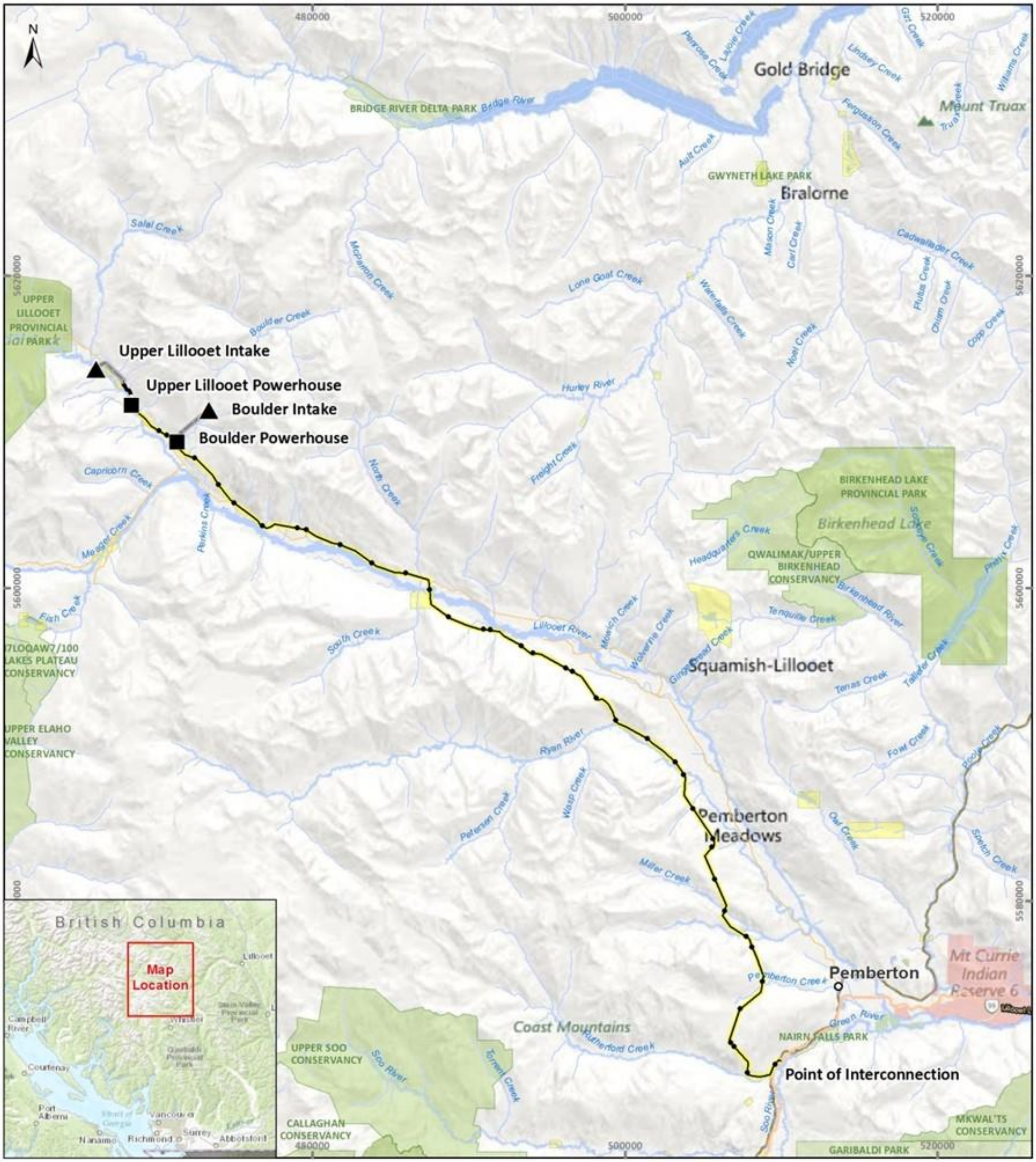
Ecofish Research Ltd. (Ecofish) was retained by the Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership (collectively, the Partnerships) to conduct Year 5 of the operational environmental monitoring program (OEMP) for the Upper Lillooet Hydro Project (ULHP) (the Project). The Project is comprised of two run-of-river hydroelectric facilities (HEFs) located in the Upper Lillooet watershed northwest of Pemberton, British Columbia (BC) (Map 1). The larger of the two HEFs (Upper Lillooet River (ULR) HEF) is located on the mainstem of the ULR (Watershed Code (WC): 119), and the smaller of the two HEFs (Boulder Creek HEF) is located on Boulder Creek (WC: 119-848100). Infrastructure for each of these HEFs includes a powerhouse and an intake. Water is diverted via penstock and/or tunnel around approximately 3.8 km of the ULR for the ULR HEF and around approximately 3.7 km of Boulder Creek for the Boulder Creek HEF. Project infrastructure also includes a 72 km long 230 kV transmission line that transports electricity produced by the Project to the point of interconnection, south of Pemberton, near Rutherford Creek (Map 1). A detailed effects assessment, addressing aquatic and terrestrial valued components, was completed for the HEFs and the transmission line (Hedberg and Associates 2011; Lacroix *et al.* 2011a, 2011b, 2011c, 2011d; NHC 2011; Lewis *et al.* 2012; Leigh Spencer *et al.* 2012).

An operational environmental monitoring plan (OEMP) was developed by Ecofish to assess potential effects of the Project on the environment, including fish communities, wildlife, and wildlife habitat present in the Project area (Harwood *et al.* 2017). This original OEMP was revised, and revisions were approved in 2021 (Harwood *et al.* 2021). The OEMP addresses the operational monitoring conditions identified during the environmental assessments (EAs) (Hedberg and Associates 2011; Lacroix *et al.* 2011a, 2011b, 2011c, 2011d; NHC 2011; Lewis *et al.* 2012; Leigh-Spencer *et al.* 2012) and the conditions listed in Schedule B of the Project's Environmental Assessment Certificate (EAC) (E13-01; BC EAO 2013). The aquatic components of the OEMP are also based on Fisheries and Oceans Canada's (DFO) Long-term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects (Lewis *et al.* 2013). Monitoring requirements address two types of effects: footprint and operational. Footprint effects are associated with Project infrastructure and can be short-term or long-term, depending on the permanence and associated disturbance. In contrast, operational effects result from changes to water flow during Project operation.

The OEMP prescribes three types of monitoring: compliance, effectiveness, and response. Compliance monitoring is conducted to ensure that conditions outlined in the EAC (BC EAO 2013), DFO *Fisheries Act* Authorization (09-HPAC-PA2-00303), and water licences (C130613 and C129969) are adhered to. Effectiveness monitoring is conducted to verify that mitigation and compensation measures implemented for a project are effective, and response monitoring is the long-term monitoring of environmental parameters to establish empirical links between project development and operation, and any effects on the environment. Compliance and effectiveness monitoring are conducted at specific locations based on the parameter being monitored. Response monitoring often requires data collection at multiple sites, with the locations dependent on the parameter(s) in question, so that Project effects can be assessed through a comparative study design. Effectiveness and response monitoring can lead to and facilitate the adaptive management of impacts.

This report presents the methods and results for Year 5 of operational monitoring in accordance with the requirements of the revised OEMP (Harwood *et al.* 2021). Aquatic and terrestrial monitoring parameters and components, summarized in Table 1 and Table 2, respectively, each have specific requirements, including frequency, duration, and reporting. Some of the aquatic and terrestrial monitoring scheduled for Year 5 could not be completed in 2022 due to access restrictions (for personnel safety) to the Project area caused by landslide risk. Fulfillment of these monitoring requirements was postponed to the following year. Thus, Year 5 monitoring was completed over 2022 and 2023.

Project Overview



Legend
- ○ Cities

ULHP Infrastructure
- ▲ Intake
- ■ Powerhouse
- Penstock
- Tunnel
- Transmission Line
- Road
- First Nation Reserve
- Recreational Site
- Parks and Protected Areas

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 2 4 6 8 10 12 14 km

Scale: 1:350,000

NO.	DATE	REVISION	BY
1	14/04/2016	1095_ULP_ProjOverview_2014Jun26_CA	CSA
2			
3			
4			
5			

Date Saved: 14/04/2016
Coordinate System: NAD 1983 UTM Zone 10N

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Map 1

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Overview\1095_ULP_ProjOverview_2014Jun26_CA.mxd

Table 1. Summary of aquatic monitoring parameters and components specified in the updated OEMP (Harwood *et al.* 2021).

Parameter	Project Component	Monitoring Type	Facility	Monitoring Requirements		
				Frequency	Duration[1]	Reporting[2]
Primary						
Instream flow	Flow magnitude and timing	Compliance	ULL, BDR	Continuous	Life of project	Annually
	Ramping rates	Compliance	ULL, BDR	Once[3]	Project Commissioning	Once
	Ramping rates	Compliance	ULL, BDR	Continuous	Life of project	Annually
	Connectivity	Compliance	ULL, BDR	Once	Immediately post-construction	Once
Mitigation and compensation measures	Compensation projects	Compliance	ULL	Once	Immediately post-construction	Once
		Effectiveness	ULL	Annually	Years 1 through 5	Annually
Aquatic and riparian habitat	Footprint impact verification	Compliance	ULL, BDR	Once	Immediately post-construction	Once
	Revegetation assessment	Effectiveness	ULL, BDR	Annually	Years 1, 3 and 5	Annually
Water temperature and icing	Overall project	Response	ULL, BDR	Continuous	Life of project	Annually
Stream morphology	Overall project	Response	ULL, BDR	Once	Year 5	Once
Fish abundance and behaviour	Compensation projects	Effectiveness	ULL	Annually	Years 1 through 5	Annually
	Resident fish density (EF)	Response	ULL	Annually	Years 1, 2, 5 and 2 more years between Year 7 and 10[4]	Annually
	Resident fish density (SN)		BDR	Annually	Years 1, 2, 5 and 2 more years between Year 7 and 10[4]	Annually
	Migration and Spawning (BT)	Response	ULL, BDR	Annually	Years 1 through 5	Annually
	Migration and Spawning (CT)		ULL	Annually	Year 1	Annually
Secondary						
Water Quality	Overall project	Response	ULL	Bi-Annual	Year 1	Annually
Species at risk or of concern[5]	BT and CT	Response	ULL, BDR	Annually	See Fish abundance and behaviour	Annually

ULL = Upper Lillooet River, BDR = Boulder Creek, EF = electrofishing, SN = snorkeling, BT = Bull Trout, CT = Cutthroat Trout

[1] Monitoring may be extended past the prerequisite minimum of five years following review of the results from the five year operational monitoring period

[2] Non-compliance must be reported on an accelerated schedule and measures taken to ameliorate risk. Non-compliance reports due shortly after event.

[3] Ramping rate rests need only be conducted once if fry are present

[4] Total of five years of operational monitoring unless otherwise approved by MFLNRORD. Value of monitoring beyond Year 5 (i.e., beyond 3 years of operational monitoring) will be re-assessed based on results after Year 5 sampling. Individual sampling years may be subject to change based on safety/access considerations.

[5] Bull Trout and Cutthroat Trout are both blue listed in BC (special concern) and will be monitored as part of regular fish response monitoring

Table 2. Summary of terrestrial monitoring parameters and components specified in the updated OEMP (Harwood *et al.* 2021).

Parameter	Project Component	Sub-component	Monitoring Type	Facility	Monitoring Requirements		
					Frequency[1]	Duration	Reporting
Wildlife Species	Harlequin Ducks	-	Response	ULL	Multiple	Years 1 to 5	Years 1, 3 and 5[2]
	Species at Risk & Regional Concern	-	Response	ULL	Continuous	Years 1 to 5	Annually[3]
Wildlife Habitat	Habitat Restoration	Coastal Tailed Frog Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Harlequin Duck Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Peregrine Falcon Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Grizzly Bear	Compliance	ALL	Once[4]	Immediately post-construction	Once
		Moose & Mule Deer Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Mountain Goat Habitat	Compliance	ULL, BDR	Once[4]	Immediately post-construction	Once
	Mitigation Effectiveness	Avian Collisions	Effectiveness	ULL	Bi-annually	Year 1[4]	Annually
		Truckwash Creek Portal Design for Mountain Goats	Effectiveness	ULL	Multiple	Year 1[4]	Annually
		Boulder Creek HEF Gate Winter Access Monitoring	Effectiveness	BDR	Multiple	Years 1 to 3[4]	Annually
		Boulder Creek Predator Presence & Behaviour Monitoring	Effectiveness	BDR	Multiple	Years 1 to 3[4]	Annually
Vegetation	Vegetation Restoration		Compliance/ Effectiveness	All	Annually	Years 1, 3 and 5	Annually
	Invasive Plants		Compliance/ Effectiveness	All	Annually	Years 1, 3 and 5	Annually

ULL = Upper Lillooet River, BDR = Boulder Creek

[1] Monitoring data collection may occur only once, annually, bi-annually, or on multiple occasions within a year.

[2] Data will compiled annually and results will be analyzed in years 1, 3, and 5.

[3] Reporting requirements consist of compilation of data and presentation in an appendix according to provincial format.

[4] Monitoring may be extended if required.

2. OBJECTIVES AND BACKGROUND

2.1. Instream Flow Monitoring

To measure compliance with the instream flow requirement (IFR) set out in the DFO *Fisheries Act* Authorization (09-HPAC-PA2-00303) and water licences, accurate, real-time, instantaneous flow data are being collected throughout the life of the Project. Ramping rate compliance reporting is also required for the life of the Project. The IFR and ramping compliance reporting for Year 5 will be completed separately by ULHP.

2.2. Aquatic and Riparian Habitat

2.2.1. Riparian Revegetation Assessment

The objective of the riparian revegetation effectiveness monitoring component of the OEMP (Harwood *et al.* 2021) is to evaluate the early successional growth and survival of natural and planted vegetation within riparian areas disturbed by Project construction to ensure compliance criteria are met. During permitting, the Project committed to the restoration of riparian areas that had been temporarily impacted during Project construction in accordance with DFO and BC Ministry of Environment, Lands and Parks (DFO and MELP 1998) riparian areas and revegetation protocols and site restoration protocols outlined in Standards and Best Practices for Instream Works (BC MWLAP 2004). Following the completion of the Project, the construction contractor (CRT-ebc 2016) was required to revegetate disturbed areas, and a detailed site-specific reclamation and revegetation plan was developed (McKeachie *et al.* 2016) that was consistent with requirements in the Project's Construction Environmental Management Plan (CEMP; Innergex 2013). In combination with amphibian habitat restoration monitoring (Section 2.7.1), riparian revegetation monitoring also contributes to the assessment of disturbed riparian areas along Coastal Tailed Frog streams.

Site reclamation and revegetation was completed following Project construction. Riparian site reclamation (i.e., replacement of stockpiled topsoil and coarse woody debris) and revegetation efforts began in the fall of 2014 and were completed by the spring of 2017 (Woodruff *et al.* 2017). Riparian reclamation and revegetation efforts included but were not limited to: preparing the substrate; adding stockpiled topsoil; distributing coarse woody debris; and planting vegetation to density, species composition, spacing, and distribution specifications (McKeachie *et al.* 2016). Dave Polster, a native plant community reclamation expert, provided additional direction on the application of local alder seed on the steep slopes above the portal and laydown area of the ULR HEF intake sites (CRT-ebc 2016). The Independent Environmental Monitor (IEM) confirmed that reclamation works were complete for the Project (Hicks and Sartori 2017). In addition, Hedberg and Associates Consulting Ltd. Confirmed that revegetation was completed at the Boulder Creek HEF powerhouse and the ULR HEF intake, penstock (including at two Coastal Tailed Frog streams), downstream portal, and powerhouse (Barker and Staven 2017).

Successful riparian revegetation was evaluated during effectiveness monitoring in accordance with DFO and MELP (1998) revegetation guidelines. Operational revegetation monitoring was recommended for years 1, 3, and 5 of operations (Table 1; Harwood *et al.* 2021). This monitoring schedule differs from that proposed in the DFO long-term monitoring protocols (years 1 through 5) because results from similar projects suggested that annual monitoring is not necessary to identify adaptive management issues. However, if concerns were identified during surveys, additional monitoring and/or management actions would have been required (Harwood *et al.* 2021). This report presents riparian revegetation monitoring results from Year 5.

2.3. Water Temperature and Air Temperature

Water extraction can potentially increase water temperature in the summer and decrease water temperature in the winter (Meier *et al.* 2003). Fish may be vulnerable to small increases and decreases in water temperature, with tolerance levels varying between species and life-history stages. Water temperature and frazil ice (Section 2.3.1) are being monitored continuously in the ULR and Boulder Creek for the life of the Project, as per the EAC (BC EAO 2013). The objective of monitoring water temperature is to identify any biologically significant differences (as defined in Harwood *et al.* 2021) between baseline and operational temperature regimes in the streams. To achieve this, water temperature was monitored continuously for over five years of operation and will be compared to the baseline data using a Before-After-Control-Impact (BACI) design. As per the OEMP (Harwood *et al.* 2021), potential Project effects, using a BACI analysis, will be evaluated after five years of temperature monitoring in a program summary report.

In addition to directly assessing potential differences in water temperature between pre- and post-Project periods in control and impact sites, water temperature monitoring was conducted to assess potential effects on fish caused by Project operation; thus, water temperature is being analyzed and compared between baseline and operational periods with statistics relevant to fish. This involves producing water temperature metrics important to key life history phases of fish and relating these to established guidelines and optimum temperature ranges and thresholds for fish species occurring in the ULR and Boulder Creek.

Commencing in Year 1 of operations (March 2018 at most sites), water temperature was monitored at four sites (one control site and three impact sites) for each of the two HEFs (ULR HEF and the Boulder Creek HEF): one upstream control site, one impact site in the lower diversion, one impact site in the tailrace, and one impact site downstream of the tailrace (Map 2, Map 3). The upstream and diversion sites were established during baseline monitoring; the sites at the tailrace and downstream of the tailrace were established for operational monitoring to assist in the evaluation of potential temperature effects in the downstream reach of the Project. During Year 1 monitoring (see Regehr *et al.* 2019), it was identified that there was a risk that the ULR upstream control water temperature loggers (ULL-USWQ02) could not be reliably accessed for data retrieval and maintenance. Therefore, an additional upstream control site (ULL-USWQ03) was established to replace the original site in November 2018 (Map 2). This site (ULL-USWQ03) was washed out sometime between May 11, 2021, and October 2021; in 2021, another new upstream control site (ULL-USWQ04) was therefore established.

It was also identified in Year 1 that the baseline water temperature regime at the upstream control site in Boulder Creek (BDR-USWQ) was influenced by groundwater from late fall to early spring. Given that data influenced by localized groundwater inflow at BDR-USWQ cannot be used as an effective baseline control record, a new upstream location was established in September 2018 for operational sampling in Boulder Creek (BDR-USWQ2) (Map 3). In addition, another reference site was established in North Creek (NTH-USWQ1) to replace baseline data from BDR-USWQ.

This Year 5 (2022/2023) annual monitoring data report provides a summary of baseline (2008 to 2013) and operational (March 2018 to October 2023) water temperature monitoring results for the ULR and Boulder Creek HEFs. Air temperature data, which may be helpful in the interpretation of water temperature results, have also been recorded at six sites in the Project area, and are included with water temperature results. This report is intended to be primarily a data summary report. Any changes in water temperature related to the operation of each HEF will be evaluated with a BACI analysis in the program summary report.

2.3.1. Frazil Ice

The objective of monitoring frazil ice is to mitigate potential adverse effects of frazil ice build-up on the availability of overwintering habitat for fish during Project operation. Frazil ice formation is largely dictated by localized climatic factors (e.g., air temperature, humidity, and wind speed) and instream characteristics (e.g., water temperature, flow rates, and channel morphology). Generally, frazil ice forms when flowing water is super-cooled to <0.08°C by very cold air temperatures (Calkins 1993).

Air temperatures recorded at Environment Canada meteorological stations in the vicinity of the Project area (i.e., Pemberton Airport and Callaghan Valley) are monitored for those that may result in frazil ice formation. A protocol is initiated when climate and weather conditions indicate the potential for frazil or anchor ice (submerged ice attached or anchored to the bottom) formation. Depending on local air temperatures, the status of Project operations, and visible evidence of ice formation within the HEF diversion reaches, a field survey may be necessary to evaluate the extent of frazil ice formation and determine the appropriate responses.

Shutdowns of the HEFs will be recommended if visual site assessments indicate that frazil ice displaces ≥50% of the fish holding habitat within the hydraulic units (i.e., monitoring sites) surveyed (Harwood *et al.* 2021). Otherwise, shutdowns of the HEFs will not be recommended but monitoring of air temperatures and hydraulic units will continue until the potential risk of frazil ice formation abates.

2.4. Stream Channel Morphology

Hydroelectric projects have the potential to impact channel stability, channel geomorphology, and sediment transport and deposition regimes due to stream flow modification and the construction of an impediment (i.e., weir or intake). These impacts may occur upstream (headpond) and downstream (diversion channel) of the impediment, as well as below the powerhouse. Modifications to stream channel morphology may directly or indirectly alter physical habitats used by fish (Lewis *et al.* 2004). For this reason, targeted mitigation is often employed, such as headpond sluicing and weir lowering during high flow events to mobilize sediment and large wood past the intake infrastructure. In addition, effectiveness monitoring of the applied mitigation and response monitoring of stream channel morphology are often part of the overall long-term environmental monitoring program. Guidelines for stream channel morphology monitoring are provided by Lewis *et al.* (2004, 2013). Stream channel morphology must be monitored before Project implementation and during operations, with a detailed overall assessment following the first 1-in-10-year flood event or after five years of operation, whichever comes first.

The objective of stream morphology monitoring is to observe and assess Project effects on morphology in the diversion reach, downstream of the powerhouse, and upstream of the intake, where the creation of a headpond has the potential to impact sediment storage and transport and thus affect sediment connectivity to reaches downstream. This report summarizes the findings for Year 5 (2023) of the channel morphology monitoring component of the OEMP by comparing the results of field surveys conducted in 2016 (i.e., baseline period) to those conducted in 2023. The assessment was completed in 2023 rather than 2022 because of landslide risks during 2022. Results are interpreted in the context of observed changes, immediate concerns, and potential long-term effects of the Project.

2.5. Fish Community

The construction and operation of a run-of-river HEF can potentially affect the health of the fish community directly or indirectly. The objective of the fish community monitoring program is to assess fish community response during operations and identify any changes in abundance, density, condition, distribution, or timing of migration relative to baseline. Per the OEMP (Harwood *et al.* 2021), the focal species of fish community monitoring are Cutthroat Trout and Bull Trout within the ULR and Bull Trout within Boulder Creek. The monitoring program assesses potential Project effects on fish communities in response to Project operations using a BACI or before-after (BA) study design. As outlined in the OEMP (Harwood *et al.* 2021), fish community monitoring includes sub-components of juvenile density and biomass, adult migration and distribution, and entrainment at the ULR HEF intake. The OEMP underwent revisions in 2021 (Harwood *et al.* 2021), and sampling for juveniles was determined not to be required in years 3 or 4 but was conducted in Year 5.

Methods used for fish community monitoring should be appropriate for the system, fish species, and/or life stage of interest (Lewis *et al.* 2013). Accordingly, methods used for monitoring juvenile fish density and biomass differed between the ULR and Boulder Creek, reflecting differing characteristics of the study reaches and fish communities within them, with closed-site electrofishing conducted in the ULR and mark re-sight snorkel surveys conducted in Boulder Creek. The design of the monitoring study is described in detail in the OEMP (Harwood *et al.* 2021).

For the juvenile fish density and biomass component in all previous years, monitoring was conducted in the diversion reach (impact) and the upstream reach (control) of the ULR and in the diversion reach (impact) and the downstream reach (control) of Boulder Creek. For Year 5 and subsequent monitoring years, access to upstream sampling sites in ULR is restricted due to limited egress options during night snorkelling surveys; therefore, three sites were added in the diversion reach of the ULR to supplement the missing upstream component.

For the adult migration and distribution component, monitoring was conducted in the diversion and downstream reaches of both the ULR HEF and the Boulder Creek HEF, as well as in three reference streams (tributary at river km 29.2 of the ULR, Alena Creek, and North Creek). Alena Creek is also the location of the fish habitat compensation for the Project. Methods used to monitor adult migration and distribution included angling and bank walk surveys with tagging used to help assess movement. Angling surveys were conducted at established monitoring sites in high-grade Bull Trout habitats identified by experienced fisheries technicians. Tributary bank walk surveys were conducted from the confluence with the ULR upstream to the same end point on each survey.

The objective of the entrainment assessment at the ULR intake is to evaluate whether fish entrainment in the ULR HEF intake has a population-level effect on the Cutthroat Trout population upstream of the intake. Sampling consisted of closed-site electrofishing at three sites in a small tributary in the upstream reach of the ULR, similar to previous monitoring years.

2.6. Wildlife Species Monitoring

Project footprint and operational effects are being evaluated for select wildlife species through response monitoring with the objective of evaluating potential operational effects and providing an opportunity to adaptively manage any such identified effects. Response monitoring is prescribed in the OEMP for Harlequin Ducks and for species at risk and of regional concern. Response monitoring was also originally prescribed for Coastal Tailed Frogs; however, due to impacts of the Boulder Creek wildfire in 2015, compliance monitoring of stream restoration was instead prescribed (Harwood *et al.* 2021), which was therefore shifted to compliance monitoring of stream restoration (Harwood *et al.* 2021) and is reported on under wildlife habitat monitoring (see Section 2.7.1). Monitoring of Grizzly Bears (*Ursus arctos*) is being conducted at a regional scale through financial support for the regional provincial population trend monitoring and collaboration on access management (see Harwood *et al.* 2021) and is therefore not a component of the OEMP. Response monitoring for Harlequin Ducks and species at risk and of regional concern was conducted in Year 5 (in 2022). Year 5 results for these two components are presented here, and both are now considered complete (Table 2).

2.6.1. Harlequin Ducks

The objective of Harlequin Duck monitoring is to confirm continued use by Harlequin Ducks of the Project area. These objectives are being met by conducting vantage point surveys (spot checks) (RISC 1998), along with the recording and compilation of incidental observations. Although these methods do not assess all impacted areas for occupancy by Harlequin Ducks or allow comparison of abundance, they can be used to compare use (i.e., presence/not detection) for a specified area pre and post-construction. Harlequin Duck response monitoring is prescribed for the first five years of Project operations (Table 2) with detailed reporting required in years 1, 3, and 5, and brief reporting, consisting of a summary table of results, provided in years 2 and 4.

2.6.2. Species at Risk and Regional Concern

Monitoring of species at risk and of regional concern (as identified within the Sea to Sky Land and Resource Management Plan (MAL 2008)) has two main objectives. First, data on the presence and distribution of wildlife species at risk and of regional concern will be used to determine occupancy and locations of occurrences relative to Project infrastructure; this will allow identification of occurrences that may be affected by Project operations and will inform Project operations on situations that may require consideration (e.g., modification of timing of activities). Second, collection and submission of these data to the province will contribute to the provincial database.

2.7. Wildlife Habitat Monitoring

Monitoring for several wildlife habitat sub-components was completed in previous years. Avian habitat restoration prescribed for Harlequin Ducks and Peregrine Falcons (*Falco peregrinus*) were completed in Year 1 (Regehr *et al.* 2019; Table 2). Similarly, mitigation effectiveness monitoring that evaluated measures developed to minimize avian mortality from transmission line collisions and to protect Mountain Goats (*Oreamnos americanus*) migrating along Truckwash Creek from sensory disturbance and movement disruption related to the ULR HEF was completed in Year 1 (Regehr *et al.* 2019; Table 2). Two wildlife cameras (ULL-CAM02 and ULL-CAM15) were left in place along the Truckwash Creek migration corridor following the completion of monitoring that was required under the OEMP. Camera maintenance was being conducted on an opportunistic basis in coordination with other fieldwork; thus, the cameras were not maintained in 2022 due to high landslide risk. One of these cameras (ULL-CAM15) was burnt in summer 2023 during a forest fire and all stored data from 2022 and 2023 were lost. The other camera (ULL-CAM02) was retrieved on October 27, 2023. This camera contained photos from 2022 and 2023 (up to October 27, 2023), and these data were archived.

2.7.1. Habitat Restoration – Amphibian Habitat

The objective of amphibian habitat restoration compliance monitoring is to confirm that key habitat restoration prescriptions were implemented post-construction for Coastal Tailed Frog terrestrial (riparian) and instream habitat. Habitat restoration measures were prescribed for riparian Coastal Tailed Frog habitat where the transmission line crosses over suitable Coastal Tailed Frog streams, and for both riparian and instream habitat where the ULR HEF penstock crosses a tributary occupied by Coastal Tailed Frogs (ULL-ASTR04). Compliance monitoring was completed at transmission line crossings in Year 1 and no further monitoring was required. At ULL-ASTR04, geotextile had become exposed within the riparian area and stream channel (Regehr *et al.* 2019) so work was completed in the fall of 2019 to cover the exposed geotextile with additional rocky substrate. This work was inspected with another spot check in Year 3, when it was noted that a small section of geotextile had become exposed; this section was re-covered on the day of the spot check. Following recommendations in Year 3, a spot check of instream Coastal Tailed Frog habitat at the penstock crossing (ULL-ASTR04) was conducted in coordination with mammal habitat monitoring in Year 5 (2023) to determine whether the geotextile had remained covered.

2.7.2. Habitat Restoration – Mammal Habitat

Mammal habitat restoration measures were prescribed for Grizzly Bear, Moose (*Alces americanus*), and Mule Deer (*Odocoileus hemionus*) owing to potential effects to habitat of these species during Project construction and to the potential for sensory disturbance that may result when vegetation is cleared and/or access is increased. The objective of mammal habitat compliance monitoring was therefore to confirm that habitat restoration measures had been implemented. For all three species, this involved: 1) confirming that vegetated screens had been maintained or restored between the transmission line RoW and active Forest Service Roads (FSR), where the transmission line RoW is within 10 m of an active FSR and the transmission line RoW passes through legislated protected habitat (Ungulate Winter Range (UWR), Wildlife Habitat Area (WHA)) or high value Grizzly Bear habitat; and 2) that the composition of planted stems met species-specific requirements, as required by conditions of the Project's EAC and GWM exemptions (Table 3). In total, 29 restoration monitoring sites were identified in Year 1 where vegetated screen assessment was conducted. For Grizzly Bears, compliance monitoring was also required to confirm deactivation of access tracks/roads within WHA 2-399 and adherence to food attractant management requirements (outlined in the Human-Bear Conflict Management Plan (Regehr *et al.* 2014) as required by Condition #12 of the TOC).

As stated in Year 1 (Regehr *et al.* 2019) and Year 2 (Harwood *et al.* 2021) reports, access roads in WHA 2-399 were confirmed to have been deactivated, garbage and food waste were being disposed of properly, and greater than 50% planted vegetation composed of native fruit bearing shrubs was confirmed (requirements for Grizzly Bear). Further, revegetation requirements for planted vegetation for Moose and Mule Deer were adequately addressed in Year 1. Thus, these monitoring components were considered complete. However, Year 3 monitoring (Faulkner *et al.* 2021) indicated that many vegetated screens had not attained the required height (5 m), and some had also not attained the required width (5 m). Thus, reassessment in Year 5 was required for 18 of the 29 sites to evaluate if the vegetated screens meet the requirements specified in the OEMP (Harwood *et al.* 2021). This reassessment was completed in 2023.

Table 3. Compliance monitoring required for mammal species (from Harwood *et al.* 2017) (see text for items previously confirmed complete).

Species	Project Component	Facility	Location	Prescription
Grizzly Bear	Upper Lillooet River HEF	Transmission Line	WHA 2-399	• A vegetated screen is maintained or is regrowing between the transmission line RoW and WHA 2-399, following construction and vegetation maintenance.[1] • At least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs.[4] • Temporary roads or access tracks are deactivated and non-drivable with an ATV.[4]
			South Lillooet River FSR	• A vegetated screen (5 m high and wide) is maintained or is regrowing between the transmission line RoW and the Lillooet South FSR where feasible.[2,3]
			All	• A vegetated screen (5 m high and wide) is maintained or is regrowing between field verified suitable foraging habitat (Class 1 and Class 2) and roads or transmission line RoWs, and additional clearings, wherever feasible, following construction and vegetation maintenance.[2,3]
	All	All	All	• Food waste is being disposed of in animal proof containers.
Moose	Upper Lillooet River HEF	Transmission Line	All	• Vegetated screens (5 m high) are permitted to grow where the transmission line RoW is within 10 m of active FSRs or permanent Project access roads, within the Moose ungulate winter range (UWR), where feasible.[2,3] • At least 50% of the planted stems within the revegetated portion of the Moose UWR, away from road verges, are preferred Moose forage species (Appendix A).[5]
Mule Deer	Upper Lillooet River HEF	Transmission Line	All	• Vegetated screens (5 m high and wide) are maintained or are regrowing where the transmission line RoW is within 10 m of active FSRs or permanent Project access roads, within the Deer UWR, where feasible.[2,3,5] • Revegetated portion of the Deer UWR were planted with native species.[5]

[1] Condition 12 of the Project's EA Certificate (EAO 2013) and condition of the GWM Exemption 39585-20 WHA (Berardunicci 2013).

[2] WorkSafeBC safety constraints may prevent such a high screens as the transmission line is designed to meet the CSA Standards.

[3] Note that locations where maintaining a vegetated screen was not feasible must be documented and presented to EAO during the construction phase, as stated within Condition 12 of the Project's EA Certificate (EAO 2013).

[4] Condition of the GWM Exemption 39585-20 WHA (Berardunicci 2013).

[5] Condition of the GWM Exemption 78700-35/06 UWR (Berardunicci 2013).

2.8. Vegetation Monitoring

The objectives of vegetation monitoring are to qualify and quantify the re-growth of vegetation in terrestrial areas disturbed through the construction of the Project, to mitigate short-term habitat loss, and to prevent the introduction of invasive species that may occur through site disturbance. Methods and results are presented in the Year 5 Upper Lillooet Hydro Project Revegetation Assessment Report (Appendix A).

3. METHODS

3.1. Aquatic and Riparian Habitat

3.1.1. Riparian Revegetation Assessment

Riparian revegetation effectiveness monitoring is designed to allow tracking of revegetation progress and thereby confirm that revegetation objectives were achieved, i.e., a diversity of well-established native tree and shrub species with low observed mortality rates. The monitoring design has three main elements (Harwood *et al.* 2021):

1) Use of permanent revegetation monitoring plots to estimate density, species composition, and survival of woody vegetation;
2) Use of quadrats to estimate percent vegetation cover; and
3) Use of photopoint monitoring to provide a visual, qualitative evaluation of revegetation success.

Twelve permanent revegetation monitoring plots (hereafter referred to as "plots") were established in 2018 (Year 1) within revegetated riparian areas associated with Project infrastructure and ancillary components as a means of tracking revegetation progress. Eleven of these plots were placed in association with ULR HEF infrastructure: three at the intake, six along the penstock, and two near the powerhouse. Two of the ULR HEF penstock plots (ULL-PRM08 and ULL-PRM09) were placed adjacent to a Coastal Tailed Frog stream (Map 4) to contribute to the assessment of disturbed riparian areas along ULL-ASTR04 that was completed in Year 1 (Section 2.7.1). One plot was placed near the Boulder Creek HEF powerhouse (Table 4; Map 4).

Plot locations were selected to be representative of the site conditions (e.g., soil, slope, moisture) present in the revegetated areas they represented. Their locations were also selected to be at, or near, vantage points with views of the revegetated areas, which was needed for effective photographic monitoring. Plot locations selected in Year 1 of the monitoring program were used for Year 3 and Year 5 monitoring. Revegetation monitoring in Year 5 was conducted on August 30 and September 5, 2023.

Each of the three main monitoring elements is described in the sections below.

Table 4. Locations of permanent riparian revegetation monitoring plots surveyed in Year 1, Year 3, and Year 5.

Location	Permanent Monitoring Plot	UTM Coordinates Zone	Easting	Northing	Description
Boulder Creek HEF Powerhouse	BDR-PRM01	10U	471338	5609325	River right of the Boulder powerhouse tailrace. Representative of the revegetation on the slope below the road adjacent to Boulder Creek.
Upper Lillooet River HEF Intake	ULL-PRM01	10U	466045	5614094	River right of Upper Lillooet River and upstream of the intake. Site provides a view of naturally revegetating slope.
	ULL-PRM02	10U	466236	5614031	River right of Upper Lillooet River and downstream of the intake. Site provides view of naturally revegetating slope. Slope is rough and loose.
	ULL-PRM03	10U	466112	5614110	River left of Upper Lillooet River and upstream of the intake. Site provides view for monitoring the revegetation on the slope below the road and above the intake.
Upper Lillooet River HEF Penstock	ULL-PRM04	10U	467946	5612993	River right of Truckwash Creek.
	ULL-PRM05	10U	468001	5612957	River left of Truckwash Creek.
	ULL-PRM06	10U	468188	5612695	River right of a tributary to the Lillooet River and upslope of the road.
	ULL-PRM07	10U	468215	5612654	River left of a tributary to the Lillooet River and downslope of the road.
	ULL-PRM08	10U	468392	5612384	River right of ULL-ASTR04, representative of the revegetated upper bench.
	ULL-PRM09	10U	468398	5612361	River left of ULL-ASTR04.
Upper Lillooet River HEF Powerhouse	ULL-PRM10	10U	468428	5611630	River left of the Upper Lillooet River HEF tailrace. Representative of the revegetated slope above the tailrace.
	ULL-PRM11	10U	468407	5611689	River right of the Upper Lillooet River HEF tailrace, representative of the revegetated slope above the tailrace.

3.1.1.1. Density, Species Composition, and Survival of Woody Vegetation

Woody vegetation is the primary focus of riparian revegetation monitoring due to its long-term contribution to maintaining and enhancing riparian habitat and function. Plots were established to measure the density and survival of perennial woody vegetation. The fixed-area circular plots were 50 m^2 in size, in accordance with the BC Silviculture Stocking Survey Procedures (BC MFLNRO 2015) and vegetation tally procedures employed by the Stand Development Monitoring Protocol (BC MFLNRO 2014).

Revegetation performance was evaluated in permanent revegetation monitoring plots through comparison with the DFO and MELP (1998) riparian revegetation guideline target stem density values. Effective revegetation was evaluated based on 80% survival of initial plant stock with a maximum target spacing of 2.0 m (or less, if appropriate, considering the size of mature stock). Survival could not be directly estimated because planted stock was not marked, and therefore could not be tracked or differentiated from natural revegetation. Instead, the proportion of dead stems to living stems (considering both planted and naturally regenerating stems) was used to provide general information on survival and possible trends in revegetation, in conjunction with other measures such as stem density.

Target stem density was calculated using the following formula (Forest Renewal BC 2001):

$$\text{spacing (m)} = \sqrt{(11{,}547/\#\text{ stems per hectare})}$$

Thus, based on single-stemmed plants planted 2.0 m apart, the target density is 2,887 stems per hectare (stems/ha). To meet the target of 80% survival, spacing must average 2.2 m, and vegetation must have a density of 2,309 stems/ha. This density was considered when setting the average target densities of 1,200 tree stems/ha and 2,000 shrub stems/ha by the end of the monitoring period (Harwood *et al.* 2021). To evaluate whether this target has been achieved across all revegetation areas, 90% confidence limits calculated from a two-tailed t-distribution were generated to reflect sample size and among-plot variability.

Within each of the twelve permanent revegetation monitoring plots (Table 4; Map 4), the number of stems of all native perennial woody plants (which includes trees and shrubs and excludes forbs, grasses, and mosses) was counted, and health and mortality checks were conducted. Stems were defined as those stems of a plant that are distinctly individual at ground level. Tree or shrub seedlings with secondary leaves that were at least the size of a quarter were large enough to be considered established and counted, and stems were counted regardless of plant height, spacing, or species. Stems showing signs of abiotic stress, insect damage, fungal blights, or other afflictions were all counted as living. Incidences of these afflictions and the species of the affected host plant were noted, where possible. As invasive plant species can impede the establishment of native woody vegetation, invasive plant species were recorded and hand-pulled, if feasible, when encountered.

3.1.1.2. Percent Vegetation Cover

Grasses and herbs and woody species provide sediment and erosion interception and ground stabilization early in the revegetation process. Quadrats were used to estimate the percent cover of low-lying vegetation within the revegetation areas represented by the permanent monitoring plots. Percent vegetation cover was estimated within a 0.25 m^2 quadrat divided into 25 - 10 x 10 cm squares. Quadrats were placed on the ground, and the 25 squares were used to guide vegetation cover estimates. For example, if 20 squares were filled with vegetation, the total estimated percent cover of the quadrat would be 80% because each square equals 4% of the total area. When squares were partially filled with vegetation, a single cover estimate was made from the combined cover within individual squares. For example, if one square was half filled with vegetation, one was a quarter filled, and three squares had only two small blades of grass each, the combination of these would equal one full square of cover, or 4%. Percent vegetation cover was estimated as an average value of ten replicates randomly placed within each revegetation area represented by the twelve permanent revegetation monitoring plots. Percent vegetation cover was considered when assessing the overall trajectory and success of riparian revegetation and the potential for erosion and sedimentation. Qualitative notes of general site conditions, including any soil erosion or potential soil erosion, were also recorded.

3.1.1.3. Photopoint Comparison

Photopoint monitoring was conducted to allow visual qualitative evaluation of changes in revegetation among years (i.e., years 1, 3, and 5 of operations) and thereby aid in the interpretation of results from the two quantitative revegetation effectiveness evaluation methods. Photos were taken from the centre of plots and from specific plot locations at vantage points that overlooked the revegetation area represented by the plot. Standard photographs were taken from 1.3 m above each of the plot's centre facing north (0º), east (90º), south (180º), and west (270º), and of the plot centre. Additional photographs were taken of specific areas where revegetation challenges were identified, or successes were observed to support professional opinions on site-specific revegetation effectiveness or future revegetation requirements. Photographs were archived to provide documentation of changes in vegetation over time.

3.2. Water Temperature and Air Temperature

3.2.1. Study Design

The ULR and Boulder Creek baseline and operational water and air temperature site names, site elevations, period of record, number of days with valid data, and the percent of the period of record where there are data gaps are summarized in Table 5 and Table 6, respectively. Detailed water and air temperature baseline methodology and data analysis are provided in the aquatic baseline report (Harwood *et al.* 2013). Representative photos for each water temperature monitoring site are provided in Appendix B. Site locations in the ULR and Boulder Creek are shown on Map 2 and Map 3, respectively.

Baseline water temperature was monitored in the ULR at an upstream control site (ULL-USWQ1; November 2008 to June 2013) and at a lower diversion site (ULL-DVWQ; November 2010 to May 2013) (Table 5; Map 2). Baseline water temperature was monitored in Boulder Creek at an upstream control site (BDR-USWQ; April 2010 to May 2013) and in the diversion reach (BDR-DVWQ; November 2008 to June 2013) (Table 6; Map 3).

Operational water temperature monitoring commenced in March 2018 at three monitoring sites in the ULR: the upstream site (ULL-USWQ02), the tailrace site (ULL-TAILWQ) and the site downstream of the tailrace (ULL-DSWQ). In November 2018, operational monitoring commenced at the lower diversion site (ULL-DVWQ01), and at a new upstream site (ULL-USWQ03), which was established due to difficult access to ULL-USWQ02 (Section 2.3). ULL-USWQ03 washed out between May 2021 and October 2021, and a new control site (ULL-USWQ04) was established in November 2021; however, this site was also washed out by October 2022, and replacement sensors were installed, which collected data through to October 2023 (Table 5).

Operational water temperature monitoring in Boulder Creek commenced in March 2018 at three monitoring sites: one in the lower diversion (BDR-DVWQ), one at the tailrace (BDR-TAILWQ), and one downstream of the tailrace (BDR-DSWQ). In September 2018, temperature loggers were installed at an upstream site in Boulder Creek (BDR-USWQ2) and in North Creek (NTH-USWQ1 because the BDR-USWQ baseline site was found to be influenced by groundwater (Section 2.3)), to continue concurrent collection of water temperature data for at least one year of operational monitoring (Table 6). Temperature data loggers that were installed in September 2018 at the upstream site (BDR-USWQ2) were destroyed during storm events. Therefore, new temperature data loggers were installed on October 11, 2019, resulting in a data gap from September 2018 to October 2019 (Table 6). Tidbits were re-installed at this site in October 2019, and data were successfully collected through to October 2023. Furthermore, the single temperature logger at BDR-DVWQ was buried in boulders and cobbles between August 3, 2022 and October 30, 2022 (the other temperature logger was lost); thus, data during this period were synthesized using water temperature data collected at the diversion reach hydrometric gauge, BDR-DVLG01 (Table 6).

Concurrent monitoring of water temperature at BDR-USWQ2 and NTH-USWQ1 was initiated in Year 3. This was continued in Year 4 to provide an additional year (October 2020 to October 2021) of data to assess the relationship between water temperatures in the two creeks, as recommended in Year 3 (Faulkner *et al.* 2021). The relationship between water temperatures at the two sites will be used to make minor adjustments to the baseline (2010 to 2013) record of late fall to early spring temperatures, which is anticipated to represent baseline temperatures more reliably in the upstream reach of Boulder Creek for the BACI analysis which will be conducted for the program summary report.

In the ULR, baseline air temperature was monitored continuously at two sites established near the water temperature sites: one upstream (ULL-USAT; April 2010 to May 2013) and one in the lower diversion (ULL-DVAT; April 2010 to May 2013) (Map 2; Table 5). Operational air temperature data are being recorded at two sites in the ULR: one in the upstream reach (ULL-USAT01; March 2018 to April 2019, ULL-USAT02; October 2019 to May 2021) and one in the downstream reach (ULL-DSAT; March 2018 to August 2021; Table 5; Map 2). Only five complete months (November and December 2019, November and December 2020, and April 2021) of air temperature data are available for ULL-USAT02 due to damage to the sensor at this location. A new sensor was installed in October 2020. However, it provided limited data because of damage sustained during the monitoring period. The sensor appears to have been buried in snow in January 2021, collecting data reflecting this (flat around 0°C) until mid-March 2021, after which the sensor began recording a minimum temperature of -9°C and continued to record data for one full month. A third air temperature site, ULL-USAT03, was established in October 2021 and has provided continual data since this date (Table 5).

Air temperature in Boulder Creek was recorded at one site in the lower diversion (BDR-DVAT) for both baseline (April 2010 to May 2013) and operational monitoring (March 2018 to October 2023; Table 6; Map 3).

At the time of site visits in November 2022, a full five years of operational water temperature data was not complete for several water temperature monitoring sites. Monitoring for Year 5, therefore, continued into 2023. This Year 5 report presents water and air temperature data collected up to October 6, 2023. The operational period of record spans five and a half calendar years (March 2018 to October 2023) and corresponds to Year 1, Year 2, Year 3, Year 4, and Year 5 of the monitoring program (Table 5, Table 6). Baseline water and air temperature data are provided for comparison in the report and for reference in Appendix C.

Table 5. Summary of water temperature site names, location, and period of data record in the Upper Lillooet River during baseline (2008 to 2013) and operational monitoring (2018 to 2023).

Type	Project Phase	Site	UTM Coordinates (10U)		Elevation	Periods of Record		Number of Days on Record	No. of Days with Valid Data	Data Gaps (% Complete)
			Easting	Northing	(masl)[1]	Start Date	End Date			
Water	Baseline	ULL-USWQ1	466,097	5,614,105	666	19-Nov-2008	03-Jun-2013	1,658	1,653	100
		ULL-DVWQ	468,283	5,612,234	490	12-Nov-2010	01-May-2013	902	632	70
	Operation	ULL-USWQ02[2]	464,122	5,614,982	684	28-Mar-2018	11-Oct-2019	563	441	79
		ULL-USWQ03	465,530	5,614,484	673	01-Nov-2018	11-May-2021	923	919	100
		ULL-USWQ04	465,530	5,614,484	673	18-Oct-2022	06-Oct-2023	354	352	100
		ULL-DVWQ01[3,4]	468,344	5,611,968	481	01-Nov-2018	06-Oct-2023	1,801	1,245	69
		ULL-TAILWQ	468,423	5,611,670	474	28-Mar-2018	06-Oct-2023	2,019	1,689	87
		ULL-DSWQ	468,601	5,611,202	463	28-Mar-2018	06-Oct-2023	2,019	1,926	96
Air	Baseline	ULL-USAT	466,097	5,614,105	666	07-Apr-2010	01-May-2013	1,121	1,084	97
		ULL-DVAT	468,375	5,612,158	483	07-Apr-2010	01-May-2013	1,121	763	69
	Operation	ULL-USAT01[5]	464,141	5,614,996	687	28-Mar-2018	11-Apr-2019	380	307	81
		ULL-USAT02	468,677	5,611,155	463	24-Oct-2019	11-May-2021	566	195	35
		ULL-USAT03	465,724	5,614,451	678	30-Oct-2021	06-Oct-2023	707	0	100
		ULL-DSAT	468,677	5,611,155	463	28-Mar-2018	06-Oct-2023	2,019	1,003	61

[1] Estimated from Google Earth.

[2] Data gap from November 14, 2018 to March 13, 2019 due to low water levels and ice affecting sensors.

[3] Data gap from March, 2020 to October, 2020 due to damaged sensor.

[4] Data gap from December, 2020 to May, 2021 due to buried sensor under snow.

[5] Data gap from January, 2020 to March, 2021 due to buried sensor under snow.

ULL-DVAT was re-named ULL-DSAT in 2018.

Table 6. Summary of water temperature site names, location, and period of data record in Boulder Creek during baseline (2008 to 2013) and operational monitoring (2018 to 2023).

Type	Project Phase	Site	UTM Coordinates (10U)		Elevation	Periods of Record		Number of Days in Record	No. of Days with Valid Data	Data Gaps in Record (% Complete)
			Easting	Northing	(masl)[1]	Start Date	End Date			
Water	Baseline	BDR-USWQ[2]	474,102	5,614,069	1,005	22-Apr-10	01-May-13	1,106	1,103	99
		NTH-USWQ1	484,433	5,605,934	911	12-Sep-10	01-May-13	963	963	100
		BDR-DVWQ	471,561	5,609,323	488	15-Nov-08	06-Jun-13	1,665	1,655	99
	Operation	BDR-USWQ2[3]	474,580	5,614,356	1,030	24-Sep-18	06-Oct-23	1,839	1,454	79
		NTH-USWQ1	484,433	5,605,934	911	24-Sep-18	06-Oct-23	1,839	1,836	100
		BDR-DVWQ[4]	471,561	5,609,323	488	16-Mar-18	27-Oct-23	2,052	1,837	90
		BDR-TAILWQ	471,326	5,609,383	488	16-Mar-18	26-Oct-23	2,051	1,527	78
		BDR-DSWQ	470,972	5,609,176	488	16-Mar-18	09-May-23	1,881	1,709	91
Air	Baseline	BDR-DVAT	471,561	5,609,323	490	08-Apr-10	01-May-13	1,120	1,120	100
	Operation	BDR-DVAT	471,561	5,609,323	490	16-Mar-18	27-Oct-23	2,052	2,047	82

[1] Estimated from Google Earth.

[2] Due to groundwater inputs at BDR-USWQ winter data during the baseline period for this site were synthesized from NTH-USWQ, including: Nov. 26, 2010 to May 21, 2011; Oct. 22, 2011 to April 23, 2012; October 24 to 30, 2012; and Nov. 8, 2012 to April 26, 2013.

[3] Data gap from Sept. 24, 2018 to Oct. 11, 2019 due to loss of temperature loggers during storm flows.

[4] Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01 (UTM Coordinates: 10U 471,478 m E; 5,609,325 m N) due to temperature logger being buried in boulders and cobbles.

3.2.2. Fish Species Distribution and Optimum Temperatures

The fish distribution in the ULR has been described in the OEMP (Harwood *et al.* 2021) (Table 7). The fish species targeted for temperature monitoring in the ULR and Boulder Creek are Bull Trout and Cutthroat Trout; Coho Salmon are also targeted for the ULR. Cutthroat Trout may be present at all temperature monitoring site locations in the ULR and at the diversion and downstream locations on Boulder Creek, while Bull Trout are limited to the diversion and downstream locations of both the ULR and Boulder Creek. Coho Salmon have been detected in the lower diversion and downstream reaches of the ULR.

Bull Trout are the most thermally sensitive species present in the ULR and Boulder Creek. This fish species generally prefers cooler temperatures than Cutthroat Trout and Coho Salmon. The BC water quality guideline (BC WQG; BC ENV 2023) for water temperature specifies optimum temperature ranges for rearing, spawning, incubation, and migration for these fish species (Table 7).

Table 7. British Columbia Water Quality Guideline (BC WQG) optimum temperature ranges for spawning, incubation, rearing, and migration of Cutthroat Trout, Bull Trout, and Coho Salmon and their distribution in the Upper Lillooet River and Boulder Creek (BC ENV 2023).

Fish Species	Optimum Water Temperature Range (°C)				Fish Presence	Reach
	Spawning	Incubation	Rearing	Migration[1]		
Cutthroat Trout	9.0 - 12.0	9.0 - 12.0	7.0 - 16.0	-	Upper Lillooet River	Upstream, diversion, and downstream
					Boulder Creek	Lower diversion and downstream
Bull Trout[2]	5.0 - 9.0	2.0 - 6.0	6.0 - 14.0	-	Upper Lillooet River	Diversion and downstream
					Boulder Creek	Lower diversion and downstream
Coho Salmon[2]	4.4 - 12.8	4.0 - 13.0	9.0 - 16.0	7.2 - 15.6		Diversion and downstream

[1] A dash (-) indicates guideline not applicable.

The BC WQG for water temperature is ± 1°C outside the optimum temperature range for each life stage.

[2] Bull Trout and Coho Salmon are only present in the lower diversion and downstream reaches of the Upper Lillooet River. They are not present above Keyhole Falls.

3.2.3. Data Collection and Analysis

Operational water temperature was recorded at intervals of 15 minutes using self-contained Onset Tidbit® data loggers. The loggers are accurate to ±0.2°C and have a resolution of 0.02°C. Two Tidbit loggers were installed on separate anchors at each location. This redundancy ensured availability of data in case one of the loggers malfunctioned or was lost. Air temperature was recorded at intervals of 15 minutes, using a self-contained Onset HOBO U23-002 Temp/RH sensor (range of -20°C to 70°C, accuracy of ±0.21°C from 0°C to 50°C).

The period of record at ULR and Boulder Creek monitoring sites for Years 1, 2, 3, 4, and 5 (2018, 2019, 2020, 2021, 2022/2023) is from March 2018 to October 2023 (Table 5, Table 6; Map 2, Map 3). Data availability is based on the most recent download of water temperature loggers, and data gaps are documented in Section 3.2.1.

Water temperature and air temperature data were processed by identifying and removing errors as part of a thorough quality assurance and quality control (QA/QC) procedure. QA/QC spot temperature figures are presented in Appendix D. Before analysis, temperature data were carefully inspected to ensure that any suspect or unreliable data were excluded from data analysis and presentation. Excluded data include those recorded when the water temperature sensor was suspected of being out-of-water/dry, affected by snow/ice, or buried in sediment.

The accuracy of the Tidbit temperature readings was evaluated by periodically performing *in situ* spot temperature measurements and comparing these results to the corresponding data logged with the Tidbit sensor (Appendix D). Note that due to an oversight by field crews, no water temperature spot measurements were collected at the ULR or Boulder Creek monitoring sites in 2021.

After removing errors identified during the QA/QC procedure, the records from duplicate loggers were averaged, and records from different download dates were combined into a single time series for each monitoring site. The time series for all sites was then interpolated to a regular interval of 15 minutes (where data were not already logged at a 15-minute interval), starting at the full hour.

Data are presented in plots generated from water and air temperature data collected at, or interpolated to, 15-minute intervals. Analysis of the data involved computing the following summary statistics: monthly statistics (mean, minimum, and maximum water temperatures for each month of record, as well as differences in water temperature among sites), days with extreme mean daily temperature (i.e., >18°C and <1°C), days with exceedances of the minimum and maximum Bull Trout temperature thresholds, the length of the growing season, accumulated thermal units in the growing season (e.g., degree days), hourly rates of temperature change, and mean weekly maximum temperature (MWMxT). These statistics are defined and described in Table 8, and applicable guidelines are discussed in Section 3.2.4.

Following Year 2 reporting (Faulkner *et al.* 2020), historical data (including baseline) underwent updated cleaning to ensure it was processed according to current standards. As a result, some revisions to historical data were made to improve accuracy, and values presented herein may differ from those presented in previous years OEM reports. Key changes included:

- Hourly Rates of Water Temperature Change - the percentage of records calculated as the total # of valid hourly change records with a rate of change >1ºC, whereas some historical data included the total # of temperature records, rather than valid records.
- Mean weekly maximum temperature (MWMxT) - changes from previous versions of this analysis include:
    - The inclusion of a cut-off whereby a day is excluded from the calculation if it does not include data during the warmest period of the day. By default, a day is excluded when it does not have at least one hourly measurement between 11:00 and 18:00.
    - The calculation of a "week" for the growing season as a centred average (i.e., three days before and three days after the day for which MWMxT is being calculated). Therefore, the growing season's computed start and end date are three days later and three days earlier, respectively.
- Growing Season Statistics - rules for the length of gaps that can be interpolated were applied to historical data: the maximum gap cannot exceed 14 days. In addition, start and end dates for weekly averages are defined in terms of calendar weeks (the start/end dates reported are the start of the calendar week containing the day the threshold was crossed), resulting in a change in start/end dates of ± 3 days.
- Further review of operational data collected at the upstream sites in the ULR has resulted in the exclusion of previously reported data collected at ULL-USWQ02 between November 14, 2018, to March 13, 2019, due to the sensors likely being buried in snow/ice.

3.2.4. Applicable Guidelines

The water temperature BC WQG for the protection of aquatic life (as per Oliver and Fidler 2001; BC ENV 2023) and the water temperature metrics that were calculated are described below and summarized in Table 8.

Table 8. Description of water temperature metrics and methods of calculation.

Metric	Description	Method of Calculation
Monthly statistics	Mean, minimum, and maximum on a monthly basis	Calculated from 15 minute data (interpolated where necessary) and presented in tabular format.
Rate of water temperature change	Hourly rate of change	Calculated from 15 minute data (interpolated where necessary); presented in summary tables and graphical form.
Degree days in growing season	The beginning of the growing season is defined as the beginning of the first week that mean stream temperatures exceed and remain above 5°C; the end of the growing season was defined as the last day of the first week that mean stream temperature dropped below 4°C (as per Coleman and Fausch 2007).*	Daily mean water temperatures were summed over this period (i.e., from the first day of the first week when weekly mean temperatures reached and remained above 5°C until the last day of the first week when weekly mean temperature dropped below 4°C).
Number of Days of Extreme Daily Mean Temperature	Daily average temperature extremes for all streams	Total number of days with daily mean water temperature >18°C , >20°C , and <1°C.
Number of Days of Exceedance	Daily maximum and minimum temperature thresholds for streams with Bull Trout / Dolly Varden	# days maximum daily temperature is >15°C; # days maximum incubation temperature is >10°C; # days minimum incubation temperature is <2°C; # days maximum spawning temperature is >10°C.
MWMxT (Mean Weekly Maximum Temperature)	Mean, minimum, and maximum on a running weekly (7 day) basis	Mean of the warmest daily maximum water temperature based on hourly data for 7 consecutive days; e.g., if MWMxT = 15°C on August 1, 2008, this is the mean of the daily maximum water temperatures from July 29 to August 4, 2008; this is calculated for every day of the year.

* See text in Section 3.2.3 discussing modification to the temperature criteria that defines the end of growing season.

3.2.4.1. Hourly Rates of Water Temperature Change

Rapid changes in heating or cooling of water temperature can affect fish growth and survival (Oliver and Fidler 2001). Hourly rates of change in water temperature were compared to the BC WQG, which specifies that the hourly rate of water temperature change should not exceed ±1.0°C/hr (BC ENV 2023).

3.2.4.2. Daily Temperature Extremes

Extreme cold or warm temperatures are monitored as part of the water temperature component. The number of days when the daily mean temperature was <1°C was calculated, along with the number of days when the daily mean temperatures were >18°C and >20°C because these temperatures correspond to the upper bound of optimum temperature conditions for salmonids

(Oliver and Fidler 2001). Since the ULR and Boulder Creek are cool streams where maximum temperatures recorded to date have not exceeded 15°C, the number of days of water temperatures >18°C and >20°C was not reported.

Bull Trout-specific water temperate guidelines (Table 7) were applied to the water temperature records by calculating the number of days of exceedance of the minimum and maximum temperature thresholds. For both ULR and Boulder Creek, the upstream sites were not considered, as Bull Trout are not present in the upstream reaches. In BC, Bull Trout are considered to have the highest thermal sensitivity of the native salmonids evaluated by Oliver and Fiddler (2001). Therefore, more restrictive guidelines are applied to streams with this species.

3.2.4.3. Mean Weekly Maximum Temperature

The MWMxT is an important indicator of prolonged periods of cold and warm water temperatures that fish may be exposed to. The BC WQG states, "Where fish distribution information is available, then mean weekly maximum water temperatures should only vary by ±1.0°C beyond the optimum temperature range of each life history phase for the most sensitive salmonid species present" (Oliver and Fidler 2001; BC ENV 2023). Accordingly, MWMxT values were compared to the optimum temperature ranges for the fish species present based on the life history and periodicity (Table 7).

Within each life history period, the completeness of the temperature data record (% complete) was calculated, and results were only included if at least 50% of the data for the period were available. The minimum and maximum MWMxT values, % data within the optimum range, and % exceedance of ±1.0°C of the optimal temperature range were calculated for each life history period to evaluate the suitability of the temperature regime for each fish species/reach (Table 7) during baseline and operational monitoring.

3.2.5. Frazil Ice

A protocol was established in December 2017 to monitor frazil ice conditions in the ULR and Boulder Creek diversion reaches and the potential effects of frazil ice formation on fish habitat availability (Harwood *et al.* 2021). An automated alarm system was set up that triggers an email alert to Ecofish QPs when mean daily air temperatures of -5ºC or lower are forecasted for five consecutive days at the Pemberton Airport and/or Callaghan Valley meteorological stations. From October 2017 to February 2022, after three consecutive days of mean daily air temperatures of -5ºC or lower, as measured at either station, if the HEFs are still operating, an Ecofish QP notifies the operators and requests photographs of the diversion reach taken from established photo monitoring points in the lower diversion reach of each HEF to determine if frazil ice is visible. Between March 2022 and December 2023, the temperature threshold was -12ºC following the recommendations of Year 4. If there is evidence of frazil ice and the HEFs remain operational, a crew is mobilized to the site to perform assessments of the percentage of fish-holding habitat displaced by frazil ice at established frazil ice monitoring sites. A total of five monitoring sites have been established in the diversion reach of each HEF (Map 5).

After a field survey has been conducted, an Ecofish QP reviews the results and provides written communication to the Project Environment and Operations teams. The communication includes a professional evaluation of the severity of frazil ice accumulations and recommended actions, which may be to cease monitoring, continue monitoring at a defined schedule, or shutdown the HEF until mean daily air temperatures increase above -12 ºC and/or a follow up survey indicates that the risk of additional ice formation has abated. This report includes Year 5 air temperature data, photographs, and frazil ice assessments completed in 2022/23 and a summary of monitoring conducted between Year 1 and Year 5.

3.3. Stream Channel Morphology

3.3.1. Study Design

The OEMP stipulates that operational monitoring of stream channel morphology will be conducted pre-Project and five years after facility commissioning. Usually, monitoring of stream channel morphology must be conducted once pre-Project and once following a 1-in-10-year flood event or after five years- whichever comes first. An overview assessment of stream channel morphology was conducted by Northwest Hydraulic Consultants in 2011 to provide background information for Project design and environmental assessment purposes (NHC 2011). However, additional geomorphic data were required to meet the requirements of the assessment and monitoring guidelines (Lewis *et al.* 2004, 2013) and the OEMP (Harwood *et al.* 2021). The additional data were collected shortly after the headpond and powerhouse were constructed in September 2016.

Several monitoring elements were assessed to identify potential Project effects on stream channel morphology and the associated quality and quantity of fish habitat. We first evaluated the natural geomorphic processes of the catchment, non-Project related disturbances that could confound the Project effects assessment, and the sluicing and operational history of the Project. A preliminary qualitative photo-based assessment followed using a Remotely Piloted Aircraft System (RPAS) to identify potential Project effects on stream channel morphology. If potential effects on stream channel morphology were detected through the RPAS photo-based assessment, the quantitative methods used for baseline were to be used to quantify Project effects further.

The stream channel morphology and habitat quality and quantity observations were summarized and interpreted to identify any Project effects. The preliminary qualitative RPAS photo review indicated that the potential Project effect pathways, including spawning gravel transport re-establishment through the headpond, substrate coarsening and loss of spawning gravel downstream of the headpond, aggradation of spawning gravel in diversion reach, channel narrowing in the diversion reach, channel incision in the downstream reach, and reduction in large wood present below the headpond were trivial in the diversion and downstream reaches. Given the minimal changes observed in the qualitative assessment, it was deemed unnecessary to complete the detailed geomorphic assessment in Year 5 (2023). Methods for each monitoring component are detailed below.

3.3.2. Natural Geomorphic Processes and Background Disturbances

A review of catchment processes that influence the sediment supply regime was completed to help interpret the cause of any observed changes. This included assessment of historical and current logging rates, development activities, and other landscape disturbances such as mass wasting, wildfire, insect outbreaks, and changes in water use. To help interpret interannual and longer-term changes in morphology, annual peak flows were also examined for ULR using the real-time hydrometric data from Water Survey Canada – Lillooet River Near Pemberton gauge (08MG005 and for Boulder Creek using the BDR-DSLG02 gauge daily averages at the downstream site on Boulder Creek.

3.3.3. Sluicing and Operational History

The intake structure of the ULR HEF comprises a sluice gate and Obermeyer spillway that can be opened or lowered to allow bedload and large wood transport. The intake structure of the Boulder Creek HEF is comprised of a sluice gate that can be opened to allow bedload and large wood transport and a Coanda spillway that can not be lowered. Transport of bedload and wood through the headpond can potentially influence diversion and downstream morphology. Sluice gate and weir operational history were recorded as specified in the OEMP to document bedload passage timing, duration, and effectiveness (Harwood *et al.* 2021). The timing, magnitude, duration, and effectiveness of sluicing and weir lowering events were examined to help interpret observed changes in the morphology of ULR and Boulder Creek.

3.3.4. Qualitative Observations of Geomorphic Change

3.3.4.1. Aerial Photograph Monitoring of Channel Morphology

Aerial imagery of the upstream, headpond, diversion, and downstream reaches was collected on September 23, 2016. Collection of aerial imagery was repeated using a DJI Mavic 2 Pro RPAS on October 27 and 28, 2023. A total of ten photo points were established in the upstream reaches of ULR and Boulder Creek in 2016, with photos looking upstream, downstream, towards the river left bank, and towards the river right bank. In 2023, photo point monitoring was collected in the upstream reaches at sites ULL-USGM01 to ULL-USGM05 and BDR-USGM01 to BDR-USGM05 (Map 6 and Appendix E, Map 7 and Appendix F, respectively). Downward-facing overlapping imagery was collected at an altitude of 90 m to create 2 cm/pixel accuracy orthomosaic images. Ten orthomosaic images were captured in the ULR (Appendix G) and five orthomosaic images were taken in Boulder Creek (Appendix H). These orthomosaic images were captured in the upstream, headpond, diversion, and downstream reaches. The photopoint and aerial imagery were compared to the 2016 baseline to qualitatively assess the changes in spawning gravel bar character, amount of large wood in each reach, and changes in active channel width.

3.3.5. Summary and Interpretation

The results of the channel morphology monitoring were summarized and interpreted to identify Project effects. The results are discussed in the context of the potential Project effects pathways that are assessed to be most likely given previous assessments of similar projects. These effects pathways include:

- Absence of spawning gravel transport through the headpond;
- Substrate coarsening downstream of the headpond (Fuller *et al.* 2016);
- Loss of spawning gravel downstream of the headpond;
- Aggradation of spawning gravel in the diversion reach (SNC Lavalin 2012);
- Channel narrowing in the diversion reach;
- Channel incision downstream of the headpond; and
- Net reduction in large wood downstream of the headpond.

Each effect pathway is discussed relative to a before and after comparison. An overall conclusion regarding each effect pathway is provided with a low, medium, or high confidence level that incorporates the agreement between each line of evidence and the uncertainty of each monitoring element.

3.4. Fish Community

Per the OEMP (Harwood *et al.* 2021), the fish community in the ULR and Boulder Creek is monitored through several components, such as juvenile fish density and biomass, adult fish distribution and migration, and fish entrainment assessment of the ULR HEF intake. Baseline ("before") data were collected from 2010 to 2014 (Harwood *et al.* 2016a, 2016b), and operational ("after") data were collected in Year 1 (2018), Year 2 (2019), and Year 5 (2022/2023). Two years of operational data are required to be collected between Year 7 and Year 10 of the Project (Harwood *et al.* 2021).

3.4.1. Juvenile Fish Density and Biomass

3.4.1.1. Overview

Per the OEMP (Harwood *et al.* 2021) and consistent with baseline sampling, methods to monitor juvenile fish density and biomass differ between the ULR and Boulder Creek based on differences in stream conditions, with closed-site electrofishing used for monitoring in the ULR and mark re-sight snorkel surveys used in Boulder Creek. Sampling of juvenile density and biomass is focussed on fry and juvenile resident and migratory species (e.g., Bull Trout and Cutthroat Trout); however, resident adults of these species are also present and are included in the assessment.

Consistent with baseline monitoring, Year 5 juvenile fish sampling was conducted in early April 2022 within both the ULR and Boulder Creek, when conditions are most suitable for closed-site electrofishing and mark-re-sight snorkel surveys (e.g., low flow and low turbidity). Consistent with baseline monitoring, sampling within both systems was conducted at night because salmonids are known to be nocturnal and hide in interstitial spaces during the day in the winter (Campbell and Neuner 1985; Thurow *et al.* 2006). Upper Lillooet River closed-site electrofishing sites are shown in Appendix L and Map 8, and Boulder Creek mark re-sight snorkel sites are shown in Appendix N and Map 9.

3.4.1.2. Upper Lillooet River

Closed-Site Electrofishing

Juvenile fish within the ULR were monitored using closed-site multi-pass electrofishing performed by experienced crews in a manner consistent with baseline sampling. Eight sites have been established within the diversion reach and ten sites in the upstream reach (Map 8; upstream sites are not included as they were not sampled in 2022 following changes to the OEMP (Harwood *et al.* 2021). In 2022, three additional sample sites were established in the diversion reach (Map 8) due to access limitations to the upstream reach, totalling seven sampled sites in 2022.

At each site, closed-site multi-pass removal electrofishing involved isolating a stream section, conducting electrofishing within this section, and collecting habitat data. Prior to conducting electrofishing, a section of stream was fully enclosed with one to two stop nets (0.5 cm mesh size) to prevent fish movement into or out of the site. Electrofishing was conducted in these enclosures using a multi-pass removal methodology consistent with guidelines (Lewis *et al.* 2004; Hatfield *et al.* 2007) and the removal-depletion procedures described in Cowx (1983). A two-person crew fished at least two full circuits of the enclosure during each pass, with two to three passes conducted at each site. As a general rule, if at least one fish was captured or observed during the second pass then a third pass was conducted. Sample sites were left undisturbed for ~15-30 minutes between electrofishing passes while captured fish were processed and/or habitat data were collected. All electrofishing was conducted using a Smith-Root electrofisher unit (LR-24).

All captured fish were anaesthetized prior to processing. During processing, fish were identified to species, weighed (±0.1 g, or 1 g for fish over 200 g), measured for fork length (±1 mm), and photographed. Scale samples were collected from subsamples of Cutthroat Trout representing all life stages and were mounted directly on microscope slides in the field for future laboratory aging. To ensure adequate representation of each life stage in the scale samples, samples were collected from each reach from at least two suspected fry (0+) from the previous year (<60 mm), and from a representative sample of juvenile-sized individuals (60 to 150 mm) and adults (>150 mm). Fin ray samples were collected from Bull Trout ≥100 mm in length. Small fin clip samples were also collected from captured fish and preserved in 95% ethanol for future DNA analysis to verify species identification. Somatic fatty acid composition was measured in fish greater than 150 mm using a non-invasive Distell Model 992 Fish Fatmeter (Distell Inc., West Lothian, Scotland). All captured fish were scanned for passive integrated transponder (PIT) tags. If no PIT tags were detected, a PIT tag was implanted into the body cavity of each fish greater than approximately 60 mm in length to allow assessment of movement in future years. After processing, fish were placed in a bucket of fresh water to recover. Upon recovery, and after all electrofishing passes were completed, fish were released back into the sample site. Any fish mortalities associated with electrofishing activities were recorded.

Physical habitat data were collected at each of the sites in accordance with guidelines outlined in RISC (2001) and Appendix A of Lewis *et al.* (2004) and described in the OEMP. Alkalinity, water temperature, and conductivity were also recorded at each site. Water depth and velocity were measured along one or two representative transects within the site (to obtain a minimum of 10 verticals per site, each placed a minimum of 0.5 m apart). Depth and velocity were measured using a calibrated Swoffer velocity meter (Model 2100) and a 140 cm top-set rod (8.5 cm diameter propeller). The mean length and wetted width of each net enclosure were measured to determine the surface area of the site.

Age Analysis

The fish density and biomass analysis require that the fish species of interest be separated into age classes. To define discrete age classes of Cutthroat Trout, the length-frequency histograms for fish captured during electrofishing were reviewed along with all of the length-at-age data from the scale analysis in previous years. Based on a review of these data, discrete fork length ranges that allow all fish to be assigned an age class based on fork length were defined for each of the following age/life history classes: fry (0+), juvenile (1-2+), and adult (≥3+) for Cutthroat Trout and fry (0+), juvenile (1-3+) and adult (≥4+) for Bull Trout. For the juvenile fish sampling in the late spring, winter annuli from the previous winter are not detected on aging structures. Thus, the age classes presented for this sampling are consistent with the age classes for the fall of the previous year, which matches the approach taken during baseline sampling (e.g., fry (0+) detected in the spring of 2022 emerged in 2021). Fin ray samples collected from Bull Trout were not processed and aged in 2022 because of the small sample size of this species and the uncertainty in the aging of Bull Trout fin ray samples in the Project area during the baseline period. For these reasons, age classes for this species were derived primarily from length-frequency results and are consistent with the baseline period. Fin ray samples have been collected and archived and may be examined in the future if required.

Fish Metrics and Condition

Data analysis of individual fish consisted of defining age class structure and describing other characteristics of the fish populations, including length-frequency distributions, length-weight relationships, relative condition factor (K_r), and length-at-age. To overcome limitations of dependencies of the condition factor on fish length, the relative condition factor (K_r) was calculated as follows:

$$K_r = \left(\frac{W}{\widehat{W}}\right)$$

where W is the weight of the fish in g, and $\hat{W}$ is the predicted body weight from a length-weight relationship (Le Cren 1951). If K_r is equal to 1, the fish is in average condition, if K_r is below 1 the fish is in condition lower than average, and if K_r is larger than 1 then the fish is in condition better than average.

Density and Biomass Estimates

Fish density and biomass were calculated from abundance estimates by age class (fry (0+), juvenile, adult, and all ages combined) for each species in each electrofishing site. Individual fish were assigned to specific age classes based on the age-length relationship analysis described in Section 3.4.1.2 above. Fish abundance estimates were computed using the Carle-Strub K-Pass removal depletion function (Carle and Strub 1978) within the FSA package (Ogle 2016) in R (R Core Team 2018). Size and age class-specific fish abundance estimates were then divided by site areas to standardize fish numbers per unit area (i.e., density). Density estimates of each age class and age class grouping were then multiplied by the corresponding average biomass values estimate biomass per unit area. Fish density and biomass estimates are expressed as FPUobs (#/100 m²) and BPUobs (g/100 m²), respectively.

3.4.1.3. Boulder Creek

Night Snorkelling Mark Re-sight

Juvenile fish within Boulder Creek were monitored using night snorkeling mark re-sight surveys performed by experienced crews consistent with baseline and operational surveys to date. Snorkel surveys were conducted within an impact stream reach located within the diversion reach and a control section within the downstream reach at sites composed of high-quality fish habitats that were selected through a stratified non-random process during baseline monitoring. Upstream of the Boulder Creek intake is non-fish-bearing; therefore, control sites were established in the downstream reach. Ten sites were sampled in 2022 (five sites in each reach; Map 9). Sites were first visited during daylight when sampling areas were measured, photographed, and marked with flagging tape.

Each site was sampled on two consecutive nights. During the first night of sampling, one to three snorkelers swam each site and captured fish using dip nets. All safely accessible areas of each site were sampled, and an attempt was made to capture all observed fish using dip nets. Captured fish were tagged and measured for fork length but were not weighed or photographed to minimize disturbance, which is consistent with Korman *et al.* (2010). Fish were also not anaesthetized because of uncertainty about behavioural effects of the anaesthetic. Fish were tagged with hook tags applied to dorsal fins and scaled with fish size to minimize the effects of tagging on fish behaviour and to help estimate their fork length during re-sight swims. After fish had recovered from tagging, they were released into a low-velocity area near where they were first captured at the end of the mark survey.

On the second night of sampling, a re-sight swim was conducted within all safely accessible areas of each site typically by a crew of two snorkelers. Snorkelers captured as many fish as possible using dip nets to collect data on weights and length-at-age and to verify fork lengths estimated by snorkelers. Captured fish were processed using the same methods described in Section 3.4.1.2, including a collection of fin ray and fin clips, scanning all fish for PIT tags, and PIT tagging fish greater than approximately 60 mm in length. After sufficient recovery time, fish were released back into the sites where they were originally captured. Habitat data were collected, and site conditions were recorded at each snorkel site as described in Section 3.4.1.2, exception for depth-velocity transects not collected in Boulder Creek, consistent with baseline sampling.

Snorkelers also conducted a re-sight swim that included the 25 m upstream and downstream of the site in cases where sites were not constrained by a physical barrier to evaluate the emigration of fish from sites. During re-sight swims snorkelers recorded species, the presence of hook tags (marks), and estimated fork length (to the nearest 5 mm or 10 mm for fish < or ≥ 100 mm, respectively) of all observed fish. Sampling these areas outside the site boundaries allowed a test of the assumption that populations within mark re-sight sites are effectively closed to fish migration for the 24 hours between the two sampling events.

Age Analysis

Calculating fish density estimates and comparing control and impact sites requires that fish be separated into age classes. Age classes were defined as described in the *Age Analysis* subsection of Section 3.4.1.2. Density analyses were conducted based on general age classes derived from combined length-frequency results from both reaches and all years of monitoring rather than reach- and year-specific length-at-age data, consistent with the approach taken during baseline monitoring.

Fish Metrics and Condition

Data from individual captured fish were analyzed following the same methods described in the *Fish Metrics and Condition* subsection of Section 3.4.1.2. Length-frequency distributions were created using all fish lengths collected, including fish captured and marked on the first night of sampling and those captured following the re-sight swim on the second night. The length-weight relationship included fewer data points as only the fish captured following the re-sight swim were weighed.

Density Estimates

Fish abundance estimates for each observed age class of Bull Trout, and Cutthroat Trout were calculated based on snorkel mark re-sight data in each site by correcting the total number of fish observed during each survey by the observer efficiency of snorkelers. Average observer efficiency for each age class was calculated separately for the diversion reach and downstream reach using the following equation (Korman *et al.* 2010):

$$oe = \frac{\sum_1^n \frac{R}{(M-O)}}{n}$$

where, *oe* is the average observer efficiency, *n* is the number of sites, *R* is the number of re-sighted fish at each site, *M* is the number of initially marked fish at each site, and *O* is the number of marked fish observed outside of the site. As indicated by the equation, any marked fish observed outside of the site were removed from the observer efficiency calculation by subtracting them from the number of initially marked fish.

Average observer efficiency was then used to calculate abundance estimates for each age class within each site using the following equation:

$$Abundance = \frac{O_{rs}}{oe}$$

where O_{rs} is the number of fish observed during the re-sight survey.

The standard assumptions in a mark recapture/re-sight study apply to adjustment of observed abundance by observer efficiency:

- The population is closed between sample dates;
- Marked fish mix with all fish in the population;
- Fish captured/observed are a random sample from the population; and
- The fish re-sighted during the re-sight swim are randomly sampled from the population.

Due to the low numbers of fish marked at each site, the mark re-sight data were pooled to calculate mean observer efficiency, as indicated by the equation above. The mean observer efficiency of Bull Trout was also used to calculate abundance estimates of Cutthroat Trout due to the low number of Cutthroat Trout captured. The density per area (#/100 m^2) of each age class within each site was then calculated by dividing the abundance estimate by the sampled area of the site. Densities are presented for individual sites and overall averages per age class and age class grouping. Biomass estimates were not calculated for fish in Boulder Creek due to the small sample size of captured fish.

Abundance Action Threshold (AAT)

Juvenile Bull Trout densities are also compared to abundance action thresholds (AAT) set for the Boulder Creek HEF (Harwood *et al.* 2021). According to the AAT rules, observed declines in all age classes combined of juvenile Bull Trout density (e.g., 0+ to 3+) of ≥50% relative to average density during the three years of baseline study in the diversion reach, with no corresponding decrease evident in the corresponding control reach, would initiate an investigation into the cause of the decline. Similarly, an 80% reduction in the number of fish within a specific age class in a diversion reach during operations (relative to average abundance of that age class in the diversion reach during the three years of baseline study) would initiate an investigation if there was no corresponding decrease in the relevant control reach. The investigation is required to consist of an analysis of the biotic (e.g., fish density, stranding observations) and abiotic (e.g., water temperature, water chemistry) data; supplemental data collection or comparison with additional data sources; data synthesis and interpretation, and a professional judgement regarding the cause-effect relationship underlying the observed changes. If this investigation supports a professional opinion that Project operations are the cause of the decline, then additional mitigation measures should be developed to avoid these effects (Harwood *et al.* 2021).

3.4.2. Adult Migration and Distribution

The objective of this sub-component is to ensure that IFR flows, along with local inflows and spill events, are adequate to allow the upstream spawning migration of Bull Trout into the Project streams.

Angling surveys were the preferred method on larger turbid waterbodies (i.e., Upper Lillooet, Boulder Creek, and North Creek), while bank walk visual surveys were conducted on smaller less turbid tributaries (i.e., tributary at river km 29.2 and Alena Creek). These two methodologies are outlined in further detail in the subsections below.

3.4.2.1. Bull Trout Angling Surveys

Angling surveys were conducted during the Bull Trout spawning migration window (September 15 to October 22, 2023) in the downstream and diversion reaches, at the tailrace of both the ULR and Boulder Creek, and in a section of North Creek (which serves as a reference creek).

The angling survey area on Boulder Creek included approximately 400 m downstream and 500 m upstream from the powerhouse and the tailrace. Angling effort upstream of the powerhouse was limited due to the safety concerns associated with accessing the entrenched canyon section. The fish-bearing reach on Boulder Creek is considered to extend from the confluence with the ULR upstream 2.64 km, with approximately 1.7 km of the diversion reach accessible to fish. The entire length of the diversion reach of ULR is fish bearing, but Bull Trout distribution is limited by Keyhole Falls, which is located approximately 3 km upstream of the ULR HEF powerhouse. The angling survey area on North Creek included an approximately 600 m section, starting 1 km upstream from the confluence with the ULR.

Angling surveys were conducted at established monitoring sites (Map 10), that had been identified by experienced fisheries technicians. Each survey was conducted by two experienced anglers, with effort scaled to account for the fishable area of each site, but no less than 0.75-rod hours were spent per site. As such, CPUE was calculated for each site and then averaged to capture variance between sites.

Typically, angling was conducted using roe as bait under a float, as this proved to be most effective during baseline monitoring. However, spoons and/or spinners were also used when appropriate. All captured fish were anaesthetized prior to processing. During processing, fish were identified to species, weighed (±0.1 g for fish ≤ 200 g, ±1 g for fish > 200 g), measured for fork length (±1 mm), assessed for sexual maturity based on the presence of gametes, and photographed. Scale samples were collected from subsamples of any Cutthroat Trout captured. Small fin clip samples were also collected from captured fish that were preserved in 95% ethanol and archived for future DNA analysis if required.

All captured fish were scanned for passive integrated transponder (PIT) tags. If no PIT tags were detected, a PIT tag was implanted into the dorsal side of the fish of each fish greater than approximately 180 mm in length or in the body cavity if <180 mm to allow assessment of movement in future years. After processing, fish were placed in a bucket of fresh water to recover. Upon recovery, fish were released back into the sample site. Relevant site characteristics and conditions were also recorded during angling surveys.

Visual assessments of the potential for fish passage and upstream access were conducted during angling surveys during the spawning migration period on the lower 1.2 km of Boulder Creek. As crews were moving upstream, the potential for fish passage at critical locations identified during baseline studies (Faulkner *et al.* 2011) was visually assessed for connectivity at the observed flows, and connectivity was estimated for maximum flows (determined from the high-water points on banks). Visual assessment of fish passage and upstream access was also assessed during angling surveys for approximately 500 m upstream of the ULR HEF powerhouse.

3.4.2.2. Tributary Bank Walk Bull Trout Spawner Surveys

Bull Trout migration, distribution, and spawning was also monitored using bank walk spawner surveys on three separate occasions (between September 13 and October 22) in fall of 2023 at two reference tributaries of the ULR as specified in the OEMP (Harwood *et al.* 2021): the tributary at km 29.2 of the ULR (29.2 km Tributary) (three surveys) and Alena Creek (three surveys). These reference tributaries are monitored to help assess the potential confounding effects of the Capricorn/Meager slide in August 2010 on the results of the monitoring program in the ULR and Boulder Creek. The additional monitoring allows the assessment of changes to fish populations in the Project and reference streams by analyzing temporal trends in metrics to identify the recovery rate of both the Project and reference streams from the slide. At 29.2 km Tributary and Alena Creek, bank walk spawner surveys were conducted by walking along the shore during the Bull Trout spawning period and recording the number of spawning fish, any carcasses, and redds. Survey lengths at 29.2 km Tributary and Alena Creek differ between year and sampling date due to changes in the highwater mark of the ULR and the current positioning of side channels in the river.

3.4.3. Assessment of Entrainment at the Upper Lillooet River Intake

Baseline sampling indicated that the Cutthroat Trout population in the upstream reach of the ULR is highly dependent on tributary habitat and movement by fish into and out of these tributaries creates a potential risk of entrainment in the ULR HEF intake. This risk is greatest for resident Cutthroat Trout in the mainstem, and those moving back and forth between tributary and mainstem habitat, in the vicinity of the intake. Assessment of entrainment at the ULR HEF intake was conducted in fall 2023 by sampling and tagging fish at three sites established in 2013 in the unnamed tributary that flows into the facility's headpond at the 87.0 km marker upstream from Lillooet Lake (hereafter referred to as "87.0 km Tributary"). Cutthroat Trout density and biomass is assessed over time to examine whether any increase or decreases in abundance have occurred.

3.5. <u>Wildlife Species Monitoring</u>

3.5.1. Harlequin Ducks

Harlequin Duck monitoring was conducted at the ULR HEF intake and powerhouse through vantage point surveys (spot checks) (RISC 1998) along with the recording and compilation of incidental observations. According to the protocols, spot checks were conducted during two time periods when Harlequin Ducks are most likely to be observed on the breeding stream: the pre-incubation period (month of May) when Harlequin Duck pairs are on the river ("pair" survey), and the brood-rearing period (late July to late August) when males have departed from breeding streams and the female is rearing her brood ("brood" survey). In Year 5 (2022), spot checks were conducted at the intake and the powerhouse on May 1, 6, and 14, and on August 10, 15, and 21. The standardized protocols (Appendix I) were followed for most surveys, but the intake vantage point was not accessible on August 10 and 15 due to landslide risk and the surveys in this location were therefore conducted using the remote camera from inside the powerhouse (using a zoomable surveillance camera) to view the headpond on these dates. Surveys on August 21 at the intake, and all surveys for the powerhouse, were completed in person with binoculars or spotting scope from the vantage points as specified in the protocols (Appendix I).

Data collected during spot checks included survey date, location, time, and number of individuals observed, as well as age, sex, and behaviour (e.g., feeding, flying, group or pair behaviour), if relevant (i.e., Harlequin Ducks were observed). Any comments on weather conditions or survey limitations were recorded, and photos were taken of any occurrence observations. Observations of other waterbirds seen during surveys were also recorded. If seen incidentally outside of targeted surveys, Harlequin Duck observations were recorded by plant operations staff, consulting biologists, and technicians throughout the year.

In accordance with objectives of Harlequin Duck monitoring, survey results were compared between pre-construction (baseline) and post-construction monitoring periods to evaluate continued use by Harlequin Ducks of the Project area. During baseline inventory surveys, Harlequin Duck observations were conducted over a larger area than visible from vantage point spot check locations visited during monitoring (Regehr *et al.* 2016). Thus, only those Harlequin Ducks seen during baseline years at locations where spot checks were conducted (vantage points at the intake and powerhouse) were included in the comparison between baseline and monitoring periods.

3.5.2. Species at Risk & Regional Concern

All incidental observations of wildlife species at risk or of regional concern documented by Innergex and Ecofish personnel within the Project area in Year 5 (2022) were recorded and were compiled according to provincial format to facilitate data sharing. In previous years, incidental observations of species at risk and regional concern also included detections from two remote infrared wildlife cameras in the vicinity of Truckwash Creek (ULL-CAM02 and ULL-CAM15) that had been left in place following the completion of the Mountain Goat mitigation effectiveness monitoring component associated with the ULR HEF portal. As described in Section 2.7, data that were available from these cameras for 2022 and 2023 were archived.

3.6. Wildlife Habitat Monitoring

3.6.1. Habitat Restoration - Amphibian Habitat

A spot check of instream and riparian Coastal Tailed Frog habitat at the ULR HEF penstock crossing (ULL-ASTR04) was conducted in Year 5 (2023) to evaluate potential exposure of geotextile. In particular, the effectiveness of the substrate addition in 2019 that was completed to cover exposed geotextile and the repairs of the small section that had been found uncovered in Year 3 (2020) were assessed. The spot check in Year 5 was conducted on July 27, 2023.

3.6.2. Habitat Restoration - Mammal Habitat

Mammal habitat restoration compliance monitoring for Grizzly Bears, Moose, and Mule Deer involved confirming compliance with prescribed habitat restoration measures, which included confirmation of the presence and adequacy of vegetated screens at established restoration monitoring sites (between active FSR and the transmission line RoW where the RoW passes through Grizzly Bear WHA 2-399 or other high value (Class 1 and Class 2) Grizzly Bear habitat and through Moose or Mule Deer UWR). Monitoring was conducted from July 27 to July 28, 2023 at the 18 monitoring sites (Table 9; Map 11, Map 12, Map 13) where reassessment in Year 5 had been recommended (see Year 3 report; Regehr *et al.* 2021). Some monitoring sites had been established to monitor requirements for a single mammal species and others applied to more than one species.

Assessment of the requirements for vegetated screens at restoration monitoring sites in high value mammal habitat required confirmation of screen presence as well as assessment of screen characteristics at each site. This involved taking three sets of measurements of screen height and width and three sets of estimated percent coverage of visibility through the screen and generating an average of each measure/estimate for the vegetated screen for each site. Photographs were also taken to photo-document screen appearance and condition and allow visual comparison to Year 1 and Year 3 results. At 1 of the 18 sites (ULH-MAMCM02) the assessment was limited to a visual inspection and photographs; measurements were not taken due to the steepness of the site and position high above the road.

Table 9. Locations of mammal vegetated screen monitoring sites that required reassessment in Year 5 and dates of reassessments.

Site	Species and Habitat[1]	Date	UTM Coordinates (Zone	
			Easting	Northing
ULH-MAMCM01	Grizzly Bear - High Value	27-Jul-2023	468746	5611295
ULH-MAMCM02	Grizzly Bear - High Value	27-Jul-2023	468915	5611147
ULH-MAMCM04B	Grizzly Bear - High Value	27-Jul-2023	476857	5603920
ULH-MAMCM06	Grizzly Bear - High Value Mule Deer - UWR	27-Jul-2023	480898	5603041
ULH-MAMCM08	Mule Deer - UWR	27-Jul-2023	481796	5602741
ULH-MAMCM09	Grizzly Bear - High Value Mule Deer - UWR	27-Jul-2023	482647	5602427
ULH-MAMCM10	Mule Deer - UWR	27-Jul-2023	482954	5602219
ULH-MAMCM12	Moose - UWR	27-Jul-2023	485810	5600967
ULH-MAMCM14	Grizzly Bear - WHA 2-399 Moose - UWR	28-Jul-2023	487543	5599229
ULH-MAMCM17	Grizzly Bear - South Lillooet River FSR	28-Jul-2023	491512	5597274
ULH-MAMCM19	Grizzly Bear - South Lillooet River FSR	28-Jul-2023	492224	5596959
ULH-MAMCM21	Grizzly Bear - High Value Mule Deer - UWR	28-Jul-2023	499872	5591204
ULH-MAMCM22	Grizzly Bear - High Value	28-Jul-2023	500113	5591109
ULH-MAMCM23	Grizzly Bear - High Value	28-Jul-2023	501095	5590537
ULH-MAMCM24	Grizzly Bear - High Value Mule Deer - UWR	28-Jul-2023	501419	5590366
ULH-MAMCM26	Grizzly Bear - High Value Mule Deer - UWR	28-Jul-2023	503208	5588834
ULH-MAMCM27	Grizzly Bear - High Value	27-Jul-2023	507825	5577642
ULH-MAMCM28	Grizzly Bear - High Value	27-Jul-2023	507856	5577626

[1] High value Grizzly Bear habitat is considered as Class 1 or Class 2 as identified by habitat suitability modelling (Leigh-Spencer *et al.* 2012) and confirmed in the field (Leigh-Spencer *et al.* 2013).

4. RESULTS

4.1. Aquatic and Riparian Habitat

4.1.1. Riparian Revegetation Assessment

Overall, Year 5 monitoring results indicate that site conditions are generally good (i.e., adequate soil retention, adequate amounts of topsoil and no major erosion concerns) and that riparian revegetation is progressing successfully. In Year 5, the average stem densities of both trees and woody shrubs, estimated from all monitoring plots combined, met the stem density targets. The results of vegetation cover and photopoint monitoring further demonstrate that riparian revegetation is on track to provide riparian functions, with no major concerns noted. The following sections present the results of each of the three monitoring methods.

4.1.1.1. Density, Species Composition, and Survival of Woody Vegetation

In Year 5 of the monitoring program, average tree and shrub stem densities (11,333 ± 2,981 tree stems/ha and 5,567 ± 2,150 shrub stems/ha) estimated from all permanent revegetation monitoring plots combined met the density targets of 1,200 tree stems/ha and 2,000 shrub stems/ha (Table 10). Although there was variability in tree and shrub stem density among plots (counts of living tree and living shrub stems per plot ranged from 25 to 127 and 7 to 77, respectively; Table 10), the target for trees was met at all individual plots, and the target for shrubs was met at all but one plot (ULL-PRM03; Table 11). The survival of planted stock could not be assessed, as discussed in Section 3.1.1.1 (DFO and MELP 1998; Harwood *et al.* 2021). However, woody vegetation—whether planted or not—is establishing successfully, as evidenced by overall high stem density, and supported by the lack of dead stems in Year 5 (Table 10).

Estimated stem densities and trends between years varied between revegetation areas, as described below.

At the Boulder Creek HEF powerhouse (plot BDR-PRM01), total woody stem density was estimated at 16,400 stems/ha, a slight increase from Year 3 (15,000 stems/ha; Faulkner *et al.* 2021). Both tree and woody shrub stem density increased from Year 3.

At the ULR HEF intake, the average density of living woody stems was estimated at 13,867 stems/ha (10,400 tree stems/ha, 3,467 shrub stems/ha), based on the three permanent monitoring plots combined (ULL-PRM01, ULL-PRM02, and ULL-PRM03; Table 11). This represented an increase from Year 3. Estimated tree stem densities for all three plots were above the 1,200 stem/ha target, and estimated shrub stem densities were at or above the 2,000 stem/ha target for all but one plot (ULL-PRM03). Although estimated shrub density remained below the target in ULL-PRM03 in Year 5, it increased to 1,400 stems/ha from 800 stems/ha in Year 3, and no mortalities were observed (Table 10, Table 11; Figure 1). Some possible mechanical disturbance was noted at ULL-PRM01, and shrub density was right at the target (2,000 stems/ha; Figure 2).

Along the ULR HEF penstock, the average density of living woody stems was estimated at 16,267 stems/ha (8,867 tree stems/ha, 7,400 shrub stems/ha) based on the six permanent monitoring plots combined (Table 11). Estimated tree and shrub stem densities exceeded the target densities in all of the individual plots, and nearly all had increased stem densities relative to Year 3. The largest increase was in tree stem density in ULL-PRM09, primarily due to a large increase in the number of black cottonwood (*Populus balsamifera* ssp. *Trichocarpa),* and red alder (*Alnus rubra*) stems (Figure 2, Figure 3).

At the ULR HEF powerhouse, the average woody stem density (23,600 stems/ha) in the two monitoring plots (ULL-PRM10 and ULL-PRM11) remained higher than in other areas, similar to the Year 1 and 3 monitoring results. This was primarily due to the abundant natural regeneration of black cottonwood, willow (*Salix* spp.) and western hemlock (*Tsuga heterophylla*) (Figure 4).

Species diversity increased slightly from Year 3, and species composition remained similar, with slight shifts in the relative abundance of species. A total of 21 species were observed within the plots (8 tree and 13 shrub species) during Year 5 monitoring (Table 12). The tree species were black cottonwood, coastal Douglas-fir (*Pseudotsuga menziesii*), red alder, western hemlock, western redcedar (*Thuja plicata*), lodgepole pine (*Pinus contorta var. latifolia*), Douglas maple (*Acer glabrum*), and a new tree species for Year 5: western white pine (*Pinus monticola*; Figure 5). Shrub species included species such as black raspberry (*Rubus leucodermis*), kinnikinnick (*Arctostaphylos uva-ursi*), red-osier dogwood (*Cornus stolonifera*), salmonberry (*Rubus spectabilis*), and thimbleberry (*Rubus parviflorus*). Snowbrush (*Ceanothus velutinus*) was newly observed in Year 5. The number of species per plot ranged from five (ULL-PRM01) to 12 (BDR-PRM08). Similar to Year 3, black cottonwood was the most abundant tree species (overall average estimated density of 5,800 ± 2,164 stems/ha) and was found in every plot. Red alder was the second most abundant tree species (overall average estimated density of 2,267 ± 1,556 stems/ha) and was found in 10 of the 12 plots. Black raspberry was again the most abundant shrub species (overall average estimated density of 2,183 ± 2,010 stems/ha) and was found in seven of 12 plots (Table 12). No bull thistle (*Cirsium vulgare*) or other invasives were observed in Year 5 in any plots (Table 11) (bull thistle was removed from ULL-PRM08 and ULL-PRM06 in Year 3).

Table 10. Numbers of living and dead woody stems within twelve permanent revegetation monitoring plots (50 m^2) in 2023.

Location	Permanent Monitoring Plot	Count of Woody Vegetation Stems within Plot			
		Live Trees	Live Shrubs	Total Live	Total Dead
Boulder Creek HEF Powerhouse	BDR-PRM01	54	28	82	0
Upper Lillooet River HEF Intake	ULL-PRM01	38	11	49	0
	ULL-PRM02	42	35	77	0
	ULL-PRM03	75	7	82	0
Upper Lillooet River HEF Penstock	ULL-PRM04	39	78	117	0
	ULL-PRM05	48	44	92	0
	ULL-PRM06	25	50	75	0
	ULL-PRM07	30	18	48	0
	ULL-PRM08	43	16	59	0
	ULL-PRM09	79	18	97	0
Upper Lillooet River HEF Powerhouse	ULL-PRM10	126	16	142	0
	ULL-PRM11	81	13	94	0
Mean		56.67	27.83	84.50	0.00
Standard Deviation		28.75	20.74	27.08	0.00
Standard error of the mean		8.30	5.99	7.82	0.00
t-value_90%		1.7959	1.7959	1.7959	1.7959
Confidence Interval		14.91	10.75	14.04	0.00
2023 Expected Density (stems/ha)		**11,333**	**5,567**	**16,900**	**0**
2023 Confidence Interval (± stems/ ha)		**2,981**	**2,150**	**2,808**	**0**
2020 Expected Density (stems/ha)		**12,333**	**4,883**	**17,217**	**50**
2020 Confidence Interval (± stems/ ha)		**8,148**	**1,504**	**8,336**	**47**
2018 Expected Density (stems/ha)		**7,317**	**2,817**	**10,133**	**117**
2018 Confidence Interval (± stems/ ha)		**7,073**	**883**	**7,377**	**150**

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Table 11. Estimated vegetation density within twelve permanent revegetation monitoring plots and percent vegetation cover within the associated riparian revegetation areas in 2023.

Location	Permanent Monitoring Plot	Estimated Tree Vegetation Density (stems/ha)	Estimated Shrub Vegetation Density (stems/ha)	Total Estimated Woody Vegetation Density (stems/ha)	Estimated Vegetation Cover (%)	Comments
Boulder Creek HEF Powerhouse	BDR-PRM01	12,600	3,800	16,400	48	Planted stock thriving, good regeneration. 1.5 m high. Limited herbaceous cover.
Mean		*12,600*	*3,800*	*16,400*	*48*	
Upper Lillooet River HEF Intake	ULL-PRM01	7,800	2,000	9,800	45	This site looks partially disturbed in some areas; appears it was accessed by large machinery to conduct rip rap work on river right of the headpond. Large woody debris present, moderate herbaceous cover. Moderate regeneration of alder and willow.
	ULL-PRM02	8,400	7,000	15,400	45	Excellent regeneration on the east side of the site, with alder, fireweed, and cottonwood. Moderate regeneration on the west side. Planted stock survival rate is good, dry rocky soil.
	ULL-PRM03	15,000	1,400	16,400	50	Dry rocky soil. Good survival rate for planted stock, but limited in height (~0.60 - 0.70 m tall). Limited herbaceous cover. Good regeneration of alder and black cottonwood, abundant.
Mean		*10,400*	*3,467*	*13,867*	*47*	
Upper Lillooet River HEF Penstock	ULL-PRM04	8,000	15,400	23,400	42	Excellent survival rate for all planted stock, growing tall (1.4 m - 2.1 m; cedars, black cottonwood). Moderate herbaceous cover with good natural regeneration.
	ULL-PRM05	9,800	8,600	18,400	59	Excellent regeneration, very dense and tall vegetation. Planted stock is thriving, moderate herbaceous cover.
	ULL-PRM06	5,000	10,000	15,000	44	Planted stock is thriving, good natural regeneration with increased heights compared to Year 3. Moderate regeneration of herbaceous cover.
	ULL-PRM07	6,000	3,600	9,600	40	Planted stock continues to thrive, excellent survival rate. Some conifers are 1.7 m high. Moderate herbaceous cover. Five spreading dogbane in plot.
	ULL-PRM08	8,600	3,200	11,800	31	Planted stock has good survival rate, with increased heights compared to Year 3 monitoring. Limited natural regeneration of herbaceous cover. South-facing aspect.
	ULL-PRM09	15,800	3,600	19,400	39	Excellent regeneration along the creek, abundant alder and cottonwood ~2 - 2.5 m tall, providing good cover and shade in the stream. Limited herbaceous cover, good survival rate for planted stock. South-facing.
Mean		*8,867*	*7,400*	*16,267*	*43*	
Upper Lillooet River HEF Powerhouse	ULL-PRM10	25,400	3,000	28,400	55	Excellent regeneration. Fir and alder trees are ~2.2 m high. Planted stock is thriving, no dead vegetation observed.
	ULL-PRM11	16,200	2,600	18,800	29	Dry, south-facing slope with no shade. Limited herbaceous cover, successful survival rate for planted stock. Moderate regeneration at this site.
Mean		*20,800*	*2,800*	*23,600*	*42*	
Overall mean		**11,550**	**5,350**	**16,900**	**44**	

Table 12. Number of trees and shrubs by species in the twelve permanent revegetation monitoring plots in 2023.

Location	Permanent Monitoring Plot	Trees								Shrubs													*Total*
		black cottonwood (*Populus balsamifera ssp. trichocarpa*)	Douglas maple (*Acer glabrum*)	Douglas-fir (*Pseudotsuga menziesii*)	lodgepole pine (*Pinus contorta var. latifolia*)	red alder (*Alnus rubra*)	western hemlock (*Tsuga heterophylla*)	western redcedar (*Thuja plicata*)	western white pine (*Pinus monticola*)	black huckleberry (*Vaccinium membranaceum*)	black raspberry (*Rubus leucodermis*)	false azalea (*Menziesia ferruginea*)	kinnikinnick (*Arctostaphylos uva-ursi*)	Oregon grape (*Berberis* sp.)	Nootka rose (*Rosa nutkana*)	red-osier dogwood (*Cornus stolonifera*)	salmonberry (*Rubus spectabilis*)	snowbrush (*Ceanothus velutinus*)	thimbleberry (*Rubus parviflorus*)	huckleberry (*Vaccinium* sp.)	western mountain-ash (*Sorbus scopulina*)	willow (*Salix* sp.)	
Boulder Powerhouse	BDR-PRM01	22	0	21	9	5	4	2	0	0	0	0	5	0	0	1	8	0	5	0	0	0	82
Upper Lillooet Intake	ULL-PRM01	10	0	0	1	28	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	7	49
	ULL-PRM02	21	0	5	0	10	0	6	0	0	13	0	0	0	0	0	0	0	0	0	1	21	77
	ULL-PRM03	25	0	8	0	39	1	2	0	0	0	0	5	0	1	0	0	0	0	0	0	1	82
Upper Lillooet Penstock	ULL-PRM04	13	0	15	0	1	0	10	1	0	65	0	0	0	0	4	0	0	1	0	0	7	117
	ULL-PRM05	25	1	21	0	2	0	0	1	0	31	0	0	0	0	0	0	1	2	0	0	8	92
	ULL-PRM06	17	0	6	0	0	1	1	0	0	12	0	15	1	0	0	0	0	21	0	0	1	75
	ULL-PRM07	7	0	13	0	3	0	7	0	0	0	0	7	0	0	0	0	1	9	0	0	1	48
	ULL-PRM08	29	0	9	0	2	0	3	0	1	1	1	5	0	2	2	0	0	1	0	0	3	59
	ULL-PRM09	40	0	0	0	39	0	0	0	0	0	0	1	0	1	4	5	0	0	0	0	7	97
Upper Lillooet Powerhouse	ULL-PRM10	69	0	12	1	7	32	6	0	0	1	0	0	0	0	1	0	0	0	0	0	13	142
	ULL-PRM11	70	0	5	0	0	2	4	0	0	8	0	0	0	0	2	0	0	0	0	0	3	94
Mean		29.0	0.1	9.6	0.9	11.3	3.3	3.4	0.2	0.3	10.9	0.1	3.2	0.1	0.3	1.2	1.1	0.2	3.3	0.0	0.1	6.0	84.5
Standard Deviation		20.87	0.29	7.06	2.57	15.01	9.11	3.23	0.39	0.89	19.39	0.29	4.57	0.29	0.65	1.53	2.61	0.39	6.22	0.00	0.29	6.11	27.08
Standard error of the mean		6.03	0.08	2.04	0.74	4.33	2.63	0.93	0.11	0.26	5.60	0.08	1.32	0.08	0.19	0.44	0.75	0.11	1.80	0.00	0.08	1.76	7.82
t-value_90%		1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796	2.796	1.796	1.796	1.796
Confidence Interval		10.82	0.15	3.66	1.33	7.78	4.72	1.68	0.20	0.46	10.05	0.15	2.37	0.15	0.34	0.79	1.35	0.20	3.23	0.00	0.15	3.17	14.04
2023 Expected Density (stems/ha)		**5,800**	**17**	**1,917**	**183**	**2,267**	**667**	**683**	**33**	**67**	**2,183**	**17**	**633**	**17**	**67**	**233**	**217**	**33**	**650**	**0**	**17**	**1,200**	**16,900**
2023 Confidence Interval (± stems/ ha)		**2,164**	**30**	**732**	**267**	**1,556**	**944**	**335**	**40**	**92**	**2,010**	**30**	**474**	**30**	**68**	**158**	**271**	**40**	**645**	**0**	**30**	**633**	**2,808**
2020 Expected Density (stems/ha)		**7,317**	**0**	**1,083**	**100**	**1,283**	**1,833**	**717**	**0**	**67**	**2,233**	**17**	**183**	**33**	**83**	**233**	**117**	**0**	**900**	**0**	**17**	**1,000**	**17,217**
2020 Confidence Interval (± stems/ ha)		**4,960**	**0**	**423**	**280**	**944**	**3,001**	**555**	**0**	**92**	**1,486**	**30**	**121**	**60**	**82**	**164**	**121**	**0**	**896**	**0**	**30**	**576**	**8,336**
2018 Expected Density (stems/ha)		**5,000**	**0**	**450**	**0**	**200**	**1,417**	**250**	**0**	**33**	**233**	**17**	**183**	**33**	**67**	**350**	**817**	**0**	**567**	**33**	**17**	**467**	**10,133**
2018 Confidence Interval (± stems/ ha)		**4,798**	**0**	**251**	**0**	**159**	**2,351**	**183**	**0**	**60**	**312**	**30**	**136**	**60**	**68**	**226**	**524**	**0**	**380**	**40**	**30**	**281**	**7,377**

4.1.1.2. Percent Vegetation Cover

The average percent vegetation cover was 44% across all revegetation areas represented by monitoring plots in Year 5 (Table 11), an increase from the average of 24% cover in Year 3. Percent cover increased from Year 3 to Year 5 at every plot except for ULL-PRM01. In Year 5, the estimated percent vegetation cover was less variable between revegetation areas than in previous years, ranging from 29% to 48% (Table 11).

Vegetation cover (i.e., ground cover of low plants) is monitored because it stabilizes the soil and provides sediment interception and erosion control functions early in the revegetation process. However, taller woody vegetation also contributes to this function. Because shrub and tree stem densities were generally high in all revegetation areas, there is little concern despite some exposed, rocky, and dry soils in the revegetation areas (Figure 6, Figure 7). Furthermore, vegetation cover has continued to increase from year to year. No major erosion concerns were noted during monitoring.

4.1.1.3. Photopoint Comparison

Standard photographs, taken through plot centres facing north (0°), are presented in Appendix S. These photos were used to support the Year 5 assessment and were compared to photographs taken in Year 1 and Year 3 of monitoring. Additional repeatable representative photographs that show specific parts of the riparian revegetation areas are presented in Appendix T. Comparison of these photographs was used to aid in the evaluation of revegetation performance and the need for additional revegetation or monitoring work. All standard photographs taken from above the plot centre to the east (090º), south (180º), and west (270º), are available upon request.

A comparison of photographs taken in Year 3 generally supports the results of the two quantitative assessment methods. In particular, the comparison demonstrates that 1) established woody vegetation continues to grow (Figure 8) and appears healthy (which is not apparent from stem density counts) and 2) vegetation cover is increasing in the majority of plots. It is also apparent that there are still areas of exposed soil in most plots. However, the overall trends of high stem density, increasing herbaceous cover, and increasing size of established woody vegetation suggest that revegetation is progressing successfully.

Figure 1. Woody vegetation at ULL-PRM03 on September 5, 2023. Shrub stem densities are below target but have increased from Year 3.

Figure 2. Area with signs of possible mechanical disturbance near ULL-PRM01 on August 30, 2023. Woody stem density and herbaceous cover are sufficient.

Figure 3. Abundant red alder and black cottonwood growth along the stream edge, with sparse herbaceous cover, at ULL-PRM09 on August 30, 2023.

Figure 4. Dense tree and woody shrub regeneration at ULL-PRM10 on August 30, 2023.

Figure 5. Western white pine seedling at ULL-PRM05 on August 30, 2023.

Figure 6. Dry, rocky substrate but healthy black cottonwood regeneration and no observed erosion at ULL-PRM11 on August 30, 2023.

Figure 7. **Dry, rocky substrate and healthy red alder and black cottonwood at ULL-PRM03, on September 5, 2023.**

Figure 8. **Tall black cottonwood and Douglas-fit regeneration at ULL-PRM05 on August 30, 2023.**

4.2. Water Temperature and Air Temperature

4.2.1. Overview

The results of the baseline (2008 to 2013) and operational (2018 to 2023) water temperature metrics for the ULR and Boulder Creek are summarized in the following sections. BC WQG for water temperature, annual water temperature figures, data summary tables, and baseline temperature records are presented in Appendix C.

The ULR and Boulder Creek operational temperature regimes are presented using a) daily average temperature data, b) daily maximum temperature data, and c) daily minimum temperature data (Appendix B, Figure 9 and Figure 18, respectively).

Differences in water temperature between the main control site relative to other control and impact sites are displayed graphically in Section 7 of Appendix C for baseline conditions; and in Section 8 of Appendix C for operational conditions. As noted in Section 3.2.1, a new upstream site was established for ULR in November 2021 (ULL-USWQ04). This upstream site recorded unusually warm winter water temperatures in 2022/2023, which may be due to local groundwater influence. Potential effects of project operations on water temperature will be assessed using a BACI analysis that will be completed as part of the final program summary report.

4.2.2. Monthly Summary Statistics

The ULR and Boulder Creek average, instantaneous minimum, instantaneous maximum, and standard deviation for water temperature for each month of the record are summarized for the baseline period (upstream and diversion) in Appendix C and operational period (upstream, diversion, tailrace and downstream) in Section 4.2.2.1.

The ULR and Boulder Creek mean/average, instantaneous minimum, instantaneous maximum, and standard deviation for air temperature for each month of the record are summarized in Appendix C.

4.2.2.1. Water Temperature

The range in monthly average water temperature in the upstream reach of ULR was 0.4°C to 7.3°C during baseline monitoring (Section 4 of Appendix C) and was 0.8°C to 6.4°C during operational monitoring from April 2018 to April 2021 and December 2022 to September 2023 (Table 13). The warmest average monthly water temperature to date in the ULR was at the diversion site during operations in July 2023 (7.7°C, Table 13), and the coolest average monthly water temperature to date in the ULR occurred during baseline at the upstream site ULL-USWQ1 in December 2009 (0.4°C) (Section 4 of Appendix C), and during operations at the tailrace site (ULL-TAILWQ) in December 2021 (0.4°C) (Table 13).

The range in monthly average water temperature in the diversion reach of Boulder Creek was 0.5°C to 7.9°C during baseline monitoring (Section 4 of Appendix C) and was 0.5°C to 9.7°C during operational monitoring to date (Table 14). In the Boulder Creek diversion reach (BDR-DVWQ) during operations, the warmest average monthly water temperature occurred in July 2023 (9.7°C), and the coldest occurred in December 2022 (0.5°C). At the Boulder Creek downstream site

(BDR-DSWQ), the monthly average water temperature ranged between 0.5°C and 8.8°C during operations. The warmest average monthly water temperature at BDR-DSWQ was recorded in August 2022 and the coldest average monthly water temperature occurred in December 2022 (Table 14).

Table 13. Upper Lillooet River operational monthly water temperature summary statistics (2018 to 2023).

Year	Month	Water Temperature[1] (°C)																							
		ULL-USWQ02				ULL-USWQ03				ULL-USWQ04				ULL-DVWQ01				ULL-TAILWQ				ULL-DSWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2018	Apr	3.0	0.0	8.6	1.8	-	-	-	-	-	-	-	-	-	-	-	-	3.7	1.8	7.8	1.3	4.3	1.9	8.0	1.1
	May	4.3	1.4	8.8	1.8	-	-	-	-	-	-	-	-	-	-	-	-	4.5	1.8	8.8	1.7	4.8	2.1	9.1	1.7
	Jun	5.9	3.3	11.0	1.5	-	-	-	-	-	-	-	-	-	-	-	-	6.1	3.5	11.2	1.5	6.3	3.7	11.3	1.5
	Jul	6.4	3.7	10.3	1.6	-	-	-	-	-	-	-	-	-	-	-	-	6.9	4.1	10.9	1.7	7.2	4.4	11.1	1.7
	Aug	5.7	3.3	9.1	1.4	-	-	-	-	-	-	-	-	-	-	-	-	6.2	3.8	9.9	1.5	6.5	4.0	10.2	1.5
	Sep	5.2	2.2	8.8	1.2	-	-	-	-	-	-	-	-	-	-	-	-	5.6	2.8	9.3	1.2	5.8	3.1	9.4	1.1
	Oct	4.0	1.0	7.2	1.3	-	-	-	-	-	-	-	-	-	-	-	-	4.6	1.0	9.2	1.0	4.8	1.7	7.2	1.0
	Nov	-	-	-	-	1.8	0.2	5.1	1.2	-	-	-	-	3.0	0.8	5.9	1.2	2.0	0.2	5.1	1.2	2.7	0.8	5.5	1.0
	Dec	-	-	-	-	1.1	0.3	3.9	0.4	-	-	-	-	1.2	0.1	2.6	0.6	0.8	0.2	2.2	0.3	1.3	0.4	2.9	0.4
2019	Jan	-	-	-	-	1.6	1.2	2.5	0.2	-	-	-	-	1.6	0.1	2.7	0.6	1.1	0.3	1.9	0.3	1.8	0.3	3.2	0.4
	Feb	-	-	-	-	2.0	1.4	3.0	0.3	-	-	-	-	0.9	0.1	2.3	0.7	-	-	-	-	1.5	0.4	3.2	0.6
	Mar	-	-	-	-	3.3	2.2	5.7	0.7	-	-	-	-	2.5	0.1	5.1	1.2	-	-	-	-	2.9	1.2	5.2	0.8
	Apr	2.9	0.4	8.2	1.7	3.7	1.1	7.7	1.4	-	-	-	-	4.3	2.0	7.4	1.2	3.3	0.8	8.0	1.6	4.0	2.0	8.1	1.3
	May	4.6	1.4	9.1	1.9	4.7	1.4	9.5	2.0	-	-	-	-	5.6	2.7	9.7	1.8	4.7	1.6	9.0	1.8	5.2	2.1	9.5	1.8
	Jun	6.1	3.1	10.9	1.7	6.3	3.3	11.2	1.7	-	-	-	-	7.2	4.2	11.7	1.6	6.3	3.3	11.1	1.7	6.8	3.7	11.5	1.7
	Jul	6.2	3.6	10.2	1.4	6.4	3.7	10.4	1.5	-	-	-	-	7.6	4.9	11.4	1.5	6.7	3.9	10.7	1.5	7.2	4.4	11.2	1.5
	Aug	5.9	3.6	9.3	1.4	6.0	3.7	9.6	1.4	-	-	-	-	7.4	4.7	10.2	1.2	6.4	4.0	10.0	1.4	6.9	4.5	10.5	1.5
	Sep	5.2	2.4	8.8	1.1	5.3	2.6	9.0	1.1	-	-	-	-	6.8	4.0	9.6	1.0	5.5	2.8	9.3	1.1	6.0	3.4	9.7	1.1
	Oct	-	-	-	-	3.8	0.5	7.4	1.4	-	-	-	-	4.8	1.4	7.1	1.4	4.0	1.0	7.2	1.3	4.3	1.4	7.6	1.4
	Nov	-	-	-	-	2.1	0.1	4.8	1.2	-	-	-	-	3.1	0.2	5.3	1.3	2.3	0.3	4.8	1.2	2.9	0.4	5.2	1.2
	Dec	-	-	-	-	0.8	0.1	2.3	0.4	-	-	-	-	1.2	0.1	2.5	0.6	1.0	0.3	2.3	0.4	1.4	0.1	2.6	0.5
2020	Jan	-	-	-	-	0.9	0.1	1.8	0.3	-	-	-	-	1.0	0.0	2.1	0.6	-	-	-	-	1.2	0.1	2.2	0.6
	Feb	-	-	-	-	1.6	0.4	4.9	0.7	-	-	-	-	1.8	0.6	3.3	0.7	1.3	0.2	3.3	0.7	2.0	0.4	3.7	0.7
	Mar	-	-	-	-	2.3	0.4	7.3	1.3	-	-	-	-	-	-	-	-	2.2	0.5	5.1	0.9	2.6	0.1	5.1	1.0
	Apr	-	-	-	-	2.9	0.3	7.9	1.7	-	-	-	-	-	-	-	-	-	-	-	-	3.8	1.4	6.1	1.0
	May	-	-	-	-	4.2	1.4	9.5	1.9	-	-	-	-	-	-	-	-	-	-	-	-	4.7	1.9	9.5	1.7
	Jun	-	-	-	-	5.8	3.4	10.9	1.5	-	-	-	-	-	-	-	-	-	-	-	-	6.3	3.9	11.1	1.5
	Jul	-	-	-	-	6.4	3.6	10.6	1.5	-	-	-	-	-	-	-	-	-	-	-	-	7.1	4.4	11.3	1.6
	Aug	-	-	-	-	6.0	3.6	9.9	1.5	-	-	-	-	-	-	-	-	6.3	3.7	10.2	1.5	6.6	3.9	10.6	1.5
	Sep	-	-	-	-	5.5	3.4	8.9	1.2	-	-	-	-	-	-	-	-	5.7	4.0	9.2	1.1	6.1	4.3	9.4	1.2
	Oct	-	-	-	-	3.6	0.1	7.2	1.5	-	-	-	-	4.5	0.6	8.9	1.5	3.8	0.1	7.6	1.6	4.0	0.6	7.8	1.5
	Nov	-	-	-	-	1.5	0.0	4.2	0.9	-	-	-	-	2.7	0.5	5.1	1.0	-	-	-	-	-	-	-	-
	Dec	-	-	-	-	1.1	0.2	2.5	0.5	-	-	-	-	-	-	-	-	0.8	0.1	2.2	0.5	2.3	1.4	3.5	0.5
2021	Jan	-	-	-	-	1.4	0.2	2.7	0.5	-	-	-	-	-	-	-	-	0.8	0.1	2.1	0.4	2.2	1.3	3.2	0.4
	Feb	-	-	-	-	1.7	0.4	4.2	0.7	-	-	-	-	-	-	-	-	1.2	0.1	2.8	0.5	2.9	1.4	4.5	0.8
	Mar	-	-	-	-	3.2	1.1	7.3	1.3	-	-	-	-	-	-	-	-	2.7	0.4	6.5	1.1	4.9	4.0	6.1	0.4
	Apr	-	-	-	-	3.8	1.2	8.5	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	May	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.7	1.6	9.9	1.9	5.1	2.2	9.9	1.6
	Jun	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	3.4	10.1	1.7	6.5	3.6	10.6	1.7
	Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.1	4.6	10.6	1.5	7.4	4.8	10.9	1.6
	Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5	4.3	10.7	1.4	6.7	4.6	10.5	1.4
	Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5	0.8	9.1	1.2	5.7	1.1	9.3	1.2
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.0	1.0	7.6	1.1	4.5	2.4	7.5	0.9
	Nov	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6	0.3	4.8	0.8
	Dec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	0.0	1.9	0.4	1.0	0.2	2.9	0.6
2022	Jan	-	-	-	-	-	-	-	-	-	-	-	-	1.8	0.1	3.3	0.9	0.8	0.1	1.9	0.4	1.4	0.1	2.6	0.6
	Feb	-	-	-	-	-	-	-	-	-	-	-	-	2.3	0.0	3.9	1.1	-	-	-	-	2.1	0.0	3.5	0.9
	Mar	-	-	-	-	-	-	-	-	-	-	-	-	3.9	0.9	5.9	0.9	2.6	0.4	5.7	1.0	3.4	1.1	5.7	0.7
	Apr	-	-	-	-	-	-	-	-	-	-	-	-	4.4	1.5	7.8	1.4	3.6	0.3	8.0	1.7	4.3	1.8	7.2	1.0
	May	-	-	-	-	-	-	-	-	-	-	-	-	5.5	2.9	9.6	1.5	4.4	1.8	9.6	1.7	4.8	2.3	9.4	1.5
	Jun	-	-	-	-	-	-	-	-	-	-	-	-	5.8	3.5	10.0	1.5	5.0	2.9	9.2	1.5	5.3	3.1	9.6	1.5
	Jul	-	-	-	-	-	-	-	-	-	-	-	-	6.7	4.4	10.8	1.6	6.1	3.9	10.1	1.5	6.5	4.2	10.5	1.6
	Aug	-	-	-	-	-	-	-	-	-	-	-	-	7.4	4.6	10.9	1.5	6.8	4.0	10.4	1.5	7.2	4.3	10.7	1.4
	Sep	-	-	-	-	-	-	-	-	-	-	-	-	6.9	4.5	10.0	1.3	-	-	-	-	6.3	4.0	9.9	1.3
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	5.8	2.5	8.6	1.3	4.2	1.4	7.4	1.2	5.0	2.2	8.6	1.3
	Nov	-	-	-	-	-	-	-	-	3.5	1.1	6.1	0.9	1.7	0.1	4.1	1.0	1.1	0.1	3.5	0.7	1.5	0.1	3.9	0.8
	Dec	-	-	-	-	-	-	-	-	3.7	0.0	5.6	1.8	0.9	0.0	2.3	0.7	0.5	0.0	1.2	0.3	0.7	0.0	1.8	0.5
2023	Jan	-	-	-	-	-	-	-	-	3.3	0.0	7.3	1.2	2.0	0.0	3.2	0.7	1.3	0.0	2.9	0.5	1.7	0.1	2.8	0.6
	Feb	-	-	-	-	-	-	-	-	2.4	0.0	7.4	1.2	2.1	0.0	3.7	1.0	1.5	0.0	3.5	0.7	-	-	-	-
	Mar	-	-	-	-	-	-	-	-	3.0	0.0	9.7	1.6	3.4	0.6	5.4	0.9	3.0	0.1	6.2	1.1	-	-	-	-
	Apr	-	-	-	-	-	-	-	-	3.3	0.1	9.1	1.3	4.3	2.0	7.2	1.1	-	-	-	-	4.2	1.2	7.1	1.1
	May	-	-	-	-	-	-	-	-	4.3	0.8	9.1	1.9	5.3	2.1	9.6	1.8	4.3	1.0	9.0	1.8	4.7	1.3	9.4	1.9
	Jun	-	-	-	-	-	-	-	-	6.4	3.3	10.7	1.7	7.5	4.3	11.5	1.6	6.6	3.3	11.0	1.8	6.9	3.5	11.2	1.8
	Jul	-	-	-	-	-	-	-	-	6.5	3.9	10.1	1.6	7.7	4.8	11.2	1.6	6.8	4.1	10.5	1.7	7.2	4.3	10.9	1.7
	Aug	-	-	-	-	-	-	-	-	6.0	3.6	10.3	1.5	7.3	5.0	11.3	1.4	6.3	3.9	10.6	1.5	6.6	4.2	11.0	1.5
	Sep	-	-	-	-	-	-	-	-	5.4	3.1	9.0	1.2	6.8	4.4	10.0	1.1	5.5	3.3	9.4	1.2	5.8	3.8	9.8	1.2
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Statistics based on continuous data logged at 15 minute intervals. Statistics were not generated for months with less than three weeks of data.
Minimum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in red.

Table 14. Boulder Creek operational monthly water temperature statistics (2018 to 2023).

Year	Month	Water Temperature[1] (°C)																			
		BDR-USWQ2				NTH-USWQ1				BDR-DVWQ[2]				BDR-DSWQ				BDR-TAILWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2018	Apr	-	-	-	-	-	-	-	-	3.5	1.0	6.5	0.9	3.4	1.6	6.0	0.6	2.8	1.6	5.5	0.5
	May	-	-	-	-	-	-	-	-	5.2	2.1	8.5	1.2	4.7	2.9	8.1	1.1	4.1	2.5	7.3	1.1
	Jun	-	-	-	-	-	-	-	-	6.9	4.6	11.1	1.3	6.3	3.9	10.8	1.4	5.8	3.4	10.9	1.4
	Jul	-	-	-	-	-	-	-	-	8.6	5.5	12.3	1.6	8.2	4.9	11.9	1.6	7.6	4.5	11.2	1.6
	Aug	-	-	-	-	-	-	-	-	8.8	6.7	12.3	1.2	8.1	5.7	12.0	1.3	7.6	5.1	11.2	1.3
	Sep	-	-	-	-	-	-	-	-	7.5	4.5	10.8	0.9	6.7	3.6	10.2	1.0	6.3	3.1	9.6	1.0
	Oct	-	-	-	-	3.7	0.8	6.3	1.1	4.9	1.3	6.8	1.1	4.5	1.4	6.7	0.9	4.3	2.2	6.5	0.9
	Nov	-	-	-	-	2.1	0.2	4.5	0.9	2.8	0.2	5.8	1.3	2.4	0.5	5.4	1.1	2.0	0.3	4.8	1.1
	Dec	-	-	-	-	1.0	0.0	2.1	0.6	0.6	0.0	2.0	0.5	0.7	0.0	2.0	0.5	-	-	-	-
2019	Jan	-	-	-	-	1.6	0.0	2.6	0.6	1.1	0.0	2.4	0.7	1.2	0.0	2.5	0.6	1.5	0.4	2.2	0.6
	Feb	-	-	-	-	1.0	0.0	2.6	0.6	0.8	0.0	2.2	0.6	0.8	0.0	2.2	0.6	-	-	-	-
	Mar	-	-	-	-	2.0	0.1	4.8	0.9	2.0	0.5	4.3	0.8	2.0	0.5	3.8	0.8	-	-	-	-
	Apr	-	-	-	-	3.0	1.6	5.9	0.8	3.8	2.7	6.0	0.7	3.5	2.7	4.7	0.4	3.0	2.1	4.8	0.5
	May	-	-	-	-	3.4	1.3	6.0	0.9	5.2	2.5	9.0	1.3	4.6	2.3	8.6	1.2	4.0	1.4	7.9	1.2
	Jun	-	-	-	-	4.8	2.8	7.9	1.1	7.2	4.2	11.4	1.5	6.7	3.7	10.8	1.5	6.2	3.2	10.2	1.5
	Jul	-	-	-	-	6.9	4.6	10.8	1.3	8.5	5.8	12.4	1.4	7.9	5.4	11.8	1.3	7.3	4.9	11.2	1.3
	Aug	-	-	-	-	7.9	5.4	11.9	1.3	8.8	6.4	12.2	1.2	8.2	5.9	11.8	1.2	7.6	5.4	11.0	1.2
	Sep	-	-	-	-	6.4	2.1	11.2	1.5	7.5	3.5	11.3	1.4	7.0	3.6	10.7	1.3	6.5	2.7	10.2	1.3
	Oct	-	-	-	-	3.1	0.3	5.7	1.3	4.4	1.0	6.8	1.5	4.0	1.1	6.5	1.4	3.7	0.7	6.4	1.2
	Nov	1.5	0.0	3.9	1.1	2.1	0.0	4.3	1.2	2.8	0.0	5.3	1.5	2.6	0.0	4.8	1.2	-	-	-	-
	Dec	0.6	0.1	1.5	0.4	1.2	0.0	2.5	0.6	1.0	0.0	2.4	0.7	1.0	0.1	2.2	0.5	1.2	0.4	2.1	0.5
2020	Jan	0.6	0.1	1.4	0.4	1.1	0.0	2.6	0.8	0.6	0.0	1.9	0.6	0.7	0.0	1.9	0.6	0.9	0.4	2.4	0.4
	Feb	1.1	0.1	1.6	0.4	1.6	0.0	2.9	0.6	1.5	0.0	2.6	0.6	1.5	0.1	2.8	0.6	-	-	-	-
	Mar	1.2	0.2	1.7	0.3	1.7	0.0	3.9	0.9	1.8	0.0	3.6	0.8	1.8	0.0	3.8	0.8	-	-	-	-
	Apr	1.8	0.3	3.0	0.6	2.6	0.0	5.6	1.0	3.5	1.1	6.1	1.0	3.1	1.1	5.2	0.7	-	-	-	-
	May	2.9	0.6	5.9	0.9	3.2	1.3	5.7	0.7	5.0	2.9	9.1	1.1	4.3	2.3	7.9	1.0	-	-	-	-
	Jun	4.3	2.2	8.6	1.3	4.0	2.6	7.0	0.9	5.9	3.7	10.1	1.3	6.0	3.9	10.3	1.3	-	-	-	-
	Jul	6.2	3.4	11.1	1.6	5.9	3.6	10.7	1.6	8.0	5.0	12.8	1.7	7.9	5.1	12.3	1.6	-	-	-	-
	Aug	6.5	3.8	10.6	1.5	7.3	4.6	11.4	1.4	8.7	6.3	12.6	1.3	7.8	5.1	12.0	1.4	7.3	4.7	11.4	1.4
	Sep	6.2	3.9	9.5	1.2	7.3	3.8	11.2	1.4	8.5	6.3	11.5	1.0	7.5	5.4	11.1	1.2	7.1	4.9	10.4	1.1
	Oct	3.5	0.1	8.4	2.1	4.0	0.0	9.1	2.3	5.3	0.1	10.1	2.6	4.6	0.2	9.5	2.3	4.2	0.2	9.1	2.2
	Nov	1.1	0.0	4.0	0.8	1.8	0.4	4.1	0.7	2.3	0.6	5.1	1.1	2.0	0.5	4.8	0.9	-	-	-	-
	Dec	0.5	0.1	1.8	0.5	1.4	0.0	2.8	0.7	1.3	0.1	3.1	0.8	1.2	0.0	2.5	0.6	1.0	0.3	2.3	0.5
2021	Jan	0.6	0.1	1.3	0.4	1.4	0.0	2.7	0.6	1.0	0.0	2.4	0.5	1.0	0.1	2.2	0.4	1.1	0.4	1.9	0.4
	Feb	0.5	0.0	1.5	0.4	1.2	0.0	2.9	0.7	0.9	0.0	2.1	0.6	0.9	0.0	2.0	0.7	-	-	-	-
	Mar	0.9	0.0	1.4	0.3	2.2	0.0	5.0	0.8	2.1	0.3	4.0	0.5	2.1	0.3	4.2	0.6	-	-	-	-
	Apr	1.6	0.0	3.8	0.8	2.7	0.1	6.1	1.1	3.6	1.0	6.9	1.2	3.3	1.0	5.6	0.8	-	-	-	-
	May	3.0	1.3	6.9	1.1	3.3	1.9	6.3	0.8	-	-	-	-	4.2	2.1	7.8	1.0	3.7	2.0	7.4	1.0
	Jun	4.6	1.9	9.8	1.6	4.4	2.4	8.6	1.2	-	-	-	-	6.1	3.1	11.4	1.7	5.5	2.7	10.6	1.6
	Jul	7.3	4.9	10.9	1.5	7.9	5.2	11.6	1.5	-	-	-	-	8.6	5.7	12.5	1.5	8.1	5.1	11.7	1.5
	Aug	6.8	4.7	10.4	1.2	8.5	6.3	12.3	1.2	-	-	-	-	8.1	5.6	12.3	1.5	7.6	5.6	11.5	1.2
	Sep	5.5	0.1	9.5	1.4	6.7	2.8	10.6	1.4	-	-	-	-	6.3	1.1	9.9	1.3	6.4	1.1	10.0	1.3
	Oct	2.7	0.1	6.3	1.2	3.5	1.0	6.1	1.0	-	-	-	-	-	-	-	-	3.6	0.9	6.7	1.1
	Nov	0.7	0.0	2.9	0.7	1.9	0.1	3.5	0.6	-	-	-	-	-	-	-	-	-	-	-	-
	Dec	0.2	0.0	1.1	0.2	0.9	0.1	2.3	0.6	-	-	-	-	-	-	-	-	0.7	0.3	1.6	0.3
2022	Jan	0.8	0.0	1.3	0.3	1.7	0.1	2.9	0.6	1.2	0.1	2.4	0.7	-	-	-	-	1.3	0.4	2.3	0.6
	Feb	0.8	0.0	1.6	0.4	1.6	0.1	3.4	0.9	1.5	0.1	2.8	0.9	-	-	-	-	-	-	-	-
	Mar	1.2	0.1	2.6	0.4	2.5	0.1	5.2	0.9	2.6	0.2	4.7	0.8	-	-	-	-	-	-	-	-
	Apr	1.5	0.1	3.4	0.6	2.7	0.3	6.3	1.2	3.3	1.2	6.9	1.0	3.0	1.3	5.5	0.9	2.3	1.2	4.1	0.5
	May	2.7	1.4	6.1	0.8	3.5	2.0	6.8	0.9	5.2	3.4	9.3	1.1	4.2	3.0	6.5	0.6	3.5	2.2	6.1	0.7
	Jun	3.1	1.2	6.5	1.0	3.5	1.9	6.1	0.8	5.2	3.4	8.9	1.2	4.7	3.0	8.4	1.1	4.0	2.3	7.5	1.1
	Jul	5.4	2.9	10.0	1.7	5.0	3.3	9.3	1.4	7.3	4.6	11.8	1.7	7.0	4.4	11.6	1.7	6.3	3.8	10.8	1.7
	Aug	7.1	4.0	10.7	1.5	7.9	4.3	12.0	1.6	9.3	5.9	12.7	1.4	8.8	5.5	12.4	1.5	8.1	4.9	11.7	1.5
	Sep	6.1	3.3	10.3	1.4	7.2	4.3	11.8	1.3	8.3	5.6	12.2	1.2	7.6	5.2	12.3	1.3	7.1	4.4	10.7	1.2
	Oct	4.3	0.0	8.6	2.3	5.5	1.6	8.9	2.0	6.5	1.9	10.1	2.3	5.7	1.6	10.1	2.1	5.3	0.5	9.3	2.1
	Nov	0.4	0.0	1.5	0.4	1.1	0.1	2.8	0.8	0.9	0.0	3.5	0.8	0.9	0.0	3.2	0.7	1.0	0.1	3.1	0.6
	Dec	0.4	0.0	1.0	0.3	0.8	0.1	2.0	0.6	0.5	0.0	1.4	0.5	0.5	0.0	1.4	0.4	0.7	0.2	1.5	0.3
2023	Jan	0.8	0.3	1.2	0.2	1.5	0.1	2.5	0.6	1.4	0.0	2.1	0.6	1.4	0.0	2.2	0.5	1.7	0.7	2.7	0.3
	Feb	0.7	0.1	1.1	0.3	1.2	0.1	2.5	0.7	1.1	0.0	2.4	0.7	1.2	0.0	2.5	0.7	-	-	-	-
	Mar	0.9	0.4	1.6	0.3	1.9	0.6	3.8	0.6	1.9	0.5	3.5	0.6	2.0	0.4	3.9	0.7	-	-	-	-
	Apr	1.3	0.3	3.6	0.5	2.7	0.5	6.6	1.0	3.1	1.2	7.0	0.9	3.1	1.2	6.0	0.8	-	-	-	-
	May	3.3	0.4	8.1	1.5	3.7	1.4	7.0	1.1	5.5	0.0	10.1	1.5	-	-	-	-	4.3	1.0	9.0	1.5
	Jun	6.2	2.6	11.3	1.9	6.0	2.8	11.5	1.8	8.3	4.9	13.3	1.8	-	-	-	-	7.1	3.5	12.3	1.8
	Jul	7.3	4.0	11.3	1.5	8.5	4.8	12.8	1.6	9.7	6.2	13.7	1.5	-	-	-	-	8.2	4.9	12.4	1.5
	Aug	7.0	4.7	10.6	1.3	8.6	6.1	13.0	1.5	9.4	7.5	12.8	1.1	-	-	-	-	8.0	5.8	11.6	1.3
	Sep	5.8	3.1	9.4	1.2	6.8	4.0	11.8	1.4	8.2	5.6	11.5	1.1	-	-	-	-	6.7	4.4	10.4	1.1
	Oct	-	-	-	-	-	-	-	-	6.3	0.4	9.6	2.0	-	-	-	-	5.6	0.6	9.3	1.5

[1] Statistics based on continuous data logged at 15 minute intervals. Statistics were not generated for months with less than three weeks of data.
[2] Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01.
Minimum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in blue.
Maximum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in red.

4.2.2.2. Air Temperature

The range in monthly average air temperature in the upstream reach of ULR was -7.8°C to 15.3°C during baseline monitoring (Section 5.1 of Appendix C) and was -10.4°C to 17.2°C during operational monitoring to date (Section 5.2 of Appendix C). The warmest month occurred in August 2022, and the coolest in December 2022 (large data gaps occurred in winter 2019 and 2020, and in fall 2021).

In the ULR lower diversion, monthly average air temperature ranged from -4.4°C to 16.7°C during baseline monitoring (Section 5.1 of Appendix C), and at ULL-DSAT (1.1 km downstream of the baseline diversion reach site in the downstream reach), the monthly average air temperature during operations ranged from -8.2°C to 19.5°C (Section 5.2 of Appendix C). Considering both sites, the warmest month occurred in July 2021, and the coolest in February 2019.

Air temperature was recorded at the same location along the lower diversion reach of Boulder Creek in baseline and operational monitoring (BDR-DVAT). The range in monthly average air temperature in the diversion reach of Boulder Creek was -4.2°C to 16.5°C during baseline monitoring (Section 5.1 of Appendix C) and -7.3°C to 20.2°C during operational monitoring to date (Section 5.2 of Appendix C). The coldest average monthly air temperatures occurred in December 2022 (-7.3°C), and the warmest average monthly air temperatures occurred in July 2021 (20.2°C).

The air temperature observations are in accordance with the water temperature trends observed in the ULR and Boulder Creek (Section 4.2.1).

4.2.3. Growing Season Degree Days

In the ULR (Table 15) and Boulder Creek (Table 16), the upstream sites generally have had shorter growing seasons than the diversion and downstream sites, as would be expected due to cooler water temperatures at higher elevations.

The start of the growing season based on the water temperature record has been variable in the ULR (Table 15). During baseline monitoring, the growing season start dates at the upstream and diversion sites varied from late May to early July. During operations, the start date occurred in mid- to late May in years 2018 to 2021 and 2023, with more variability displayed in 2022 when the start date occurred in mid-April to mid-June (Table 15). The growing season end dates occurred in October during baseline and operational years for most sites, except in the downstream reach (ULL-DSWQ) and tailrace (ULL-TAILWQ) during operations in 2018 and the diversion reach (ULL-DVWQ01) during operations in 2021, when the growing season ended in early November. A notable exception was at ULL-USWQ02 in 2018 when the growing season ended on September 30. This coincided with cooler air temperatures (Figure 20 of Appendix B); however, the cooling was not enough to end the growing season at the tailrace and downstream sites where it continued until early November. During baseline monitoring, the growing season in the ULR ranged from 644-degree days to 861-degree days at the upstream site and 825-degree days at the diversion site. During operations, the growing season ranged from 746 to 839-degree days at the upstream sites, from 858 to 1,214-degree days at the diversion and downstream sites, and from 779 to 963-degree days in the tailrace (Table 15). The longest growing season occurred in the diversion during operations (ULL-DVWQ01) in 2022.

In Boulder Creek, during the baseline period, the growing season start and end dates were variable (Table 16). Start dates occurred between late May and mid-August (North Creek), with end dates occurring from early October to early November. The growing season ranged from 280-degree days (North Creek) to 898-degree days in the diversion. The operational growing season start date occurred from late April to mid-July and ended from late September (North Creek in 2019) to late October. During operations, the length of the growing season ranged from 613-degree days (upstream site BDR-USWQ2) to 1,185-degree days, with the longest growing season recorded in 2019 in the diversion reach at BDR-DVWQ (Table 16).

Table 15. Upper Lillooet River growing season length and degree days during baseline and operational periods.

Project Phase	Site	Year	No. of days with valid data	Growing Season[1]				
				Start Date	End Date	Length (day)	Gap (day)	Degree Days[2]
Baseline	ULL-USWQ1	2008	41	-	-	-	-	-
		2009	365	22-May-09	8-Oct-09	141	0	861
		2010	365	28-Jun-10	13-Oct-10	109	0	644
		2011	365	2-Jul-11	23-Oct-11	114	0	693
		2012	364	20-Jun-12	17-Oct-12	119	2	707
		2013	153	23-May-13	-	-	-	-
	ULL-DVWQ	2010	49	-	-	-	-	-
		2011	97	-	-	-	-	-
		2012	366	6-Jun-12	18-Oct-12	135	0	825
		2013	120	-	-	-	-	-
Operation	ULL-USWQ02	2018	230	23-May-18	30-Sep-18	132	0	746
		2019	211	20-May-19	6-Oct-19	141	0	798
	ULL-USWQ03	2018	60	-	-	-	-	-
		2019	364	18-May-19	7-Oct-19	143	0	839
		2020	365	24-May-20	11-Oct-20	142	0	817
		2021	130	-	-	-	-	-
	ULL-USWQ04	2022	74	-	-	-	-	-
		2023[3]	278	21-May-23	2-Oct-23	135	0	808
	ULL-DVWQ01	2018	60	-	-	-	-	-
		2019	365	13-May-19	25-Oct-19	167	0	1,121
		2020	121	-	21-Oct-20	-	44	-
		2021	57	-	8-Nov-21	-	19	-
		2022	364	21-Apr-22	31-Oct-22	194	1	1,214
		2023[3]	278	9-May-23	3-Oct-23	148	0	1,034
	ULL-TAILWQ	2018	259	21-May-18	3-Nov-18	167	6	963
		2019	293	20-May-19	7-Oct-19	142	0	854
		2020	250	-	12-Oct-20	-	40	-
		2021	320	21-May-21	8-Oct-21	141	18	865
		2022	330	12-Jun-22	21-Oct-22	132	27	779
		2023[3]	237	21-May-23	2-Oct-23	135	10	835
	ULL-DSWQ	2018	278	19-May-18	4-Nov-18	171	0	1,020
		2019	365	16-May-19	23-Oct-19	161	0	1,016
		2020	356	21-May-20	13-Oct-20	147	0	922
		2021	347	21-May-21	10-Oct-21	143	0	904
		2022	360	9-Jun-22	23-Oct-22	137	1	858
		2023[3]	220	18-May-23	3-Oct-23	138	0	895

[1]A dash (-) indicates that the growing season could not be estimated because the period of record did not cover the entire growing season based on a threshold of 14 consecutive or 28 cumulative missing days.

[2]Degree days are accumulated thermal units.

[3]End dates for the 2023 growing season correspond with the end of available sensor data as complete data are not yet available, but are provided where the growing season was close to completion.

We defined the start of the growing season as the beginning of the first week that average stream temperatures exceeded and remained above 5°C for the season; the end of the growing season was defined as the last day of the first week that average stream temperature dropped below 4°C as per Coleman and Fausch (2007).

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Table 16. Boulder Creek growing season length and degree days during baseline and operational periods.

Project Phase	Site	Year	No. of days with valid data	Growing Season[1]				
				Start Date	End Date	Length (day)	Gap (day)	Degree Days[2]
Baseline	BDR-USWQ	2010	235	06-Jul-10	02-Nov-10	119	11	634
		2011	364	02-Aug-11	12-Oct-11	71	0	367
		2012	365	23-Jul-12	16-Oct-12	86	1	479
		2013	118	-	-	-	-	-
	NTH-USWQ1	2010	111	-	17-Oct-10	-	-	-
		2011	365	18-Aug-11	10-Oct-11	55	0	280
		2012	366	26-Jul-12	16-Oct-12	83	0	474
		2013	121	-	-	-	-	-
	BDR-DVWQ	2008	45	-	-	-	-	-
		2009	365	31-May-09	08-Oct-09	131	0	898
		2010	351	13-Jun-10	29-Oct-10	139	11	895
		2011	354	07-Jul-11	14-Oct-11	100	2	617
		2012	366	03-Jul-12	19-Oct-12	109	0	726
		2013	156	23-May-13	-	-	-	-
Operation	BDR-USWQ2	2019	81	-	-	-	-	-
		2020	366	30-Jun-20	11-Oct-20	104	0	644
		2021	365	20-Jun-21	04-Oct-21	107	0	677
		2022	364	16-Jul-22	20-Oct-22	98	0	613
		2023	278	31-May-23	-	-	-	-
	NTH-USWQ1	2018	98	-	25-Oct-18	-	-	-
		2019	283	17-Jun-19	30-Sep-19	106	0	721
		2020	366	11-Jul-20	12-Oct-20	93	0	651
		2021	365	24-Jun-21	06-Oct-21	104	0	770
		2022	364	19-Jul-22	22-Oct-22	97	0	676
		2023	278	04-Jun-23	-	-	-	-
	BDR-DVWQ	2018	290	17-May-18	03-Oct-18	140	0	1,062
		2019	296	15-May-19	24-Oct-19	164	0	1,185
		2020	366	02-Jun-20	21-Oct-20	142	0	1,077
		2021	152	30-Apr-21	-	-	-	-
		2022[3]	365	11-Jun-22	23-Oct-22	136	0	1,038
		2023	299	08-May-23	-	-	-	-
	BDR-TAILWQ	2018	255	09-Jun-18	29-Oct-18	143	8	919
		2019	235	29-May-19	07-Oct-19	132	2	887
		2020	222	-	13-Oct-20	-	-	-
		2021	257	15-Jun-21	07-Oct-21	115	7	813
		2022	301	03-Jul-22	22-Oct-22	113	1	784
		2023	205	23-May-23	-	-	1	-
	BDR-DSWQ	2018	290	20-May-18	02-Oct-18	136	0	959
		2019	296	23-May-19	08-Oct-19	138	0	997
		2020	366	30-May-20	20-Oct-20	144	0	1,013
		2021	287	08-Jun-21	07-Oct-21	122	3	886
		2022	273	22-Jun-22	23-Oct-22	124	0	914
		2023	128	-	-	-	-	-

[1]A dash (-) indicates that the growing season could not be estimated because the period of record did not cover the entire growing season based on a threshold of 14 consecutive or 28 cumulative missing days.

[2]Degree days are accumulated thermal units.

[3]Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01.

We defined the start of the growing season as the beginning of the first week that average stream temperatures exceeded and remained above 5°C for the season; the end of the growing season was defined as the last day of the first week that average stream temperature dropped before 4°C as per Coleman and Fausch (2007).

4.2.4. Hourly Rates of Water Temperature Change

During baseline, the percentage (%) of water temperature measurements where exceedances of the ±1.0°C/hr rate of change threshold were observed was low (≤0.51%) in the ULR and Boulder Creek monitoring sites (Table 17, Table 18 and Section 9 of Appendix C). Exceedances occurred more often during operations, particularly at the upstream control sites ULL-USWQ02 and ULL-USWQ04 in the ULR (Table 17) and at the tailrace and downstream sites for Boulder Creek; however, exceedances as a percentage of the record (all temperature measurements in all years) remain infrequent (≤2.95% (ULR) and ≤1.31% (Boulder Creek; Table 18). Based on Ecofish's experience collecting baseline temperature data on numerous other streams with run-of-river hydroelectric development in BC, it is normal for a small percentage of data points to have hourly rates of water temperature change that exceed ±1.0°C/hr under natural conditions. Given that exceedances of the ±1.0°C/hr rate of change threshold were observed more frequently at the upstream sites compared to the diversion sites during operations at both ULR and Boulder Creek, these results suggest that high hourly rates of water temperature change are not an issue in the hydro diversion reaches of either project.

Table 17. Upper Lillooet River hourly water temperature rate of change (°C/hr) summary statistics and occurrence of rate of change in exceedance of ± 1.0°C/hr.

Project Phase	Site	Period of Record		Number of Datapoints	Occurrence		Min -ve	Percentile				Max+ ve
		Start	End		No.	% of Record		1st	5th	95th	99th	
Baseline	ULL-USWQ1	19-Nov-08	3-Jun-13	158,955	803	0.51	-1.34	-0.73	-0.50	0.64	0.92	1.97
	ULL-DVWQ	12-Nov-10	1-May-13	60,846	25	0.04	-1.02	-0.67	-0.41	0.51	0.79	1.12
Operation	ULL-USWQ02	28-Mar-18	11-Oct-19	42,503	661	1.56	-1.42	-0.88	-0.65	0.80	1.03	2.42
	ULL-USWQ03	1-Nov-18	11-May-21	88,504	619	0.70	-2.73	-0.80	-0.52	0.65	0.94	2.07
	ULL-USWQ04	18-Oct-22	6-Oct-23	33,877	1,000	2.95	-5.03	-1.18	-0.66	0.75	1.18	5.05
	ULL-DVWQ01	1-Nov-18	6-Oct-23	120,072	226	0.19	-1.53	-0.70	-0.43	0.54	0.82	1.53
	ULL-TAILWQ	28-Mar-18	6-Oct-23	168,516	1,328	0.79	-4.56	-0.81	-0.55	0.68	0.93	5.05
	ULL-DSWQ	28-Mar-18	6-Oct-23	186,006	712	0.38	-2.92	-0.77	-0.52	0.63	0.87	2.78

Table 18. Boulder Creek hourly water temperature rate of change (°C/hr) summary statistics and occurrence of rate of change in exceedance of ± 1.0°C/hr.

Project Phase	Site	Period of Record		Number of Datapoints	Occurrence		Min -ve	Percentile				Max +ve
		Start	End		No.	% of Record		1st	5th	95th	99th	
Baseline	BDR-USWQ	22-Apr-10	1-May-13	26,274	157	0.15	-1.91	-0.54	-0.31	0.40	0.79	1.22
	NTH-USWQ1	12-Sep-10	1-May-13	92,297	10	0.01	-1.56	-0.43	-0.25	0.33	0.67	1.11
	BDR-DVWQ	15-Nov-08	6-Jun-13	158,252	454	0.29	-1.36	-0.5	-0.3	0.36	0.82	1.58
Operation	BDR-USWQ2	24-Sep-18	6-Oct-23	139,756	1,310	0.94	-2.71	-0.65	-0.40	0.49	0.99	2.13
	NTH-USWQ1	24-Sep-18	6-Oct-23	176,425	981	0.56	-3.50	-0.58	-0.36	0.49	0.90	1.52
	BDR-DVWQ[1]	16-Mar-18	27-Oct-23	176,571	1,245	0.71	-3.20	-0.59	-0.36	0.45	0.93	2.08
	BDR-TAILWQ	16-Mar-18	26-Oct-23	153,080	1,993	1.31	-5.79	-0.62	-0.40	0.54	1.06	4.13
	BDR-DSWQ	16-Mar-18	9-May-23	164,282	1,505	0.92	-2.96	-0.58	-0.37	0.44	0.97	2.80

[1]Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01.

4.2.5. Daily Temperature Extremes

Daily average water temperatures in the ULR and Boulder Creek rarely exceeded 18°C during baseline or operational monitoring (Table 19 and Table 20). Considering all measurements collected to date in the ULR, the maximum instantaneous water temperature during baseline monitoring was 11.8°C at the upstream site in July 2009[1]; during operations it was 11.7°C at the diversion site in June 2019 (Table 13). Considering all measurements collected to date in Boulder Creek, the maximum instantaneous water temperature during baseline monitoring was 11.4°C at the diversion site in July 2009; during operations it was 13.7°C at the diversion site in July 2023 (Table 14).

The number of days in a calendar year with daily average temperatures <1°C in ULR during baseline ranged from 32 at ULL-DVWQ in 2012 to 95 at ULL-USWQ1 in 2009, and during operations ranged from 12 at ULL-DSWQ in 2020 to 68 at ULL-TAILWQ in 2022 (Table 19).

The number of days with daily average temperatures <1°C in Boulder Creek during baseline ranged from 33 at BDR-DVWQ in 2010 to 83 at BDR-DVWQ in 2011, and during operations ranged from zero at the upstream, diversion, and downstream sites in multiple years to 49 at BDR-DVWQ in 2019 (Table 20).

[1] The lower diversion site in July 2009 was likely warmer than the maximum instantaneous water temperature observed at the upstream site. However, there is no data for the lower diversion site during this period as temperature sensors were damaged in the 2009 freshet.

Table 19. Upper Lillooet River summary of daily average water temperature extremes (number of days >18°C and <1°C).

Project Phase	Site	Year	n (days)	Days T_{water} > 18°C	Days T_{water} > 20°C	Days T_{water} < 1°C
Baseline	ULL-USWQ1	2008	41	-	0	-
		2009	365	0	0	95
		2010	365	0	0	58
		2011	365	0	0	86
		2012	365	0	0	74
		2013	153	-	-	-
	ULL-DVWQ	2010	49	-	-	-
		2011	97	-	-	-
		2012	366	0	0	32
		2013	120	-	-	-
Operation[1]	ULL-USWQ02	2018	230	0	0	-
		2019	211	0	0	-
	ULL-USWQ03	2018	60	-	-	-
		2019	364	0	0	28
		2020	365	0	0	43
		2021	130	-	-	-
	ULL-USWQ04	2022	74	-	-	-
		2023	278	0	0	-
	ULL-DVWQ01	2018	60	-	-	-
		2019	365	0	0	36
		2020	121	-	-	-
		2021	57	-	-	-
		2022	364	0	0	37
		2023	278	0	0	-
	ULL-DSWQ	2018	278	0	0	-
		2019	365	0	0	21
		2020	356	0	0	12
		2021	347	0	0	17
		2022	360	0	0	42
		2023	220	0	0	-
	ULL-TAILWQ	2018	259	0	0	-
		2019	293	0	0	-
		2020	250	-	-	56
		2021	320	0	0	62
		2022	330	0	0	68
		2023	237	0	0	-

"n" is the number of days that have observations for at least 23 hours.

"-" denotes periods when insufficient data were available.

[1] Data stops on 6-Oct-2023, before the cold temperatures of late fall and early winter.

Table 20. Boulder Creek summary of daily average water temperature extremes (number of days >18°C and <1°C).

Project Phase	Site	Year	n (days)	Days T_{water} > 18°C	Days T_{water} > 20°C	Days T_{water} < 1°C
Baseline	BDR-USWQ	2010	235	0	0	-
		2011	364	0	0	42
		2012	365	0	0	47
		2013	118	-	-	-
	NTH-USWQ1	2010	98	-	-	-
		2011	365	0	0	43
		2012	366	0	0	48
		2013	121	-	-	-
	BDR-DVWQ	2008	45	-	-	-
		2009	365	0	0	66
		2010	351	0	0	33
		2011	354	0	0	83
		2012	366	0	0	58
		2013	156	-	-	-
Operation[1]	BDR-USWQ2	2019	81	-	-	-
		2020	366	89	0	0
		2021	365	132	0	0
		2022	364	111	0	0
		2023	278	71	0	-
	NTH-USWQ1	2018	98	-	-	-
		2019	365	0	0	36
		2020	366	89	0	0
		2021	365	132	0	0
		2022	364	111	0	0
		2023	278	71	0	-
	BDR-DVWQ	2018	290	0	0	-
		2019	365	0	0	49
		2020	366	48	0	0
		2021	152	-	-	-
		2022[2]	365	71	0	0
		2023	299	14	0	-
	BDR-TAILWQ	2018	255	0	0	-
		2019	287	0	0	-
		2020	222	-	-	-
		2021	257	36	0	-
		2022	301	46	0	-
		2023	205	1	0	-
	BDR-DSWQ	2018	290	0	0	-
		2019	365	0	0	48
		2020	366	54	0	0
		2021	287	28	0	-
		2022	273	41	0	-
		2023	128	-	-	-

"n" is the number of days that have observations for at least 23 hours.

"-" denotes periods when insufficient data were available.

[1] Data stops on Oct. 6, 2023 before the cold temperatures of late fall and early winter.

[2] Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01.

4.2.6. Bull Trout Temperature Guidelines

During baseline and operational monitoring periods, the highest maximum daily temperatures did not exceed the prescribed thresholds for Bull Trout rearing in ULR or Boulder Creek (15°C; Oliver and Fidler 2001; Table 21 and Table 22).

The number of days where daily maximum water temperatures were above the Bull Trout thresholds for spawning and incubation (i.e., >10°C) in a calendar year during baseline monitoring is only available for 2012 in the diversion reach of the ULR (six days; Table 21). During operations, considering the diversion, tailrace, and downstream sites, this number ranged from five to 15, zero to six, and 4 to 10 days, respectively (Table 21). In Boulder Creek, the number of days in a calendar year where daily maximum water temperatures were above the thresholds for spawning and incubation (i.e., >10°C) ranged from two to 16 during the baseline record at the diversion site and from 23 to 124 days at the diversion, 12 to 17 days at the tailrace, and 5 to 124 days at the downstream sites during operations (Table 22).

The number of days where the minimum temperature was less than the incubation threshold (i.e., <2°C) was high in both streams (Table 21 and Table 22) due to cooler temperatures during the winter months (Table 13 and Table 14). Overall, the number of exceedances of the lower temperature threshold of 2°C was, on average, less during operations to date (2018 to 2023) at the diversion, tailrace, and downstream sites in both streams than during the baseline period at the diversion sites.

Table 21. Upper Lillooet River summary of the number of days where the daily minimum or maximum water temperature (°C) exceeds the Bull Trout BC WQG thresholds (Oliver and Fidler 2001).

Project Phase	Site	Year	n (days)[1]	Rearing (Year-round)	Spawning (Aug.1 - Dec. 8)	Incubation (Aug. 1 - Mar. 1)	
				T_{water} > 15°C	T_{water} > 10°C	T_{water} < 2°C	T_{water} > 10°C
Baseline	ULL-DVWQ	2010	49	-	-	-	-
		2011	97	-	-	-	-
		2012	366	0	6	110	6
		2013	120	-	-	-	-
Operation	ULL-DVWQ01	2018	60	-	-	102	-
		2019	365	0	5	92	5
		2020	121	-	-	-	-
		2021	57	-	-	-	-
		2022	364	0	15	96	15
		2023	278	0	-	-	-
	ULL-TAILWQ	2018	259	0	0	75	0
		2019	293	0	0	90	0
		2020	250	0	3	113	3
		2021	320	0	4	109	4
		2022	330	0	6	113	6
		2023	237	0	-	-	-
	ULL-DSWQ	2018	278	0	4	105	4
		2019	365	0	9	101	9
		2020	356	0	7	60	7
		2021	347	0	7	84	7
		2022	360	0	10	92	10
		2023	220	0	-	-	-

[1] n is the number of days that have observations for at least 23 hours within the calendar year.

Data is incomplete for the 2023 year; data ends on October 6, 2023.

T_{water} is the total number of days where the minimum or maximum water temperature is outside the BC WQG threshold.

A dash (-) denotes values that are not reported due to data gaps exceeding a threshold of 14 consecutive or 28 cumulative days during spawning or incubation periods, or less than 50% of the year for rearing.

Incubation spans two calendar years; the results are reported in the calendar year when the period started (i.e., August 2018 to March 2019 is reported in 2018).

Table 22. Boulder Creek summary of the number of days where the daily minimum or maximum water temperature (°C) exceeds the Bull Trout BC WQG thresholds (Oliver and Fidler 2001).

Project Phase	Site	Year	n (days)[1]	Rearing (Year Round)	Spawning (Aug.1 - Dec. 8)	Incubation (Aug. 1 - Mar. 1)	
				T_{water} > 15°C	T_{water} > 10°C	T_{water} < 2°C	T_{water} > 10°C
Baseline	BDR-DVWQ	2008	45	-	-	-	-
		2009	365	0	7	124	11
		2010	351	0	12	92	16
		2011	354	0	2	125	2
		2012	366	0	12	112	16
		2013	156	-	-	-	-
Operation	BDR-DVWQ	2018	290	0	23	48	30
		2019	365	0	32	108	32
		2020	366	0	38	38	117
		2021	152	-	-	-	-
		2022[2]	365	0	45	45	124
		2023	299	0	38	-	-
	BDR-TAILWQ	2018	255	0	12	-	-
		2019	287	0	14	62	14
		2023	205	0	17	-	-
	BDR-DSWQ[3]	2018	290	0	15	52	21
		2019	365	0	25	110	25
		2020	366	0	27	27	121
		2021	287	0	12	12	5
		2022	273	0	36	36	124
		2023	128	-	-	-	-

[1] n is the number of days that have observations for at least 23 hours within the calendar year.

[2] Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01.

[3] BDR-DSWQ has no data between 2021-10-19 06:45 and 2022-04-02 17:45

T_{water} is the total number of days where the minimum or maximum water temperature is outside the BC WQG threshold.

A dash (-) denotes values that are not reported due data gaps exceeding a threshold of 14 consecutive or 28 cumulative days during spawning or incubation periods, or less than 50% of the year for rearing.

Incubation spans two calendar years; the results are reported in the calendar year when the period started (i.e. August 2018 to March 2019 is reported in 2018).

4.2.7. Mean Weekly Maximum Temperature (MWMxT)

A comparison of MWMxT temperature data to optimum temperature ranges for Coho Salmon, Cutthroat Trout, and Bull Trout was completed for each species based on their distribution (Table 7) in the upstream, diversion, and downstream reaches of the ULR (Section 10.1 of Appendix C), and the diversion and downstream reaches of Boulder Creek (Section 10.2 of Appendix C). The upstream reach of Boulder Creek is non-fish-bearing.

Each MWMxT table shows the completeness of the data record (in percent) for each life stage along with the minimum and maximum MWMxT range in each period. The percentage of data within each optimum temperature range is provided to evaluate the overall suitability of the temperature range for each life stage of each fish species. Exceedance of the BC WQG range (Oliver and Fidler 2001; greater than ±1°C outside the optimum ranges) is highlighted in each summary table in Section 10 of Appendix C where blue indicates MWMxTs are cooler than the lower guidelines by more than 1°C and red indicates temperatures are higher than the upper guidelines by more than 1°C (see shading in Sections 10.1 and 10.2 of Appendix C). The MWMxT results were not calculated for the tailrace sites.

The rearing life stage for all the fish species is year-round, corresponding to the annual MWMxT range. During baseline monitoring, MWMxT ranged from 0.1°C to 10.8°C in ULR and from 0.0°C to 11.0°C in Boulder Creek. During operational monitoring to date (2018 to 2023), MWMxT ranged from 0.3°C to 10.9°C in the ULR and from 0.0°C to 13.2°C in Boulder Creek.

The MWMxT values in relation to species-specific optimal temperature ranges differed by species and location. In general, with the exception of Bull Trout, MWMxTs are within or below (cooler than) the optimal temperature ranges. Bull Trout prefer cooler temperatures overall in comparison to Cutthroat Trout and Coho Salmon. Therefore, fewer exceedances of the cooler temperature limits are observed for this species. Exceedances of the upper limit of the optimum temperatures for Bull Trout spawning and incubation were observed during baseline and operational monitoring in ULR and Boulder Creek (see red shading in Sections 10.1 and 10.2 of Appendix C).

4.2.8. Frazil Ice

Air temperature recorded at Callaghan Valley and Pemberton Airport weather stations was monitored from March 2022 to the end of December 2023. The lowest monthly average and instantaneous air temperatures in Year 5 at Callaghan Valley and Pemberton airport weather stations were recorded in December 2022 (averages of -17.5°C and -15.0°C with instantaneous minimums of -20.1°C and -15.8°C respectively).

Analysis of air temperature data from Callaghan Valley weather station confirmed there was one occurrence of five consecutive days of temperatures averaging <-12°C in December 2022 (Table 23; Figure 9). In addition, one occurrence of five consecutive days of temperatures averaging <-12°C in December 2022 was observed at the Pemberton Airport weather station (Table 23; Figure 10). When air temperatures were less than -12°C for at least three consecutive days, Callaghan Valley and Pemberton airport had minimum average daily temperatures of -17.5°C and -15.0°C which occurred between December 18, 2022, and December 22, 2022 (Table 23).

Per the frazil ice monitoring protocol, site photographs were collected by operations staff for ULR and Boulder Creek during recorded occurrences of three consecutive days of <-12°C at both Pemberton Airport and Callaghan Valley Station. Representative photos of the ice conditions during the coldest recorded conditions on Boulder Creek in Year 5 are shown in Figure 11 and Figure 12. Extensive ice cover is present in Figure 11 looking upstream on Boulder Creek; however, Figure 11 and Figure 12 show clear flowing water, free of frazil ice. Representative photos of the ice conditions during the coldest recorded conditions on ULR in Year 5 are shown in Figure 13 and Figure 14. Additional photographs were reviewed for both facilities during the one <-12°C period in 2022 identified in Table 23, and it was determined that conditions did not warrant a site visit as frazil ice was not detected.

Table 23. Summary of dates when air temperature was less than -12°C for at least three consecutive days during Year 5 (March 2022 to December 2023).

Weather Station Air Temperature	Year	Start Date	End Date	Length (days)	Average Daily Temperature (°C)	Minimum Daily Temperature (°C)
Callaghan Valley	2022	18-Dec	22-Dec	5	-17.5	-20.1
Pemberton Airport	2022	19-Dec	23-Dec	5	-15.0	-15.8

Figure 9. Average daily air temperature data from March 2022 to December 2023 at Callaghan Valley air temperature monitoring station. Note the threshold was met when air temperature was less than -12°C for at least three consecutive days. This figure was inclusive of those three days.

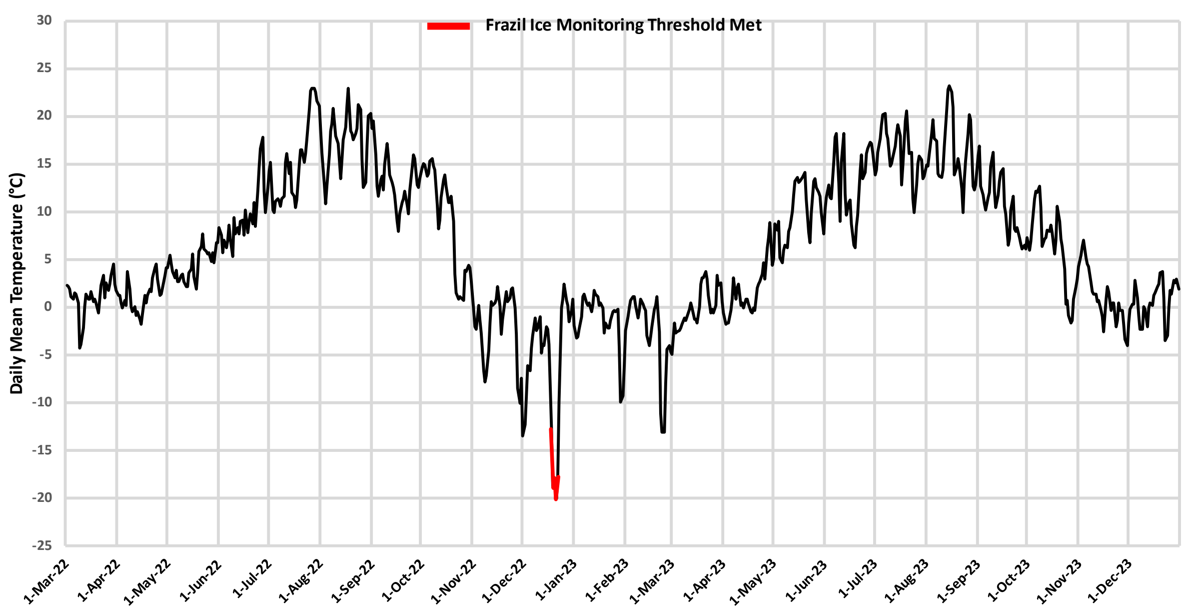

Figure 10. Average daily air temperature data from March 2022 to December 2023 at Pemberton Airport air temperature monitoring station. Note the threshold was met when air temperature was less than -12°C for at least three consecutive days. This figure was inclusive of those three days.

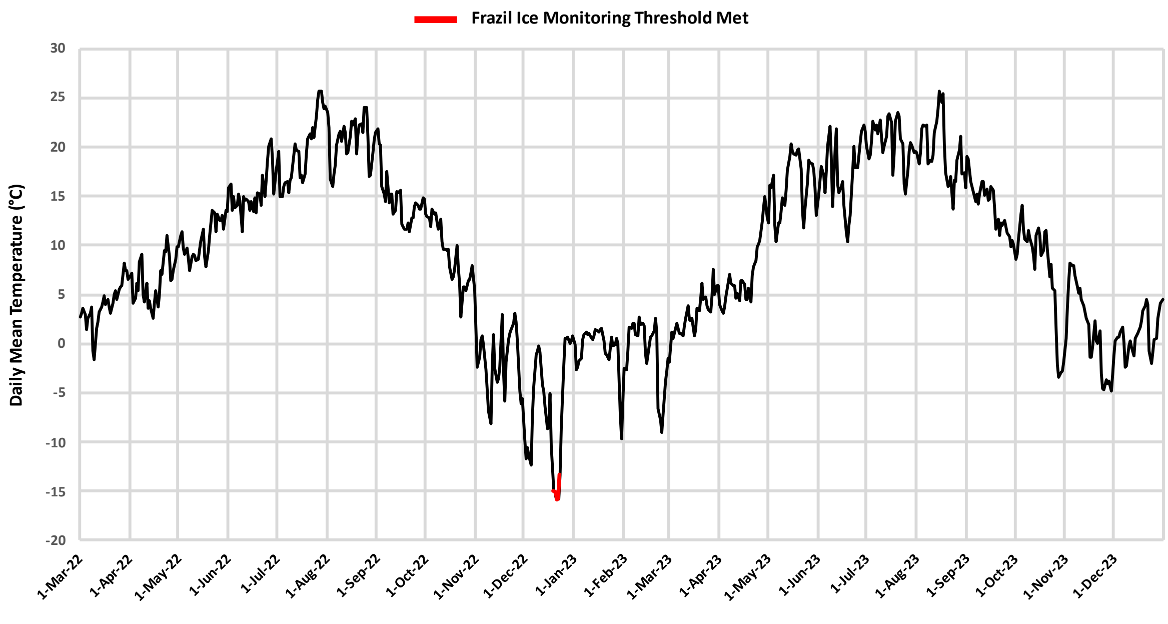

Figure 11. Looking upstream at Boulder Creek diversion reach on December 22, 2022.

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Figure 12. Looking downstream at Boulder Creek diversion reach towards the tailrace confluence on December 22, 2022.

Figure 13. Looking upstream at Upper Lillooet diversion reach from the tailrace on December 22, 2022.

Figure 14. View of Upper Lillooet diversion reach at the tailrace confluence on December 22, 2022.

4.2.8.1. Frazil Ice Summary (Years 1 through 5)

Air temperature at Callaghan Valley and Pemberton Airport weather stations was monitored from October 2017 to the end of December 2023. Analysis of air temperature data from Callaghan Valley Station confirmed there were 14 occurrences ranging from three to twelve consecutive days of temperatures averaging <-5°C (-12°C in Year 5) between October 2017 to December 2023 (Table 24; Figure 15). Pemberton Airport weather station confirmed there were 11 events ranging from three to thirteen consecutive days of temperatures averaging <-5°C (-12°C in Year 5) from October 2017 to December 2023 (Table 24; Figure 16).

As per the frazil ice monitoring protocol, site photographs were collected by operations staff for ULR and Boulder Creek during recorded occurrences of three consecutive days of <-5°C (-12°C in Year 5, per recommendation from Year 4) at both Pemberton Airport and Callaghan Valley Station. Photographs were reviewed for both facilities during periods identified in Table 24. Based on a review of photographs, it was determined that conditions did not warrant a site visit as frazil ice was not detected, with the exception of site visits conducted on December 23 and 24, 2017, and January 2, 2018. Frazil ice was identified in the margin habitat of Boulder Creek during the December 23 and 24, 2017 survey; however, the mainstem was free of frazil ice, and pool holding habitat was still available. Further, the Boulder Creek facility was shut down at the time of survey, and no frazil ice was identified in ULR during this survey. No frazil ice was identified on ULR or Boulder Creek during the January 2, 2018, survey.

The overall minimum three-day average air temperature threshold during occurrences was -19°C as measured at the Callaghan Valley weather station across all monitoring years (occurred December 18 - 22, 2022), while the Pemberton Valley station saw a three-day average threshold of -16.0°C; (December 25, 2021 to January 2, 2022; Table 24). Conditions on Boulder Creek during the December 2022 period are shown in Figure 11 and Figure 12 above. Extensive ice cover is present; however, clear flowing water, free of frazil ice, is also present. Conditions on the ULR during the same period are shown in Figure 13 and Figure 14, with the river flowing clear and free of frazil ice. Results from the first five years of operational monitoring support that frazil ice is not an issue in the diversion reaches of either the ULR or Boulder Creek.

Table 24. **Summary of dates when air temperature was less than -5°C for at least three consecutive days during years 1 through 4 (October 2017 to February 2022), and when air temperature was less than -12°C for at least three consecutive days during year 5 (March 2022 to December 2023).**

Weather Station Air Temperature	Year	Start Date	End Date	Length (days)	Average Daily Air Temperature (°C)	Minimum Daily Air Temperature (°C)	Minimum 3-Day Threshold Air Temperature (°C)[2]
Callaghan Valley	2017	03-Nov	06-Nov	4	-7.9	-8.6	-7.8
		20-Dec	31-Dec	12	-7.4	-10.7	-8.2
	2018	18-Feb	23-Feb	6	-10.0	-11.2	-10.8
	2019	03-Feb	14-Feb	12	-11.2	-14.4	-11.5
		24-Feb	26-Feb	3	-8.5	-9.8	-6.5
		28-Feb	05-Mar	6	-7.6	-9.5	-7.3
		28-Nov	30-Nov	3	-6.9	-7.8	-6.3
	2020	12-Jan	18-Jan	7	-11.5	-17.9	-16.0
	2021	08-Feb	14-Feb	7	-10.7	-15.3	-11.0
		19-Dec	21-Dec	3	-9.3	-12.8	-7.5
		24-Dec[1]	01-Jan[1]	9	-14.1	-21.1	-16.4
	2022	04-Jan	06-Jan	3	-9.6	-13.4	-7.1
		21-Feb	25-Feb	5	-7.7	-11.0	-6.5
		18-Dec	22-Dec	5	-17.5	-20.1	-19.0
Pemberton Airport	2018	23-Dec	04-Jan	13	-7.7	-12.5	-9.0
		19-Feb	23-Feb	5	-8.8	-10.6	-9.2
	2019	03-Feb	14-Feb	12	-9.5	-14.2	-10.7
	2020	13-Jan	18-Jan	6	-13.2	-15.1	-14.0
	2021	09-Feb	14-Feb	6	-8.8	-11.2	-9.0
		17-Dec	22-Dec	6	-8.3	-14.0	-5.9
	2022	25-Dec[1]	02-Jan[1]	9	-14.1	-18.5	-16.0
		04-Jan	10-Jan	7	-10.4	-12.4	-12.1
		27-Jan	29-Jan	3	-7.1	-8.4	-5.2
		23-Feb	25-Feb	3	-5.8	-6.1	-5.6
		19-Dec	23-Dec	5	-15.0	-15.8	-14.9

[1] Occurrence start date is in the previous year, or ends in the following year.

[2] Minimum 3-day Thresholds are based on minimum daily temperature during the coldest 3 day period.

Figure 15. Average daily air temperature data from October 2017 to December 2023 at Callaghan Valley air temperature monitoring station. Note the threshold was met when air temperature was less than -5°C (-12°C in year 5) for at least three consecutive days. This figure was inclusive of those three days.

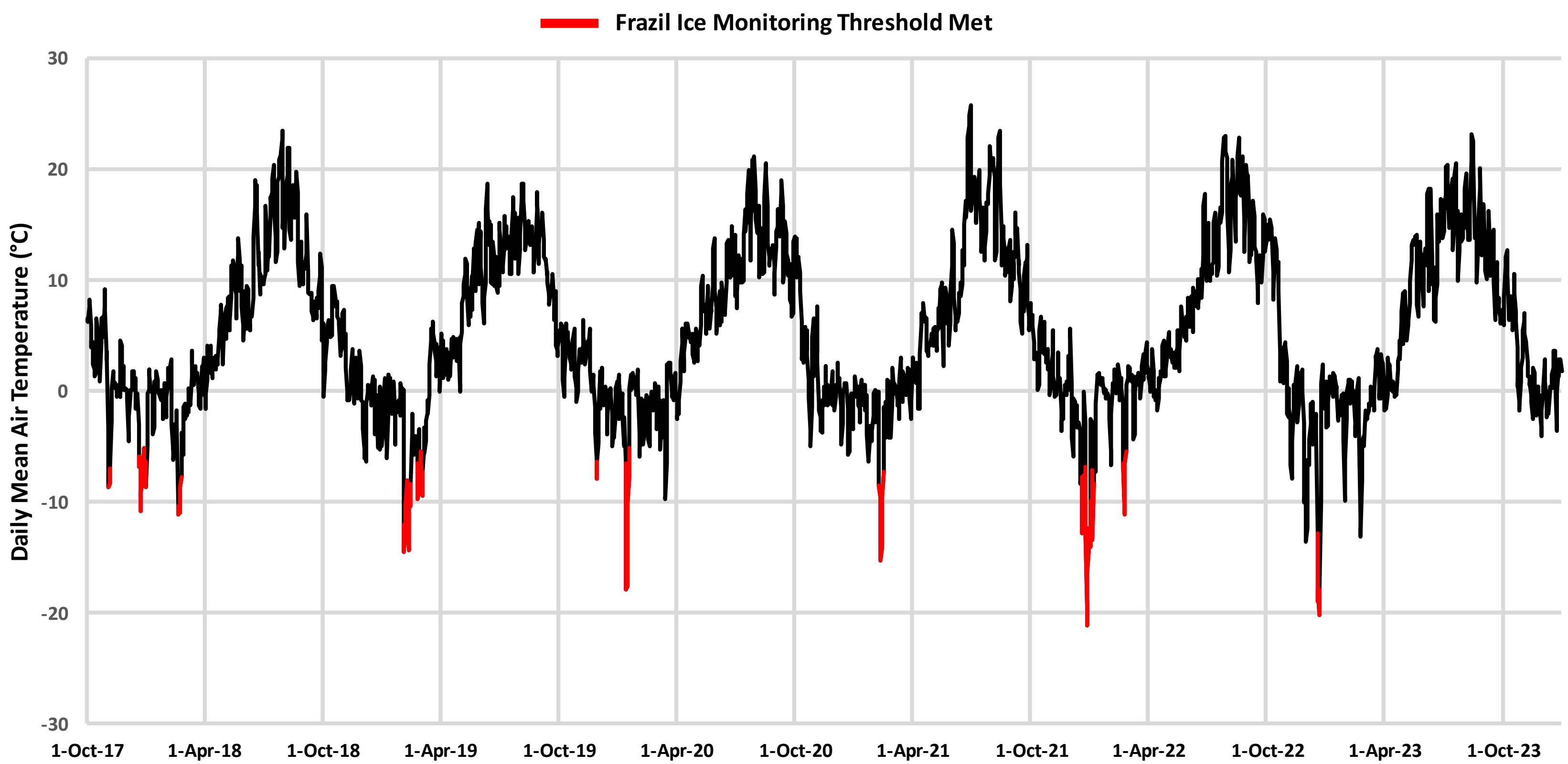
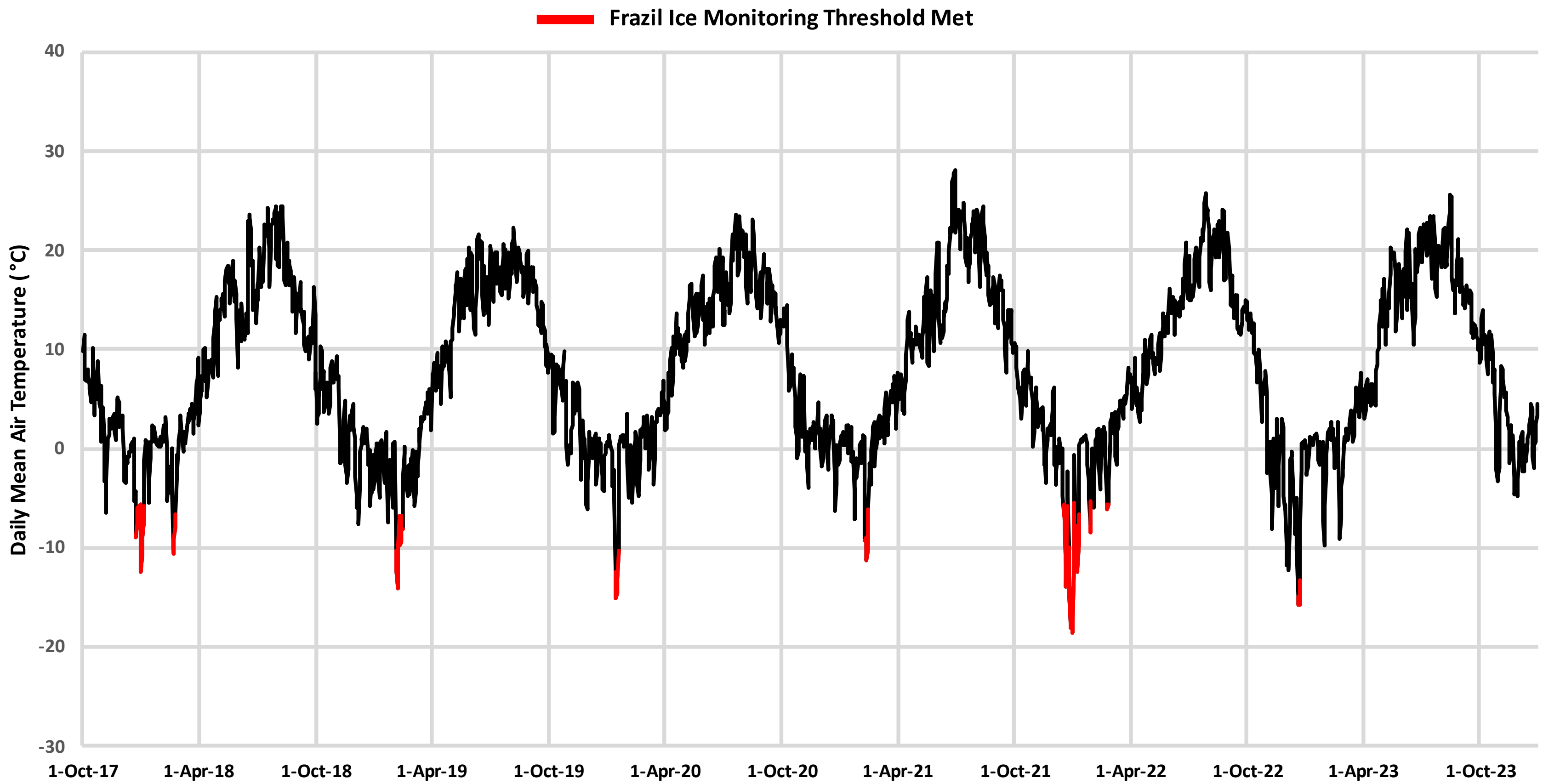


Figure 16. **Average daily air temperature data from October 2017 to December 2023 at Pemberton Airport air temperature monitoring station. Note the threshold was met when air temperature was less than -5°C (-12°C in year 5) for at least three consecutive days. This figure was inclusive of those three days.**



4.3. Stream Channel Morphology

The following subsections include overviews for each of the monitoring elements, reach-specific data, a description of uncertainty, and a summary and interpretation of results concerning Project effects.

4.3.1. Natural Geomorphic Processes and Background Disturbances

The Lillooet River and Boulder Creek watersheds are in the Pacific Ranges of the southern Coast Mountains. As a result of the last major glacial period that ended approximately 10,000 years ago, the landscape surrounding the Lillooet River and Boulder Creek watersheds is composed of glacial features carved into the granite rock (NHC 2011). The Lillooet River and Boulder Creek originate from glacial meltwater. They are influenced by both past and present glacial activity that supplies much of the eroded sediment to the valley bottom.

The Lillooet River and Boulder Creek are characterised by steep, mountainous watersheds in the upper to middle valley with relatively wide and flat valley bottoms. The Lillooet River has a moderately low gradient riverbed that runs along the valley bottom while Boulder Creek is a moderate to steep gradient creek that transitions to a lower gradient as it reaches the Lillooet River floodplain. The watersheds are influenced by the steep surrounding landscape that promotes naturally occurring mass wasting events and avalanches. Slope failure and areas of channel instability occurred naturally prior to anthropogenic changes within these watersheds. Boulder Creek experienced several natural landslides over the operational years of the HEF that may have influenced the stream morphology and the sediment load of the creek. These landslides deposited coarse colluvial material within the creek and along the river left bank (Figure 2 of Appendix J). This material shifted the active channel towards the river right, increasing the channel sinuosity and scouring spawning gravel along the creek margins (Figure 3 of Appendix J). Furthermore, two naturally-occurring landslides within the Boulder Creek diversion reach were generated between the baseline and Year 5 (2023) assessment (Figure 7 of Appendix K). These slope failures typically deliver sediment to the downstream reaches of Boulder Creek, contributing to stream morphology changes.

Glacial coverage substantially influences the annual hydrograph of these watersheds, with low flows in the winter and high flows observed in late spring through the early fall. Glacial melt, snowpack, and rain contribute to flooding events that primarily occur in the summer (i.e., June, July, and August) and occasionally in late fall/early winter (i.e., September and October) (Knight Piésold Ltd. 2011). Peak flows have been observed to alter the channel beds and riparian areas within Boulder Creek. A 2- to- 5- year return period peak flow event occurred on September 20, 2015, followed by a 10- to- 20- year return period peak flow event on November 09, 2016. These events likely caused the abandonment of the river left active channel below the forest service road in the downstream reach, shifting flows into a new channel on river right. This shift in active channel considerably widened the lower reach of Boulder Creek (Figure 12 of Appendix J).

In June 2015, the Boulder Creek Wildlife burnt 6,735 ha of land, starting in the upper Boulder Creek drainage, and reaching and crossing over the ULR. Substantial rainfall occurred following the wildfire, resulting in flooding of the ULR and promoting debris flows in several tributaries

(Boultbee *et al.* 2018). This wildfire caused considerable vegetation and soil damage within the Lillooet River and Boulder Creek watersheds, contributing to changes in the surrounding landscape. Changes to channel morphology within the HEF footprints were observed in the 2023 aerial surveys and are discussed in Section 4.3.3.

Logging activities have been conducted for many decades in the Lillooet River, Salal Creek, and Boulder Creek watersheds. The logging has potentially contributed to instream sediment input and accumulations within these watercourses. Google Earth imagery shows evidence of historical forest harvesting on steep side slopes. No evidence of mass wasting with high sediment supply was observed that appeared to be related to forestry activities during the 6-year monitoring period (2016-2023).

4.3.2. Sluicing and Operational History

Spring freshet, fall rain, and short-term episodic storms cause high flows in ULR and Boulder Creek. The five largest peak flows recorded for Lillooet River near the Pemberton gauge downstream of the Project (Water Survey of Canada (WSC) 08MG005) from 2016 to 2023 are presented in Table 25. The five largest peak flows recorded for Boulder Creek downstream of the powerhouse (BDR-DSLG02) from 2016 to 2023 are shown in Table 26. Although Knight Piésold *et al.* (2011) provided peak flow estimates and return periods for the HEFs, they appeared outdated and may have been overly conservative for the Project's design. Thus, flow data recorded at the WSC 08MG005 gauge, as part of the British Columbia Extreme Flood Project (BCEFP), and data recorded at the BDR-DSLG02 gauge were used to assess peak flows and return periods for the ULR and Boulder Creek, respectively.

Flow data recorded at the ULL-DSLG01 gauge in the ULR were limited due to data discrepancies among monitoring years (i.e., 2021 to 2023). Flow data recorded at the ULL-DSLG01 gauge from 2015 to 2020 was considered reliable and, therefore, used to compare peak flows to the WSC 08MG005 gauge (Table 25). The mean difference (78%) between the ULL-DSLG01 and WSC 08MG005 gauges was applied to the missing data from August 16, 2021, to October 19, 2023, for the ULL-DSLG01 gauge. This was completed to allow for better interpretation of flows in the ULR during the monitoring period.

Flow data recorded at the BDR-DSLG02 gauge in Boulder Creek from October 14, 2016, to June 23, 2023, were considered reliable (Table 26). No data were available from November 1, 2015, to October 13, 2016.The five largest peak flows recorded for Hurley River below Lone Goat Creek (WSC 08ME027) and associated return periods from the BCEFP were used when data were unavailable. These return periods correlated with those from the WSC 08MG005 gauge. For both Boulder Creek and ULR, powerhouse flow data indicated that annual peak flows were passed through the diversion reaches.

Table 25. Five largest daily peak flows for Lillooet River near the Pemberton gauge downstream (Water Survey Canada 08MG005), 2016 to 2023.

Water Year[1]	Date	Peak Flow (m^3/s)[2]	Upper Lillooet Downstream Peak Flows (m^3/s)[3]	Return Period (yrs)[4]
2016	Jun 07, 2016	379	100	<2
	Jun 30, 2016	346	86	<2
	Jul 28, 2016	322	84	<2
	Jul 18, 2016	299	70	<2
	May 18, 2016	297	82	<2
2017	Nov 09, 2016	790	126	10 to 20
	Jun 26, 2017	424	87	<2
	Jul 02, 2017	419	84	<2
	May 31, 2017	396	67	<2
	Jun 09, 2017	393	66	<2
2018	Jun 21, 2018	449	102	<2
	May 20, 2018	392	86	<2
	Jul 18, 2018	321	86	<2
	Jul 07, 2018	319	76	<2
	Nov 23, 2017	364	55	<2
2019	Aug 02, 2019	513	124	2 to 5
	May 30, 2019	390	90	<2
	Jun 18, 2019	332	83	<2
	Jul 11, 2019	332	75	<2
	Jul 18, 2019	327	74	<2
2020	Aug 21, 2020	444	122	<2
	Jun 24, 2020	474	114	<2
	Jul 16, 2020	308	101	<2
	Jul 22, 2020	312	97	<2
	Oct 10, 2020	411	92	<2
2021	Jun 03, 2021	424	101	<2
	Jun 15, 2021	364	76	<2
	Aug 16, 2021	281	63	<2
	Nov 05, 2020	283	55	<2
	Jun 28, 2021	691	27	5 to 10
2022	Jul 28, 2022	557	125	2 to 5
	Jul 13, 2022	436	98	<2
	Jul 04, 2022	431	97	<2
	Aug 04, 2022	423	95	<2
	Jun 28, 2022	421	95	<2
2023	May 17, 2023	465	105	<2
	May 28, 2023	364	82	<2
	Oct 19, 2023	360	81	<2
	Jun 13, 2023	321	72	<2
	Jun 28, 2023	299	67	<2

[1] Water year is based on reporting period and is from Nov 1 - Oct 31 (e.g., 2018 water year is from Nov 1, 2017 to Oct 31, 2018).

[2] Peak flows from Water Survey Canada (WSC) - Lillooet River Near Pemberton gauge used due to unreliability of ULL-DSLG01 data.

[3] Reliable flow data from 2015 to 2020 from the ULL-DSLG01 gauge was used to scale flows from WSC - Lillooet River Near Pemberton gauge for missing data for the period of Aug 16, 2021 to Oct 19, 2023.

[4] Return periods retrieved from the British Columbia Extreme Flood Project for the Water Survey Canada - Lillooet River Near Pemberton gauge.

Table 26. Five largest daily peak flows for Boulder Creek downstream of the powerhouse (BDR-DSLG02), 2016 to 2023.

Water Year[1]	Date	Peak Flow (m^3/s)[2]	Return Period (yrs)[3]
2016	Jun 07, 2016	-	<2
	Jun 30, 2016	-	<2
	Jul 28, 2016	-	<2
	Jul 18, 2016	-	<2
	May 18, 2016	-	<2
2017	Dec 18, 2016	60	10 to 20
	Nov 08, 2016	44	<2
	Jun 08, 2017	26	<2
	Jun 26, 2017	25	<2
	May 31, 2017	23	<2
2018	Jun 21, 2018	24	<2
	Nov 23, 2017	22	<2
	May 20, 2018	15	<2
	Jul 18, 2018	14	<2
	Jul 31, 2018	14	<2
2019	Aug 02, 2019	36	2 to 5
	Jul 17, 2019	21	<2
	Jul 10, 2019	21	<2
	May 30, 2019	21	<2
	Jun 13, 2019	18	<2
2020	Jun 23, 2020	31	<2
	Aug 21, 2020	28	<2
	Oct 09, 2020	19	<2
	Jul 21, 2020	17	<2
	Jul 16, 2020	16	<2
2021	Jun 29, 2021	46	5 to 10
	Feb 14, 2021	39	<2
	Jun 03, 2021	24	<2
	Jun 14, 2021	22	<2
	Sep 09, 2021	20	<2
2022	Jul 27, 2022	57	2 to 5
	Jul 12, 2022	45	<2
	Jul 04, 2022	42	<2
	Jun 28, 2022	41	<2
	Aug 10, 2022	34	<2
2023	Oct 19, 2023	-	<2
	Jun 28, 2023	-	<2
	Jun 29, 2023	35	<2
	Jun 30, 2023	23	<2
	Jul 01, 2023	21	<2

[1] Water year is based on reporting period and is from Nov 1 - Oct 31 (e.g., 2018 water year is from Nov 1, 2017 to Oct 31, 2018).

[2] As estimated at BDR-DSLG02 gauge. "-" = no data available.

[3] Return periods based on comparison of flows at Water Survey Canada - Lillooet River Near Pemberton gauge to values from British Columbia Extreme Flood Project. These return periods were used because Boulder flood frequency analysis is out dated.

Upper Lillooet River

The ULR intake is composed of an Obermeyer weir structure that can be lowered to facilitate the passage of the accumulated bedload in the headpond. Sediment load in the Lillooet River is naturally very high, requiring routine headpond flushing during peak flows. Sluicing to allow sediment, substrate, and large wood passage through the headpond (i.e., headpond flushing) has been conducted throughout the operational period. The headpond was flushed 6 days in 2020, 10 days in 2021, 7 days in 2022, and 9 days in 2023. Sonar surveys of the headpond bathymetry were taken before and after the flushing events to confirm the conveying of the material downstream (Figure 17). The Obermeyer weir was observed to be fully lowered on June 29, 2023, to flush accumulated headpond sediment downstream. The weir sill and streambed appeared to be at the same elevation, indicating no dead storage (i.e., permanent accumulation) in the headpond after the flushing (Figure 18).

Figure 17. Example Upper Lillooet Headpond bathymetry sonar image displaying pre-flush elevation (top) and post-flush elevation (bottom) collected during the sluicing event on August 18, 2023.

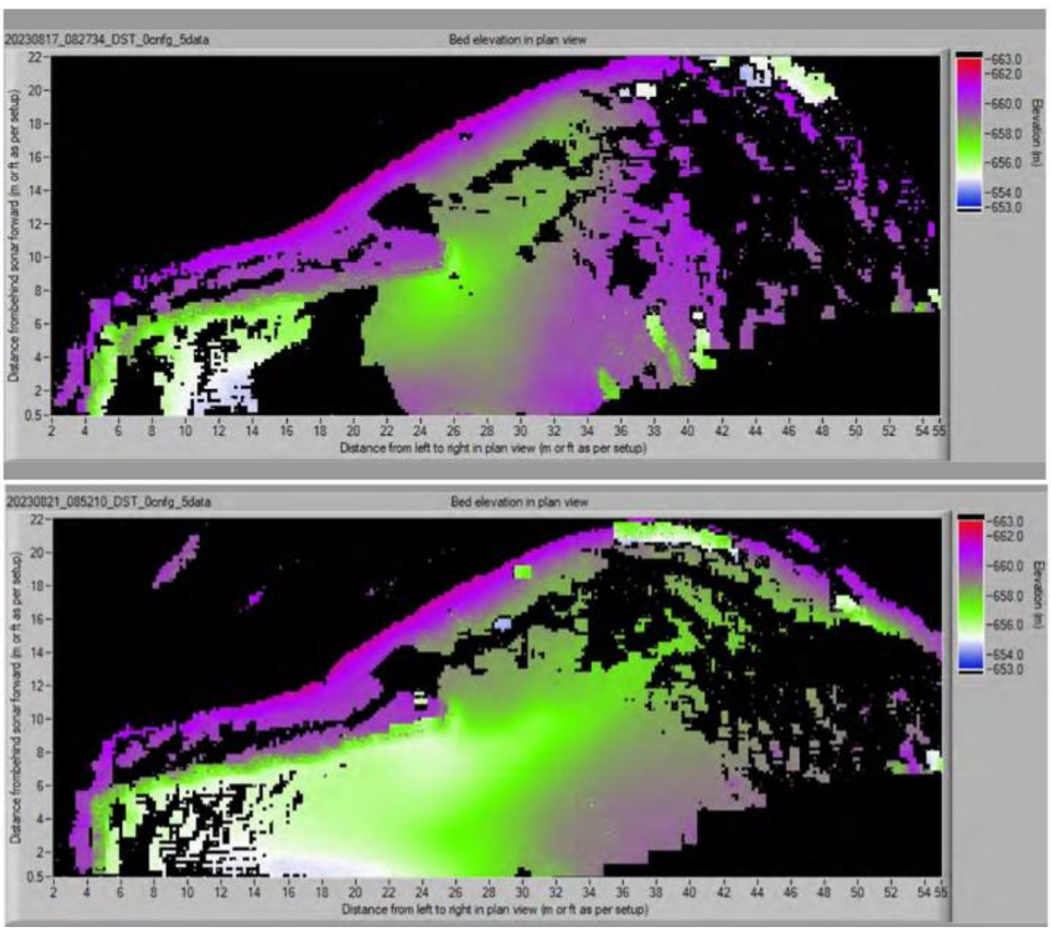


Figure 18. Obermeyer weir fully lowered during peak flow event to convey accumulated headpond sediment to be flushed downstream on June 29, 2023.

Boulder Creek

The Boulder Creek intake is composed of a Coanda screen-type water intake structure. Sediment load in Boulder Creek is naturally very high, requiring frequent headpond flushing during peak flows. Sluicing is used as a mechanism to allow sediment, substrate, and large wood passage through the headpond (i.e., headpond flushing). However, additional sediment mobilization (referred to as sediment management) has been required using an excavator (Sims 2019). The additional sediment management requires the opening of the sluice gate, and the shutdown of the generating plant and flows through the facilities infrastructure. An excavator is used to move accumulated bedload in the headpond into the thalweg to allow the flow to transport the sediment load downstream. Sluicing was conducted routinely during the operational period, while additional sediment management was conducted 8 times from December 2017 to October 2019, once in 2021 and once in 2022. These combined methods successfully transport bedload from the headpond to the lower reaches of Boulder Creek (Figure 19, Figure 20).

Figure 19. Boulder intake displaying naturally-accumulated bedload in the headpond prior to routine sediment management on August 9, 2019.

Figure 20. Boulder intake displaying the successful removal of bedload from the headpond post sediment management on August 9, 2019. Red arrow is a visual representation of the height of sediment pre-sediment management activities.

4.3.3. Qualitative Observations of Geomorphic Change

Assessment of geomorphic changes associated with the possible Project effects pathways are described in the following subsections.

4.3.3.1. Aerial Photograph Monitoring of Channel Morphology

Oblique photographs were taken in 2016 and 2023 for the geomorphic photographic monitoring of the ULR (Appendix E) and Boulder Creek (Appendix F). Aerial imagery captured as part of the stream morphology assessment of the ULR (Appendix J), and Boulder Creek (Appendix K) were used for orthomosaic comparison. Channel morphology changes from photographic monitoring and aerial images between the two years are summarized for the upstream, headpond, diversion, and downstream reaches. Sediment observations were limited to exposed bars and river margins as water turbidity limited channel bed visibility.

Upper Lillooet River – Upstream

Two photographic monitoring points (ULL-USGMPP01 to ULL-USGMPP02) were established for the upstream reach (Map 6; Figure 1 and Figure 2 of Appendix E). The photographic monitoring points and aerial imagery display extensive changes in the control reach caused by natural channel instability from 2016 to 2023 (Figure 1 of Appendix J). The channel's ability to migrate to the river left is largely attributed to the wide floodplain and high sediment load of the ULR. The channel migration scoured the riparian area along the river left bank, contributing a substantial sediment load to the active channel. The mid-channel bar adjacent to the scoured riparian area was substantially wider and longer in 2023. Large wood abundance tripled in 2023 compared to 2016 with pieces scattered across the mid-channel bar and river margins.

The confluence delta of Salal Creek appears to have stabilized, displaying one active channel in 2023 rather than two channels in 2016 (Figure 2 of Appendix J). The tributary shows no reduction of sediment accumulated at its ULR confluence and continues to supply considerable amounts of sediment to the ULR. A large gravel bar downstream of the Salal Creek/ULR confluence, noticeable in 2016, was observed in aerial imagery to be submerged in 2023 due to backwatering caused by the intake.

Upper Lillooet River – Headpond

Three photographic monitoring points (ULL-USGMPP03 to ULL-USGMPP05) were established for the headpond (Map 6; Figure 3 to Figure 5 of Appendix E). These photos show expected changes due to the headpond creation including flooding of riparian vegetation on the river left and right banks and submerging of exposed gravel bars (Figure 2 and Figure 3 of Appendix E). A depositional delta can be common at the upper extent of a headpond; however, 2023 aerial imagery observations were inconclusive in assessing delta formation due to high water turbidity caused by glacial silt. The headpond flushing operations allow accumulated sediments and large wood to be transported through the headpond. In 2016, three pieces of large wood were observed in the headpond, while in 2023, 15 pieces of large wood were observed on the headpond banks that appeared to be transient. We conclude that the HEF has not impacted the natural flow of sediment through the ULR headpond. The confidence level of this conclusion is moderate to high.

Slope erosion likely triggered by HEF construction has occurred along the river left bank of the headpond as water levels increased during infilling (Figure 4 of Appendix J). Prior to infilling, flow energy was attenuated by the boulder armouring at the toe of the slope. As water levels increased, the energy could access the slope surface, causing minor erosion between 2016 and 2023. Field crews witnessed minor erosion of this slope into the headpond while on-site during October 2023. We do not anticipate that major effects have occurred downstream regarding fine sediment loading, with a moderate to high level of confidence.

Upper Lillooet River – Diversion Reach

Aerial imagery did not reveal large changes in bar orientation, channel pattern, or vegetation encroachment in the diversion reach between 2016 and 2023. Common geomorphic indicators of channel incision were not observed, such as cut faces on bars, terrace formation, suspended armour layers, or increases in bedrock or lag deposit exposure. Prior to HEF operations, the channel bed was composed of boulders and lag deposits that limited the potential for channel incision in the diversion reach. Some changes in the distribution of spawning gravel and fines were observed with moderate coarsening and fine sediment accumulation on river margins (Figure 5 to Figure 9 of Appendix J). Spawning gravel was detected to be more abundant on river left in 2023 than in 2016, indicating a redistribution of sediment within the reach. No substantial spawning gravel aggradation was observed, indicating that the bedload cleared from the headpond during the operational flushing events is likely being transported downstream of the ULR HEF powerhouse. The confidence level of this conclusion is high.

Large wood abundance was similar between 2016 and 2023; however, there was an increase in small wood on exposed gravel bars, likely an outcome of the 2015 wildfire. The similarity in large wood between monitoring years leads to the conclusion that there is no evidence of a reduction caused by the headpond trapping. The confidence level of this conclusion is high.

Upper Lillooet River - Downstream Reach

Minimal changes were observed in the downstream reach between 2016 and 2023. Channel morphology was maintained throughout the reach with no apparent channel incision, scouring, or signs of bank instability. An unnamed tributary located on river right was observed to naturally contribute a large amount of spawning-sized gravel at the upper extent of the reach, causing scouring of the ULR left bank (Figure 10 of Appendix J). Spawning gravel and fine sediment were similar within the reach, and redistribution of sediment deposits was apparent. Some localized spawning gravel patches were altered to fine sediment accumulation; however, this was not consistent throughout the reach. The lower end of the downstream reach experienced minor coarsening of sediment and loss of spawning gravel. This may have been caused by a steeper gradient that promotes transient spawning gravel transport comparatively to the upper extent of the downstream reach (Figure 14 to Figure 18 of Appendix J). The changes observed are likely associated with natural variability. Short-term transient trapping of bedload sediment in the headpond was considered a possible cause of changes and determined to be inconsequential due to the flushing frequency (Section 4.3.2). Spawning gravel connectivity has been re-established between the headpond and downstream reach, with a high level of confidence.

The large wood abundance roughly doubled between 2016 and 2023, and the small wood increased substantially. Both additions are likely attributed to the 2015 wildfire. Aerial imagery shows evidence of an abundance of burnt trees lying along the riverbanks of the ULR. Similar to the diversion reach, it was concluded that large wood supply disruption to the downstream reach has likely not occurred, with a moderate to high level of confidence.

Boulder Creek - Upstream Reach

Five photographic monitoring points (BDR-USGMPP01 to BDR-USGMPP02) were established for the upstream control reach in 2016 (Map 7; Appendix F). In October 2019, the upstream reach experienced a landslide approximately 100 m upstream from the intake, causing changes within the reach and potentially supplying sediment to the downstream reaches (Section 4.3.1; Figure 2b and Figure 3a of Appendix F). Upstream of the landslide, minimal changes in channel morphology and spawning gravel distribution were observed between 2016 and 2023 (Figure 1 to Figure 5 of Appendix K). However, large wood supply has more than tripled in the upstream reach from 2016 to 2023. The 2015 wildfire impacted Boulder Creek's steep banks and aerial imagery shows the supply of large and small wood to the confined upstream reach. This supply appears more prevalent in the upstream reach than the diversion and downstream reach due to gentler slopes found in the lower reaches of the watershed.

Boulder Creek – Headpond

The operational flushing and sediment management activities appear to be allowing the passage of spawning gravel and large wood through the Boulder headpond to the downstream reaches. Two pieces of large wood were observed in the headpond in 2023. However, aerial imagery shows ten pieces of large wood and abundant spawning gravel below the headpond; this suggests that large wood and spawning gravel transport through the headpond has been re-established with a high level of confidence (Figure 21).

Figure 21. Evidence of large wood and spawning gravel being transported below the Boulder Creek headpond bay on October 28, 2023.

Boulder Creek – Diversion Reach

Natural scouring of vegetation and sediment in the lower diversion reach was observed during baseline studies. The scouring was likely due to the 2-to-5-year return period peak flow event that occurred on September 20, 2015. This event was followed by a 10-to-20-year return period peak flow event on November 9, 2016 that occurred one month after the stream morphology baseline surveys were completed. It appears that the reach has stabilized since as no considerable changes in channel width and channel pattern were observed from 2016 to 2023 (Figure 6 to Figure 10 of Appendix K). Aerial monitoring has not shown substantial vegetation encroachment on the active channel in recent years. The water turbidity was low in 2023, allowing for better interpretation of the channel bed composition compared to 2016. Spawning gravel aggradation and substrate coarsening were not observed; however, the channel bed in the fish-bearing section of the diversion reach experienced minor spawning gravel loss. Two natural slope failures on the steep river left bank occurred between monitoring years, (Figure 8 of Appendix K). Although slope failures are potentially a source of spawning-sized gravels, spawning gravel transport from the headpond through the diversion reach is successfully occurring, with a high level of confidence.

Large wood substantially increased, doubling in number within the diversion reach in 2023 compared to 2016. While movement and addition of large wood were noticeable between monitoring years, it is unclear whether the increase is related to transport from the upstream reach or lateral inputs. The 2015 wildfire and historical/recent logging impacted the left slope of the diversion reach; however, less wood appeared to be scattered along the slopes of the creek in 2023 compared to the ULR. Large wood transport appears to be occurring from the upstream reach, with a moderate to high level of confidence.

Boulder Creek - Downstream Reach

The downstream reach experienced substantial changes from 2014 to 2023. The 2015 wildfire impacted the left and right riverbanks, making them more susceptible to erosion. The lack of trees on the landscape further limited peak flow buffering. A 2-to-5-year return peak flow event occurred in 2015, before baseline monitoring, causing the active channel to reroute below the forest service road. This created a new channel on river right, widening the downstream reach substantially (Figure 18 of Appendix K). These major changes were caused by natural disturbances and not by HEF effects, with a high level of confidence. Changes in channel patterns have occurred in the lower downstream reach (Figure 19 of Appendix K). The river left channel is displaying signs of revegetation since it was abandoned (Figure 17 of Appendix K). The confluence with the ULR has stabilized to one channel.

A slope failure was observed on river left in the downstream reach below the transmission line (Figure 12 and Figure 13 of Appendix K). This site is highly subjective to erosion since the slope failure is in the outer bend of the channel where water velocity is higher than the inner bend. At flows observed in 2023 imagery, the slope failure has caused the shifting of the active channel from river right to river left, scouring the gravel bar (Figure 13 of Appendix K). The slope failure impact is minimal as it only slightly accelerates the sediment delivery that would likely already be occurring.

There were no considerable changes in spawning gravel quantities and distribution in the downstream reach from 2016 to 2023. Spawning gravel connectivity has been re-established through the headpond, with a high level of confidence. A reduction in large wood was observed in the downstream reach where approximately one-third was lost in 2023 compared to 2016. Given the changes caused by the natural flooding events in the downstream reach and the increase of large wood in the diversion reach, we conclude that the reduction in wood was likely due to natural variability and that the HEF has not impacted the transport of large wood through the headpond, with a moderate to a high level of confidence.

4.3.4. Evaluation of Uncertainty

The primary sources of uncertainty in comparison of changes between baseline (2016) and Year 5 (2023) include: broad interannual variability within the watershed, antecedent catchment conditions prior to sampling, and the contributing influences of natural disturbances. These sources of uncertainty were considered when assigning the confidence levels for the assessment of Project effects.

One of the greatest sources of uncertainty in interpreting Project effects on channel morphology is the interannual variability and often cyclical nature of change within a dynamic system (Eaton and Hassan 2013). Such variability could result from broader-scale adjustments in sediment supply within the watershed, which could be due to a wide range of factors, including climatic variability, continued logging or slope disturbances, legacy effects of Project construction, road maintenance activities, or the effect of climate change on the hydrologic cycle. Natural variability in sediment supply is likely an important driver of spawning gravel dynamics through the system. Flows had enough energy to mobilize sediment and substrate through the ULR and BDR headpond. Therefore, these events may have restructured bed surfaces and gravel deposits multiple times within the operational monitoring period.

Natural differences in baseline conditions and the timing of sampling relative to seasonal variability in hydrologic conditions introduce further uncertainty in interpreting Project effects. Since natural high flows usually occur from June through November each year (and field observations were made during this period), a small difference between the time of sampling for comparisons could introduce large uncertainties due to interannual variability in the magnitude and frequency of natural high flows preceding observations.

Natural disturbances such as the observed wildfire and mass wasting events can alter natural patterns of sediment and large wood supply within the watersheds, introducing uncertainty in the evaluation of Project effects. The wildfire impacted a large portion of both watersheds to the stream edges, contributing unnatural quantities of large and small wood to the channels. Landslides and slope failures may have added a substantial sediment load to the channels, compensating for sediment trapping in the headponds.

4.3.5. Summary and Interpretation

The results of the stream morphology monitoring are discussed below in the context of theoretical Project effects, including spawning gravel transport re-establishment through the headpond, substrate coarsening downstream of the headpond, loss of spawning gravel downstream of the headpond, aggradation of gravel in diversion reach, channel narrowing in the diversion reach, channel incision downstream of the headpond, and net reduction in large wood downstream of the headpond.

4.3.5.1. Gravel Transport Re-establishment Through the Headpond

Review of the Flush Compliance reports for both HEFs and the Sediment Management reports of the Boulder headpond provided primary evidence for understanding gravel transport re-establishment through the headponds (Sims 2019). Bathymetry sonar surveys and images collected during flushing operations provide visual evidence of headpond bedload being transported through the headpond. The photographic monitoring provided secondary evidence that gravel transport was re-established by showing a redistribution of spawning gravel downstream of the headponds of both facilities.

Spawning gravel transport through the headponds of the ULR and Boulder Creek HEFs has been re-established, with a high level of confidence.

4.3.5.2. Substrate Coarsening Downstream of the Headpond

Aerial imagery comparison of channel bed composition between 2016 and 2023 was the primary method to assess the potential for substrate coarsening. Boulder Creek did not experience coarsening downstream of the headpond. The ULR downstream and diversion reach experienced low to moderate coarsening, respectively. However, some fine sediment accumulation and spawning gravel movement were evident within the reach. These changes are expected due to natural variability or short-term transient trapping of bedload sediment in the headpond. The confidence level of this conclusion is moderate to high.

4.3.5.3. Loss of Spawning Gravel Downstream of Headpond

Aerial imagery comparison of channel bed composition between 2016 and 2023 was the primary method to assess the potential for loss of spawning gravel downstream of the headpond. Photographic monitoring of the ULR upstream and downstream reach showed abundant spawning gravel supply from Salal Creek and the unnamed tributary. The shifting of the active channel in the upstream reach provided further evidence that sediment supply is continually occurring in the system. The upstream sediment supply combined with the frequent operational flushing of the headpond supports that a loss of spawning gravel has likely not occurred downstream of the headpond. The confidence level of this conclusion is moderate.

Boulder Creek headpond sediment management activities show that gravel is transported through the headpond to the downstream reaches. Boulder Creek 2023 imagery showed abundant spawning gravel directly downstream of the headpond with only minor losses of spawning gravel and no evidence of coarsening in the diversion reach. The downstream reach experienced no spawning gravel quantity and distribution changes. Therefore, a loss of spawning gravel has likely not occurred downstream of the headpond in Boulder Creek between 2016 and 2023. The confidence level of this conclusion is moderate to high.

4.3.5.4.Aggradation of Spawning Gravel in Diversion Reach

Aerial imagery comparison of channel bed composition between 2016 and 2023 was the primary method used to assess the potential for aggradation of spawning gravel in the diversion reaches of ULR and Boulder Creek. Imagery provided evidence of slope failures in both systems. The slope failure assessments provided conclusions that these are only slightly accelerating the sediment delivery that would already be occurring naturally and are likely to have minimal impact on affected reaches. Photographic evidence showed no spawning gravel aggradation in the diversion reaches of both HEFs. The confidence level of this conclusion is high.

4.3.5.5. Channel Narrowing in the Diversion Reach

Channel narrowing in the diversion and downstream reaches was assessed using aerial photographic monitoring. In recent years, the photographic monitoring did not show channel narrowing or substantial vegetation encroachment on the active channel. Common geomorphic indicators of channel narrowing such as terrace formation or new lateral bars were not observed in aerial photos. Therefore, active channel narrowing was negligible. The confidence level of this conclusion is high.

4.3.5.6. Channel Incision Downstream of the Headpond

Channel incision in the diversion and downstream reaches was assessed using aerial photographic monitoring. Common geomorphic indicators of channel incision were not observed, such as cut faces on bars, terrace formation, suspended armour layers, or increases in bedrock or lag deposit exposure in both ULR and Boulder Creek. Furthermore, the ULR channel bed was composed of boulders and lag deposits while Boulder Creek was dominated by boulder substrate prior to the Project, limiting the potential for channel incision. Channel incision downstream of the headpond has not occurred in both the ULR and Boulder Creek. The confidence level of this conclusion is high.

4.3.5.7. Reduction of Large Wood Downstream of the Headpond

Loss of large wood was assessed using aerial and oblique photographs. Photographic monitoring provides evidence that the ULR has not had a reduction of large wood downstream of the headpond. Boulder Creek photographic monitoring showed an increase in large wood in the diversion reach and a loss of large wood in the downstream reach. The loss of large wood was likely caused by the 2015 flooding event (2-to-5-year return period) that caused major changes in the downstream reach. While the large wood increases observed between 2016 and 2023 may be attributed to the 2015 wildfire on both the ULR and Boulder Creek. This increased supply could mask HEF effects; however, an inspection of the headpond conditions and operational plans indicate that large wood transport is unlikely to be affected by the HEFs. Given that there was no substantial reduction in large wood quantity between 2016 and 2023, the HEFs have not impacted the connectivity of large wood downstream of the headpond. The confidence level of this conclusion is moderate to high.

4.4. Fish Community

4.4.1. Juvenile Fish Density and Biomass

4.4.1.1. Upper Lillooet River

Closed-Site Electrofishing

Closed-site electrofishing was conducted from April 3 to 8, 2022. Habitat summaries and representative photographs of closed-site electrofishing sites are provided in Appendix L. Sites in the diversion reach were primarily composed of riffles, with some runs and cascades, with gradients ranging from 1.0% to 4.0%. Substrates varied considerably among sites, with either boulders, cobble, gravel, or fines comprising a large proportion of substrates in some sites. Instream cover primarily consisted of boulder and cobble.

Sampling sites ranged from 13 to 50 m in length and 85.6 to 241.4 m² in area in the diversion reach (Table 27). During the field sampling, average daily flows ranged from 27.14 to 30.35 m³/s in the diversion reach. Conductivity ranged from 112 to 140 µS/cm, and water temperature ranged from

3.2°C to 5.3°C in the diversion reach. Water turbidity was medium to high, and alkalinity (as $CaCO_3$) was 36 to 44 mg/L in the diversion reach (Table 27).

Two to three electrofishing passes were conducted at all sites, with total effort ranging from 1,780 seconds to 1,924 seconds in the diversion reach (Table 27). In total, ten Cutthroat Trout, six Bull Trout, and nine Mountain Whitefish were captured during electrofishing in the diversion reach.

Table 27. Summary of closed-site electrofishing site characteristics, conditions, effort, and fish captures in the Upper Lillooet River Diversion Reach in 2022.

Site	Sampling Date	Daily Average Flow (m^3/s)[1]	Conductivity (µS/cm)	Water Temperature (°C)	Turbidity	Alkalinity (mg/L)	Sampled Size		Total Electrofishing Effort (sec)			Electrofishing Catch (# of fish)								
							Length (m)	Area (m^2)				Cutthroat Trout			Bull Trout			Mountain Whitefish		
									Pass 1	Pass 2	Total	Pass 1	Pass 2	Total	Pass 1	Pass 2	Total	Pass 1	Pass 2	Total
ULL-DVEF02b	3-Apr-22	30.35	128	3.2	Medium	44	50	241	1,031	867	1,898	0	0	0	4	0	4	1	0	1
ULL-DVEF04	3-Apr-22	30.35	130	4.3	High	44	21	86	1,006	803	1,809	0	0	0	1	0	1	4	0	4
ULL-DVEF07	3-Apr-22	30.35	137	3.8	Medium	38	13	104	1,024	825	1,849	0	0	0	0	0	0	1	0	1
ULL-DVEF09	8-Apr-22	27.14	126	4.2	Medium	36	13	111	1,095	829	1,924	0	0	0	0	0	0	3	0	3
ULL-DVEF10	8-Apr-22	27.14	112	5.3	Medium	36	15	115	987	793	1,780	9	0	9	0	0	0	0	0	0
ULL-DVEF11	8-Apr-22	27.14	140	4.0	Medium	36	18	114	1,013	804	1,817	0	0	0	0	0	0	0	0	0
ULL-DVEF12	8-Apr-22	27.14	126	4.2	Medium	36	15	120	1,024	894	1,918	1	0	1	1	0	1	0	0	0
						Total	**146**	**891**			**12,995**			**10**			**6**			**9**
						Average	**21**	**127**			**1,856**			**1**			**1**			**1**

[1] Diversion flow was calculated as Penstock intake flows subtracted from downstream Powerhouse flows at ULR-DSPH-R3.

Age Analysis

Length-frequency distributions, length-weight relationships, and length-at-age relationships of Bull Trout and Cutthroat Trout captured during 2022 closed-site electrofishing surveys in the ULR diversion reach, as well as data on individual captured fish (including length, weight, and marks/tags applied), are provided in Appendix M. No scale or fin ray samples of any species were aged in 2022. Based on a review of aging data and length-frequency distributions and a review of 2019 size classes, discrete fork length ranges were defined for fry, juvenile, and adult age classes of both Bull Trout (Table 28) and Cutthroat Trout (Table 29). Juvenile Bull Trout included 1+ to 3+ fish, with ≥4+ fish considered adults, whereas for Cutthroat Trout, which mature at an earlier age in the ULR, 1+ and 2+ fish were considered juveniles, and ≥3+ fish considered adults.

Table 28. Fork length range used to define age classes of Bull Trout captured in the Upper Lillooet River diversion reach in 2022.

Age Class	Fork Length Range (mm)
Fry (0+)	51-85
Juvenile (1-3+)	154 - 199
Adult (≥4+)	200+

Table 29. Fork length ranges used to define age classes of Cutthroat Trout in the Upper Lillooet River diversion reach in 2022.

Age Class	Fork Length Range (mm)
Fry (0+)	0 - 54
Juvenile (1-2+)	94 - 146
Adult (≥3+)	183+

Fish Metrics and Condition

Fork length, weight, and condition factor for all captured Bull Trout and Cutthroat Trout are summarized by age class in Table 30 and Table 31, respectively. Weights were assigned to all fish not weighed in the field from the established length-weight relationships (Appendix M). Average condition factor was similar for all age classes of Bull Trout and Cutthroat Trout in the diversion reach. Mountain Whitefish are not included in fish metrics and condition; all Mountain Whitefish were large-bodied fish ranging in fork length from 235 to 292 mm. Further information can be found in Appendix M.

Table 30. Summary of fork length, weight, and condition for Bull Trout captured during closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

Age Class	Fork Length (mm)				Weight (g)				Relative Condition Factor			
	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Fry (0+)	3	69	51	85	3	4.1	1.0	7.1	3	1.0	0.8	1.2
Juvenile (1-3+)	2	177	154	199	2	66.6	46.1	87.0	2	1.2	1.1	1.3
Adult (≥4+)	1	215	215	215	1	108.0	108.0	108.0	1	1.1	1.1	1.1
All	**6**	**154**	**51**	**215**	**6**	**60**	**1.0**	**108**	**6**	**1.1**	**1.0**	**1.2**

Table 31. Summary of fork length, weight, and condition for Cutthroat Trout captured during closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

Age Class	Fork Length (mm)				Weight (g)				Relative Condition Factor			
	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Fry (0+)	1	54	54	54	1	1.7	1.7	1.7	1	1.1	1.1	1.1
Juvenile (1-2+)	7	123	94	146	7	21.4	9.7	35.9	7	1.1	1.0	1.2
Adult (≥3+)	2	204	183	224	2	85.2	67.3	103.0	2	1.0	0.9	1.1
All	**10**	**127**	**54**	**224**	**10**	**36**	**2**	**103**	**10**	**1.1**	**1.0**	**1.1**

Density and Biomass Estimates

Bull Trout

During closed-site electrofishing in the ULR in 2022, Bull Trout fry, juveniles, and adults were captured within the diversion reach (Table 32 and Table 33). Observed fish densities (FPUobs; #/100 m²) and biomass (BPUobs; g/100 m²) are the focus of the results below (Table 32). Densities of Bull Trout fry were highest in 2022 among all age classes, while adults were lowest. Biomass was higher for juveniles than other age classes in 2022.

Table 32. Observed density and biomass by age class of Bull Trout determined from closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

A) Fry (0+)

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	0.8	2.1
ULL-DVEF04	1.2	8.3
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	0.0	0.0
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.0	0.0

B) Juvenile (1-3+)

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	0.4	19.1
ULL-DVEF04	0.0	0.0
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	0.0	0.0
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.8	72.5

C) Adult (≥4+)

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	0.4	44.7
ULL-DVEF04	0.0	0.0
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	0.0	0.0
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.0	0.0

D) All

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	1.7	65.9
ULL-DVEF04	1.2	8.3
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	0.0	0.0
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.8	72.5

[1] FPU_{obs} = Observed fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[2] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

Table 33. Observed average Bull Trout densities and biomass by age class, as determined from closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

Age Class	FPUobs (#/100 m²)[1]		BPUobs (g/100 m²)[2]	
	Average	SE	Average	SE
Fry (0+)	0.3	0.2	1.5	1.2
Juvenile (1-3+)	0.2	0.1	13.1	10.3
Adult (≥4+)	0.1	0.1	6.4	6.4
All	0.5	0.3	21.0	12.5

[1] FPUobs = Observed fish per unit (100 m2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[2] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

Cutthroat Trout

In Year 5, Cutthroat Trout fry, juveniles, and adults were captured in the diversion reach. Among the three age classes present, observed densities were lowest for fry and highest for juveniles (Table 34 and Table 35). For biomass, values were highest for adults but very similar to juveniles.

Table 34. Observed density and biomass by age class of Cutthroat Trout per sampling site determined from closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

A) Fry (0+)

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	0.0	0.0
ULL-DVEF04	0.0	0.0
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	0.9	1.5
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.0	0.0

B) Juvenile (1-2+)

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	0.0	0.0
ULL-DVEF04	0.0	0.0
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	6.1	130.3
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.0	0.0

C) Adult (≥3+)

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	0.0	0.0
ULL-DVEF04	0.0	0.0
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	0.9	58.5
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.8	85.8

D) All

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	0.0	0.0
ULL-DVEF04	0.0	0.0
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	7.8	190.2
ULL-DVEF11	0.0	0.0
ULL-DVEF12	0.8	85.8

[1] FPU_{obs} = Observed fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[2] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

Table 35. Observed average Cutthroat Trout densities and biomass by age class determined from closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

Age Class	FPUobs (#/100 m²)[1]		BPUobs (g/100 m²)[2]	
	Average	SE	Average	SE
Fry (0+)	0.1	0.1	0.2	0.2
Juvenile (1-2+)	0.9	0.9	18.6	18.6
Adult (≥3+)	0.2	0.2	20.6	13.6
All	1.2	1.1	39.4	27.9

[1] FPUobs = Observed fish per unit (100 m2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[2] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

All Fish Combined (Trout)

During closed-site electrofishing in the ULR in 2022, Bull Trout and Cutthroat Trout were captured within the diversion reach (Table 36 and Table 37). Observed fish densities (FPUobs; #/100 m²) and biomass (BPUobs; g/100 m²) are the focus of the results below, ranging from sites with no observed fish to sites with FPUobs and BPUobs of 7.8 Trout/100 m² to 190.2 g/100 m² respectively (Table 36).

Table 36. Observed density and biomass of all Trout determined from closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

Site	Observed Densities[1,2]	
	FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)
ULL-DVEF02b	1.7	65.9
ULL-DVEF04	1.2	8.3
ULL-DVEF07	0.0	0.0
ULL-DVEF09	0.0	0.0
ULL-DVEF10	7.8	190.2
ULL-DVEF11	0.0	0.0
ULL-DVEF12	1.7	158.3

[1] FPU_{obs} = Observed fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[2] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

Table 37. Trout densities and biomass all age classes combined as determined from closed-site electrofishing in the Upper Lillooet River diversion reach in 2022.

Age Class	FPUobs (#/100 m²)[1]		BPUobs (g/100 m²)[2]	
	Average	SD	Average	SD
All	1.8	1.1	60.4	30.9

[1] FPUobs = Observed fish per unit (100 m2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[2] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

Comparison Among Years

Bull Trout

Bull Trout density and biomass during 2022 were lower than baseline and previous operational years for all age classes (Figure 22, Figure 23). However, Bull Trout juvenile biomass in 2022 was similar to 2019. Overall, the density of all Bull Trout of all age classes combined (0.52 Bull Trout/100 m²) was below the range observed in the three baseline years (0.88 to 3.13 Bull Trout/100 m²) and the previous two operational years (1.20 to 2.34 Bull Trout/100 m²).

Cutthroat Trout

Cutthroat Trout density and biomass during 2022 were lower than baseline and previous operational years for the fry age class (Figure 24, Figure 25). However, Cutthroat Trout juvenile, adults, and all age classes combined density and biomass in 2022 were similar to that in baseline and previous operational years. Overall, the density of all Cutthroat Trout age classes combined in 2022 (1.24 Cutthroat Trout/100 m²) was within the range observed in the three baseline years (0.45 to 1.58 Cutthroat Trout/100 m²) and the previous two operational years (0.98 to 1.47 Cutthroat Trout/100 m²).

All Fish Combined (Trout)

All combined Trout density and biomass during 2022 were lower than baseline and previous operational years for all age classes combined (Figure 26; Figure 27). However, Trout fry and adult biomass in 2022 were within range of baseline, although lower than previous operational years. Overall, the density of all Trout of all age classes combined in 2022 (1.76 Trout/100 m²) was below the range observed in the three baseline years (1.96 to 4.71 Trout/100 m²) and the previous two operational years (2.67 to 3.31 Trout/100 m²).

Figure 22. **Average observed Bull Trout density (FPUobs; ± standard error) determined from closed-site electrofishing in the Upper Lillooet River diversion reach, before (2010, 2012, 2014) and after (2018, 2019, 2022) Project operations began, presented by age class: fry (0+); juveniles (1-3+); adult (≥4+); and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.**

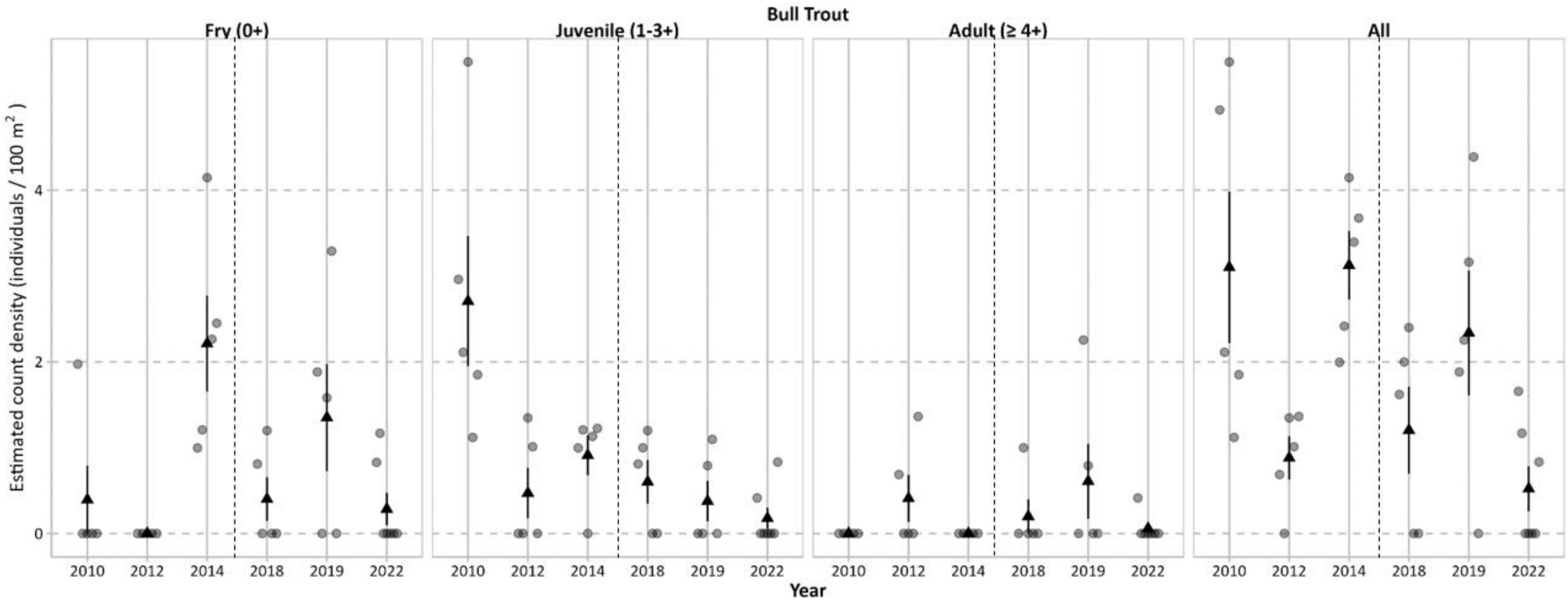


Figure 23. **Average observed Bull Trout biomass (BPUobs; ± standard error) determined from closed-site electrofishing in the Upper Lillooet River diversion reach, before (2010, 2012, 2014) and after (2018, 2019, 2022) Project operations began, presented by age class: fry (0+); juveniles (1-3+); adult (≥4+); and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.**

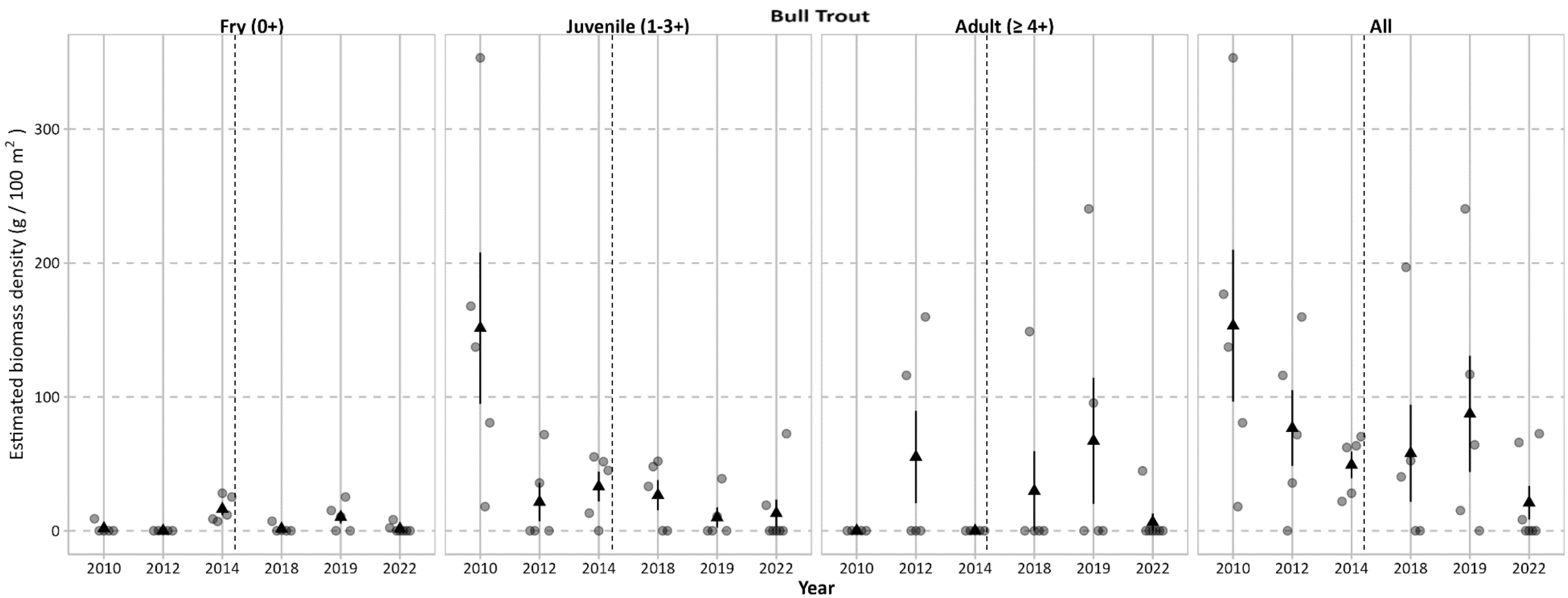


Figure 24. Average observed Cutthroat Trout density (FPUobs; ± standard error) determined from closed-site electrofishing in the Upper Lillooet River diversion reach, before (2010, 2012, 2014) and after (2018, 2019, 2022) Project operations began, presented by age class: fry (0+); juveniles (1-2+); adult (≥3+); and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.

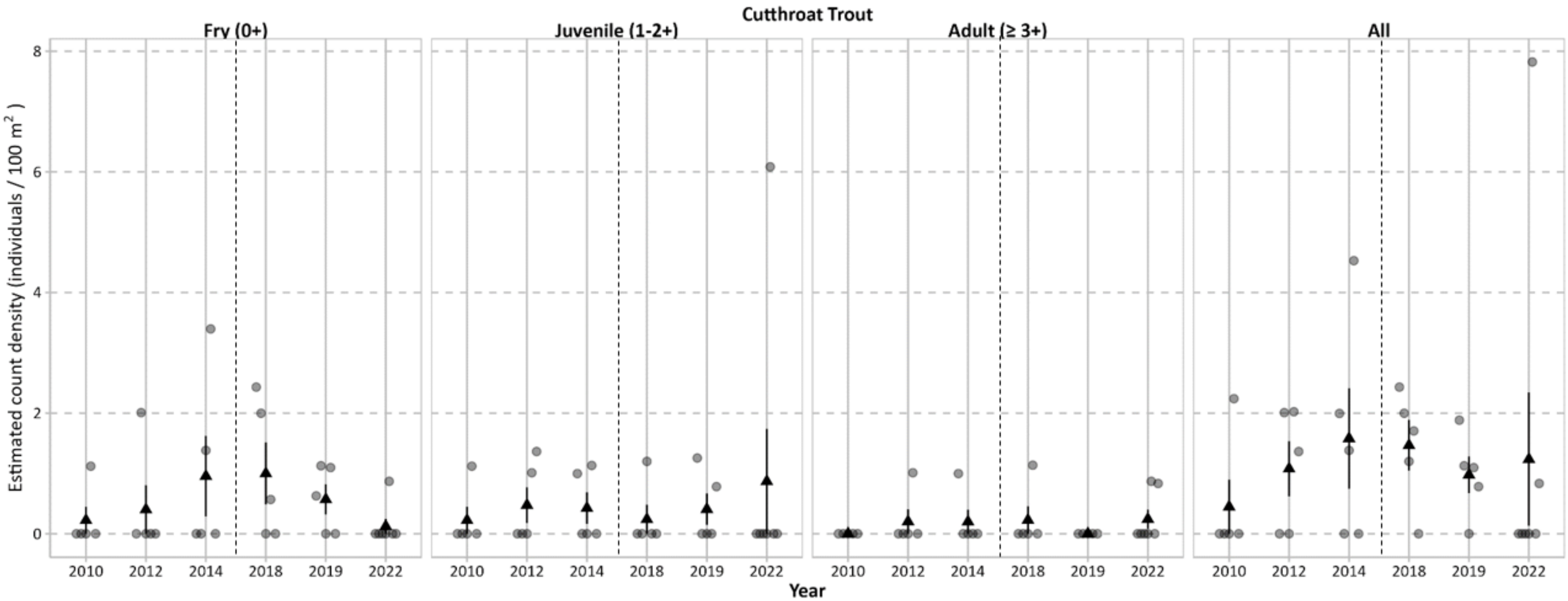


Figure 25. **Average observed Cutthroat Trout biomass (BPUobs; ± standard error) determined from closed-site electrofishing in the Upper Lillooet River diversion reach, before (2010, 2012, 2014) and after (2018, 2019, 2022) Project operations began, presented by age class: fry (0+); juveniles (1-2+); adult (≥3+); and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.**

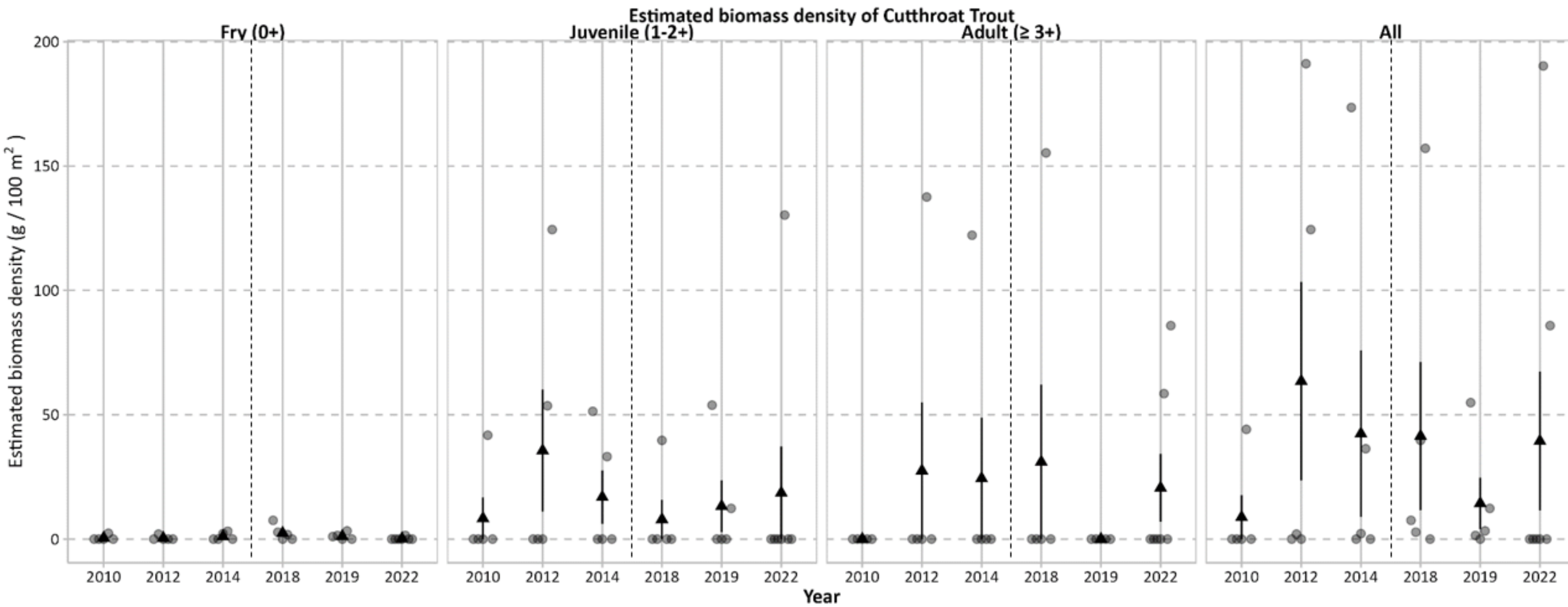


Figure 26. Average observed all Trout density (FPUobs; ± standard error) determined from closed-site electrofishing in the Upper Lillooet River diversion reach, before (2010, 2012, 2014) and after (2018, 2019, 2022) Project operations began, presented by age class: fry (0+); juveniles (1-2+); adult (≥3+); and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.

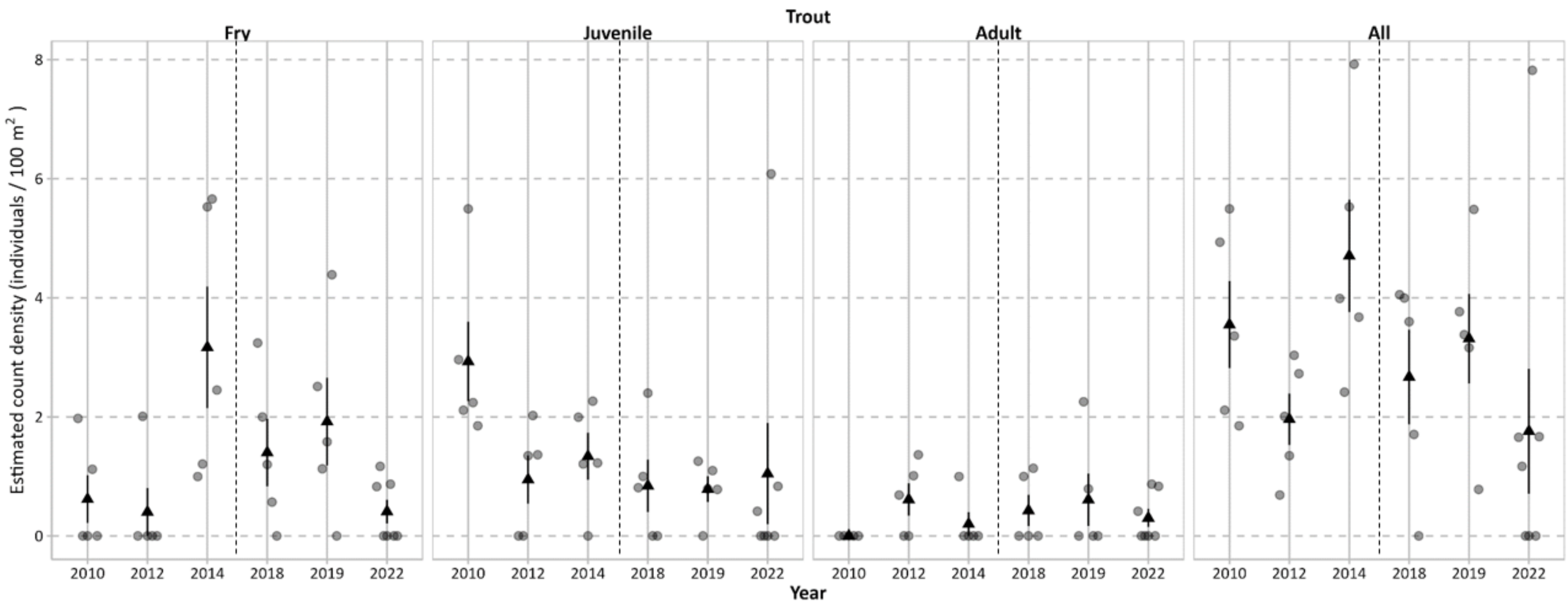
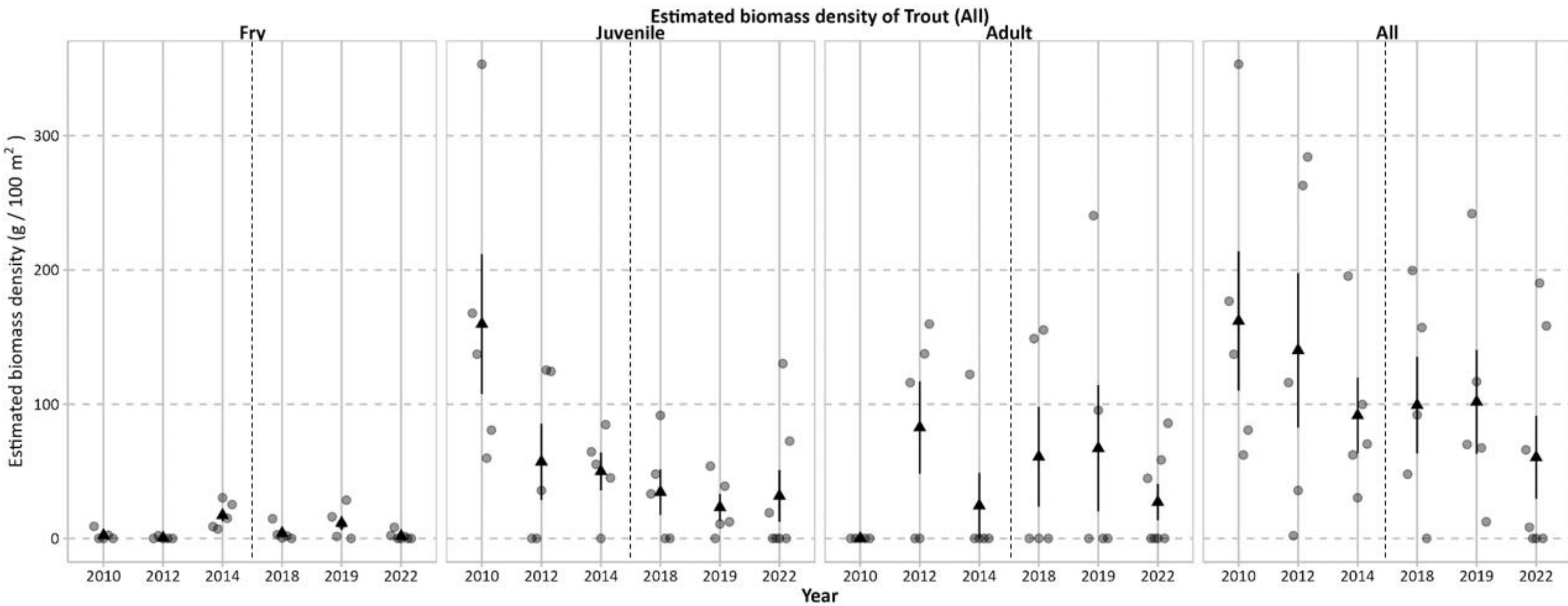


Figure 27. **Average observed all Trout biomass (BPUobs; ± standard error) determined from closed-site electrofishing in the Upper Lillooet River diversion reach, before (2010, 2012, 2014) and after (2018, 2019, 2022) Project operations began, presented by age class: fry; juveniles; adult; and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.**



4.4.1.2. Boulder Creek

Night Snorkelling Mark Re-sight

Night snorkelling mark re-sight surveys were conducted in Boulder Creek from April 4 to 7, 2022. Habitat summaries and representative photographs of mark re-sight sites are provided in Appendix N. Sites were composed of cascade, cascade/riffle, or riffle mesohabitat types and had average gradients that ranged from 2.5% to 4.0%. Stream substrate was primarily boulder, cobble, and gravel, and cover was provided primarily by boulder.

Sites ranged from 88 to 125 m in length and 895 to 1,791 m² in area in the diversion reach and from 95 to 120 m in length and 1,109 to 1,356 m² in area in the downstream reach. Maximum depths of sites were similar in both reaches, ranging from 0.75 to 2.2 m. At the time of sampling, the water temperature was between 2.9°C and 3.9°C. Water visibility was clear to lightly turbid during sampling in both downstream and diversion reaches. Visibility was estimated to be between 1.5 and 3.8 m. Average daily flow ranged from 0.46 to 0.51 m^3/s during sampling in the diversion reach and ranged from 1.18 to 1.19 m^3/s during sampling in the downstream reach (Table 38).

During the mark sampling, 57 Bull Trout were observed in the diversion reach, of which 36 were marked (zero to 16 fish marked at individual sites; Table 39). In the downstream reach, 81 Bull Trout were observed, of which 61 were marked (six to 17 fish marked at individual sites). No Cutthroat Trout were observed in the diversion, and one was observed in the downstream reach.

During the re-sight sampling, 58 Bull Trout were observed in the diversion reach, of which 13 were re-sights of marked fish (Table 39). In the downstream reach, 56 Bull Trout were observed, of which 23 were re-sights of marked fish. No Cutthroat Trout were observed in the diversion reach, and two Cutthroat Trout were observed in the downstream reach.

Observer efficiency for Bull Trout ranged from 0.00 to 0.78 within individual sites and was 0.37 when considering all marked and re-sighted fish from both reaches (Table 39). For Cutthroat Trout, observer efficiency was not calculated due to low captures.

As noted in the Years 1 and 2 reports, in both 2018 and 2019, Cutthroat Trout were observed during mark re-sight snorkelling surveys in Boulder Creek in both the diversion and downstream reaches. In 2022, Cutthroat Trout were only observed in the downstream reach during mark re-sight snorkelling surveys. In 2022, seven Mountain Whitefish were observed on the first night of snorkelling, with six observed in the downstream reach and one in the diversion. During the re-sight sampling, six Mountain Whitefish were observed in the downstream reach and none in the diversion.

Age Analysis

Length-frequency distributions, length-weight relationships, and length-at-age relationships of Bull Trout and Cutthroat Trout captured in 2022, including individual fish metrics, are provided in Appendix O. As with ULR sampling, no Bull Trout fin ray or Cutthroat Trout scale samples were aged in 2022. Based on reviewing age data and length-frequency distributions from baseline years, 2018 and 2019, discrete fork length ranges were defined for fry, juvenile, and adult age classes of Bull Trout (Table 40). Only one juvenile (135 mm) and two adult Cutthroat Trout (≥ 181 mm) were observed or captured in 2022. In line with age class assignment of fish captured in the ULR, 1+ to 3+ and ≥4+ Bull Trout were considered juveniles and adults, respectively, whereas for Cutthroat Trout, 1+ to 2+ and ≥3+ fish were considered juveniles and adults, respectively.

Fish Metrics and Condition

Fork lengths, weights, condition factors, and percent fat are summarized by age class and reach for all captured Bull Trout in Table 41 and for Cutthroat Trout in Table 42. Bull Trout condition factors were similar between locations and among age classes. Percent fat content was slightly higher in the diversion reach than the downstream reach (3.1% vs. 2.8% when adult fish are compared), although juvenile percent fat content was slightly higher in the downstream reach than the diversion reach (3.5% vs. 3.3%). No comparisons could be made for Cutthroat Trout, given that only two adults were captured and weighed in the downstream reach.

Density Estimates

Bull Trout

Bull Trout densities (observed and adjusted for observer efficiency) for 2022 are presented by site in Table 43. The average adjusted density for all age classes was 2.30 fish/100 m^2 (± 0.57 standard error (SE)) in the diversion reach and 2.60 fish/100 m^2 (± 0.21 SE) in the downstream reach. Densities of juveniles (1-3+) and all age classes combined were higher in the downstream reach than the diversion. Fry (0+) and adult (≥4+) densities were slightly higher in the diversion than in the downstream reach.

Cutthroat Trout

Cutthroat Trout densities (observed and adjusted for observer efficiency) for 2022 are presented by site in Table 44. Year 5 (2022) is the third year that Cutthroat Trout have been observed during mark re-sight snorkel surveys in Boulder Creek (2018 and 2019 were the first two years). Juveniles and adults were only observed in the downstream reach in 2022 (average adjusted density was 0.02 fish/100 m^2 (± 0.02 SE) and 0.04 fish/100 m^2 (± 0.02 SE), respectively). No fry were observed in either reach in 2022.

Table 38. Summary of mark re-sight snorkeling site characteristics, conditions, effort, and fish observations within each site in Boulder Creek in 2022.

Project Reach	Sampling Type[1]	Site	Date	Water Temp. (°C)	Estimated Visibility (m)	Daily Average Flow (m^3/s)[2]	Sampled Area (m^2)	Shorkeling Effort (hr)	Number of Fish[3]			
									BT	CT	MW	Total
Diversion	Mark	BDR-DVSN01	4-Apr-22	2.2	3.0	0.51	895	2.00	13	0	1	14
		BDR-DVSN02	4-Apr-22	1.7	3.0	0.51	1,333	1.50	12	0	0	12
		BDR-DVSN03	4-Apr-22	2.1	3.8	0.51	1,791	1.76	23	0	0	23
		BDR-DVSN04	4-Apr-22	-	3.8	0.51	1,080	1.54	7	0	0	7
		BDR-DVSN05	4-Apr-22	1.6	3.8	0.51	900	1.80	2	0	0	2
	Re-sight	BDR-DVSN01	5-Apr-22	2.9	3.0	0.46	895	1.71	17	0	0	17
		BDR-DVSN02	5-Apr-22	-	3.0	0.46	1,333	1.74	15	0	0	15
		BDR-DVSN03	5-Apr-22	2.7	3.0	0.46	1,791	1.80	14	0	0	14
		BDR-DVSN04	5-Apr-22	-	3.0	0.46	1,080	2.01	10	0	0	10
		BDR-DVSN05	5-Apr-22	-	3.0	0.46	900	1.86	2	0	0	2
						Mark Total	**5,999**	**9**	**57**	**0**	**1**	**58**
						Re-sight Total	**5,999**	**9**	**58**	**0**	**0**	**58**
Downstream	Mark	BDR-DSSN01B	6-Apr-22	2.7	-	1.18	1,109	1.76	11	1	4	16
		BDR-DSSN02B	6-Apr-22	2.6	-	1.18	1,356	1.50	19	0	2	21
		BDR-DSSN03	6-Apr-22	3.0	3.0	1.18	1,356	1.74	23	0	0	23
		BDR-DSSN04	6-Apr-22	3.0	3.0	1.18	1,320	2.00	16	0	0	16
		BDR-DSSN05	6-Apr-22	3.0	3.0	1.18	1,193	2.00	12	0	0	12
	Re-sight	BDR-DSSN01B	7-Apr-22	3.9	3.5	1.19	1,109	2.01	9	0	2	11
		BDR-DSSN02B	7-Apr-22	3.2	3.5	1.19	1,356	1.89	12	0	2	14
		BDR-DSSN03	7-Apr-22	2.7	3.0	1.19	1,356	1.89	14	1	1	16
		BDR-DSSN04	7-Apr-22	-	2.0	1.19	1,320	1.89	11	1	0	12
		BDR-DSSN05	7-Apr-22	-	1.5	1.19	1,193	1.50	10	0	1	11
						Mark Total	**6,334**	**9**	**81**	**1**	**6**	**88**
						Re-sight Total	**6,334**	**9**	**56**	**2**	**6**	**64**
						Grand Mark Total	**12,334**	**18**	**138**	**1**	**7**	**146**
						Grand Re-sight Total	**12,334**	**18**	**114**	**2**	**6**	**122**

[1] Mark = The initial sample night, where fish were captured and marked, Re-sight = The second sample night, occuring 24 hr after the mark, where fish were observed or captured and the presence or absence of a mark was recorded.
[2] Diversion flow was calculated by subtracting powerhouse flows from downstream flows as measured at BDR-DSPH-R3.
[3] BT = Bull Trout, CT = Cutthroat Trout and MW = Mountain Whitefish; includes both captured and observed fish.

Table 39. Summary of the number of observed, marked, and re-sighted Bull Trout, and species-specific observer efficiency, during mark re-sight snorkelling surveys in Boulder Creek in 2022.

Project Reach	Site	Number of Fish[1]				Observer Efficiency[2]
		T	M	C	R	
Diversion	BDR-DVSN01	13	5	17	1	0.20
	BDR-DVSN02	12	9	15	7	0.78
	BDR-DVSN03	23	16	14	3	0.19
	BDR-DVSN04	7	6	10	2	0.33
	BDR-DVSN05	2	0	2	0	0.00
	Average ± SE	**57**	**36**	**58**	**13**	**0.37 ± 0.13**
Downstream	BDR-DSSN01B	11	10	9	4	0.50
	BDR-DSSN02B	19	14	12	8	0.57
	BDR-DSSN03	23	17	14	4	0.25
	BDR-DSSN04	16	14	11	3	0.21
	BDR-DSSN05	12	6	10	4	0.67
	Average ± SE	**81**	**61**	**56**	**23**	**0.44 ± 0.09**
	Overall Total	**138**	**97**	**114**	**36**	**0.37**

[1] T = total number of fish observed or captured during on the mark night; M = the number of fish marked on the mark night; C = total number of fish observed or captured during the re-sight night; R = the number of fish observed or captured on the re-sight night that were marked.

[2] Observer efficiency for BDR-DVSN05 was not included in the average as no fish were marked.

Table 40. Fork length ranges used to define age classes of Bull Trout captured in Boulder Creek in 2022.

Age Class	Fork Length Range (mm)
Fry (0+)	0-85
Juvenile (1-3+)	99-206
Adult (≥ 4+)	209+

Table 41. Summary of fork length, weight, condition, and percent fat of Bull Trout captured during mark re-sight snorkeling within Boulder Creek in 2022.

Reach	Age Class	Fork Length (mm)[1]				Weight (g)[1]				Relative Condition Factor[1]				Percent Fat (%)			
		n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Diversion	Fry (0+)	2	92	85	99	1	6.4	6.4	6.4	1	1.0	1.0	1.0	0	-	-	-
	Juvenile (1-3+)	42	153	100	206	24	37.0	9.5	80.1	24	1.0	0.9	1.1	11	3.3	2.3	4.1
	Adult (≥ 4+)	29	257	212	357	12	164.4	95.2	340.7	12	1.0	0.9	1.1	11	3.1	1.6	4.1
	All	**73**	**167**	**85**	**357**	**37**	**69.3**	**6.4**	**340.7**	**37**	**1.0**	**0.9**	**1.1**	**22**	**3.2**	**1.6**	**4.1**
Downstream	Fry (0+)	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-
	Juvenile (1-3+)	80	144	105	200	29	32.2	12.0	81.3	29	1.0	0.7	1.1	10	3.5	2.5	4.3
	Adult (≥ 4+)	18	260	209	379	8	140.8	93.0	305.0	8	1.0	0.9	1.1	8	2.8	0.9	3.6
	All	**98**	**202**	**105**	**379**	**37**	**86.5**	**12.0**	**305.0**	**37**	**1.0**	**0.7**	**1.1**	**18**	**3.1**	**0.9**	**4.3**

[1]Summary only includes measured values.

Table 42. Summary of fork length, weight, condition, and percent fat of Cutthroat Trout captured during mark re-sight snorkeling within Boulder Creek in 2022.

Reach	Age Class	Fork Length (mm)[1]				Weight (g)[1]				Relative Condition Factor[1]				Percent Fat (%)			
		n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Diversion	Fry (0+)	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-
	Juvenile (1-2+)	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-
	Adult (≥ 3+)	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-
	All	**0**				**0**				**0**				**0**			
Downstream	Fry (0+)	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-
	Juvenile (1-2+)	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-
	Adult (≥ 3+)	2	186	181	190	2	58.9	56.8	61.0	2	0.9	0.8	1.0	2	1.2	1.2	1.2
	All	**2**	**186**	**181**	**190**	**2**	**58.9**	**56.8**	**61.0**	**2**	**0.9**	**0.8**	**1.0**	**2**	**1.2**	**1.2**	**1.2**

[1]Summary only includes measured values.

Table 43. Observed and observer-efficiency-adjusted densities of Bull Trout by age class determined from mark re-sight snorkelling in Boulder Creek in 2022.

A) Fry (0+)

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN02	1,333	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN03	1,791	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN04	1,080	0	2	0.00	0.19	0.09	0.00	0.50	0.25
	BDR-DVSN05	900	2	0	0.22	0.00	0.11	0.60	0.00	0.30
				Mean	**0.04**	**0.04**	**0.04**	**0.12**	**0.10**	**0.11**
				SE	**0.04**	**0.04**	**0.03**	**0.12**	**0.10**	**0.07**
Downstream	BDR-DSSN01B	1,109	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN02B	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN03	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN04	1,320	1	0	0.08	0.00	0.04	0.20	0.00	0.10
	BDR-DSSN05	1,196	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.02**	**0.00**	**0.01**	**0.04**	**0.00**	**0.02**
				SE	**0.02**	**0.00**	**0.01**	**0.04**	**0.00**	**0.02**

B) Juveniles (1-3+)

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	11	13	1.23	1.45	1.34	3.31	3.91	3.61
	BDR-DVSN02	1,333	7	12	0.53	0.90	0.71	1.41	2.43	1.92
	BDR-DVSN03	1,791	10	5	0.56	0.28	0.42	1.50	0.75	1.13
	BDR-DVSN04	1,080	4	7	0.37	0.65	0.51	1.00	1.75	1.37
	BDR-DVSN05	900	0	1	0.00	0.11	0.06	0.00	0.30	0.15
				Mean	**0.54**	**0.68**	**0.61**	**1.45**	**1.83**	**1.64**
				SE	**0.20**	**0.24**	**0.21**	**0.54**	**0.64**	**0.57**
Downstream	BDR-DSSN01B	1,109	10	9	0.90	0.81	0.86	2.43	2.19	2.31
	BDR-DSSN02B	1,356	19	12	1.40	0.88	1.14	3.77	2.38	3.08
	BDR-DSSN03	1,356	18	12	1.33	0.88	1.11	3.58	2.38	2.98
	BDR-DSSN04	1,320	14	7	1.06	0.53	0.80	2.86	1.43	2.14
	BDR-DSSN05	1,196	8	7	0.67	0.59	0.63	1.80	1.58	1.69
				Mean	**1.07**	**0.74**	**0.91**	**2.89**	**1.99**	**2.44**
				SE	**0.14**	**0.08**	**0.10**	**0.36**	**0.20**	**0.26**

C) Adults (≥4+)

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	2	4	0.22	0.45	0.34	0.60	1.20	0.90
	BDR-DVSN02	1,333	5	3	0.38	0.23	0.30	1.01	0.61	0.81
	BDR-DVSN03	1,791	13	8	0.73	0.45	0.59	1.96	1.20	1.58
	BDR-DVSN04	1,080	2	1	0.19	0.09	0.14	0.50	0.25	0.37
	BDR-DVSN05	900	2	1	0.22	0.11	0.17	0.60	0.30	0.45
				Mean	**0.35**	**0.26**	**0.31**	**0.93**	**0.71**	**0.82**
				SE	**0.10**	**0.08**	**0.08**	**0.27**	**0.21**	**0.21**
Downstream	BDR-DSSN01B	1,109	1	0	0.09	0.00	0.05	0.24	0.00	0.12
	BDR-DSSN02B	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN03	1,356	5	2	0.37	0.15	0.26	0.99	0.40	0.70
	BDR-DSSN04	1,320	2	4	0.15	0.30	0.23	0.41	0.82	0.61
	BDR-DSSN05	1,196	2	3	0.17	0.25	0.21	0.45	0.68	0.56
				Mean	**0.16**	**0.14**	**0.15**	**0.42**	**0.38**	**0.40**
				SE	**0.06**	**0.06**	**0.05**	**0.16**	**0.17**	**0.14**

D) All

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	13	17	1.45	1.90	1.68	3.91	5.12	4.52
	BDR-DVSN02	1,333	12	15	0.90	1.13	1.01	2.43	3.03	2.73
	BDR-DVSN03	1,791	23	14	1.28	0.78	1.03	3.46	2.11	2.78
	BDR-DVSN04	1,080	7	10	0.65	0.93	0.79	1.75	2.49	2.12
	BDR-DVSN05	900	2	2	0.22	0.22	0.22	0.60	0.60	0.60
				Mean	**0.90**	**0.99**	**0.95**	**2.43**	**2.67**	**2.55**
				SE	**0.22**	**0.27**	**0.23**	**0.60**	**0.73**	**0.63**
Downstream	BDR-DSSN01B	1,109	11	9	0.99	0.81	0.90	2.67	2.19	2.43
	BDR-DSSN02B	1,356	19	12	1.40	0.88	1.14	3.77	2.38	3.08
	BDR-DSSN03	1,356	23	14	1.70	1.03	1.36	4.57	2.78	3.68
	BDR-DSSN04	1,320	16	11	1.21	0.83	1.02	3.27	2.25	2.76
	BDR-DSSN05	1,196	12	10	1.00	0.84	0.92	2.70	2.25	2.48
				Mean	**1.26**	**0.88**	**1.07**	**3.40**	**2.37**	**2.88**
				SE	**0.13**	**0.04**	**0.09**	**0.36**	**0.11**	**0.23**

[1] Density corrected by mean observer efficiency for all age classes of Bull Trout of 0.37.

Table 44. Observed and observer efficiency adjusted densities of Cutthroat Trout by age class determined from mark re-sight snorkelling in Boulder Creek in 2022.

A) Fry (0+)

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN02	1,333	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN03	1,791	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN04	1,080	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN05	900	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
				SE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Downstream	BDR-DSSN01B	1,109	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN02B	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN03	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN04	1,320	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN05	1,196	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
				SE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

B) Juveniles (1-2+)

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN02	1,333	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN03	1,791	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN04	1,080	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN05	900	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
				SE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Downstream	BDR-DSSN01B	1,109	1	0	0.09	0.00	0.05	0.24	0.00	0.12
	BDR-DSSN02B	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN03	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN04	1,320	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN05	1,196	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.02**	**0.00**	**0.01**	**0.05**	**0.00**	**0.02**
				SE	**0.02**	**0.00**	**0.01**	**0.05**	**0.00**	**0.02**

C) Adults (≥3+)

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN02	1,333	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN03	1,791	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN04	1,080	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN05	900	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
				SE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Downstream	BDR-DSSN01B	1,109	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN02B	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN03	1,356	0	1	0.00	0.07	0.04	0.00	0.20	0.10
	BDR-DSSN04	1,320	0	1	0.00	0.08	0.04	0.00	0.20	0.10
	BDR-DSSN05	1,196	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.00**	**0.03**	**0.01**	**0.00**	**0.08**	**0.04**
				SE	**0.00**	**0.02**	**0.01**	**0.00**	**0.05**	**0.02**

D) All

Project Reach	Site	Area (m^2)	Number of Fish Observed[1]		Observed Density (fish/100 m^2)			Adjusted Density (fish/100 m^2)		
			Mark	Re-sight	Mark	Re-sight	Average	Mark	Re-sight	Average
Diversion	BDR-DVSN01	895	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN02	1,333	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN03	1,791	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN04	1,080	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DVSN05	900	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
				SE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Downstream	BDR-DSSN01B	1,109	1	0	0.09	0.00	0.05	0.24	0.00	0.12
	BDR-DSSN02B	1,356	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	BDR-DSSN03	1,356	0	1	0.00	0.07	0.04	0.00	0.20	0.10
	BDR-DSSN04	1,320	0	1	0.00	0.08	0.04	0.00	0.20	0.10
	BDR-DSSN05	1,196	0	0	0.00	0.00	0.00	0.00	0.00	0.00
				Mean	**0.02**	**0.03**	**0.02**	**0.05**	**0.08**	**0.06**
				SE	**0.02**	**0.02**	**0.01**	**0.05**	**0.05**	**0.03**

[1] Density corrected by mean observer efficiency for all age classes of Bull Trout combined of 0.37.

Comparison Among Years

Bull Trout

Adjusted Bull Trout densities varied considerably between reaches and among years in Boulder Creek (Figure 28). Overall densities of all Bull Trout age classes combined were higher but less variable in the downstream reach than in the diversion reach in 2022 (2.88 fish/100 m^2 ± 0.23 vs. 2.55 fish/100 m^2 ± 0.63, respectively). Densities of all Bull Trout age classes combined were higher in 2022 than in 2018 and 2019. In 2022, the diversion reach had higher density than the downstream reach for fry and adult age classes at 0.11 fish/100 m^2 and 0.82 fish/100 m^2 vs. 0.02 fish/100 m^2 and 0.40 fish/100 m^2 respectively.

Juvenile densities in the downstream reach in 2022 were higher than in the diversion reach at 2.44 fish/100 m^2 vs 1.64 fish/100 m^2, respectively, and higher than values from 2018 and 2019. Adult Bull Trout density in the downstream reach has been relatively consistent among years. In 2022, adult density in the downstream reach was slightly higher than in 2019 (0.40 fish/100 m^2 vs. 0.28 fish/100 m^2) but lower than the density measured in the baseline years (Figure 28). Fry and juvenile densities have been more variable than adult densities across years. Fry densities in 2022 in the diversion reach were low (0.02 fish/100 m^2), similar to 2018.

Cutthroat Trout

Cutthroat Trout were only detected in the downstream reach in 2022 but detected in the diversion and downstream reaches in 2018 and 2019 (not detected during baseline surveys). In 2022, only juveniles and adults were captured during mark and re-sight at an average adjusted density of 0.02 fish/100 m^2 and 0.04 fish/100 m^2 for juveniles and adults, respectively, which is lower than in 2018 and 2019 values (Figure 29). The overall density of all age classes combined for Cutthroat Trout was 0.06 fish/100 m^2 in the downstream reach, lower than in 2018 and 2019.

All Fish Combined (Trout)

As in previous years, Bull Trout made up the majority of re-sight captures in 2022, with Cutthroat Trout contributing only two individuals to all fish combined total (Figure 30). The among years Bull Trout comparison are nearly identical for all fish combined due to the low captures of Cutthroat Trout. Fish densities in the downstream reach were within the range of previous years (except no fry were detected in 2022), while the diversion reach fish densities were higher than previous years.

Figure 28. **Average observer efficiency adjusted densities (± standard error) of Bull Trout determined from mark re-sight snorkelling in Boulder Creek in 2011, 2012, 2013, 2018, 2019, and 2022 for: fry, juveniles, adults, and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.**

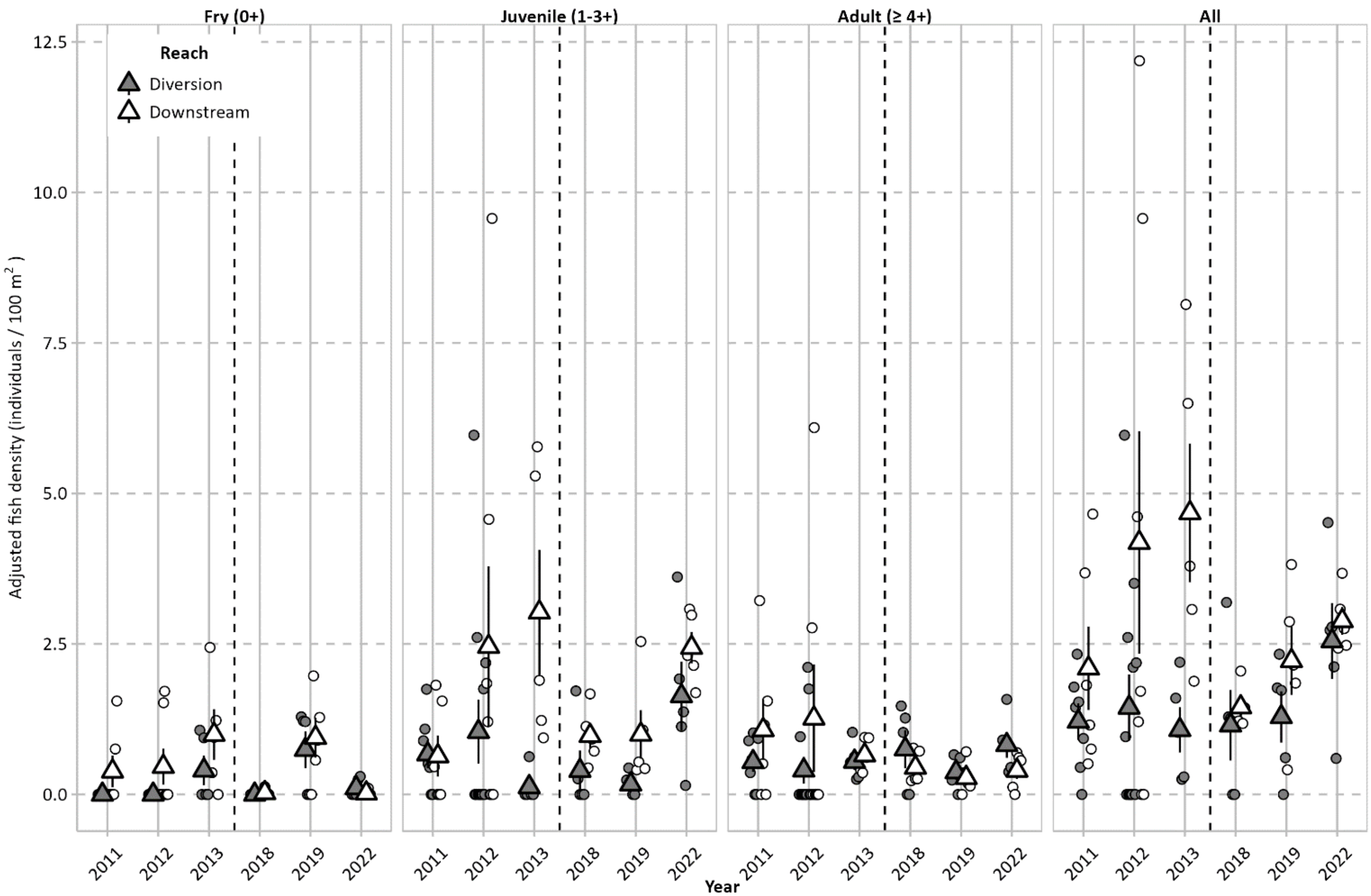


Figure 29. Average observer efficiency adjusted densities (± standard error) of Cutthroat Trout determined from mark re-sight snorkelling in Boulder Creek in 2011, 2012, 2013, 2018, 2019, and 2022 for: fry, juveniles, adults, and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.

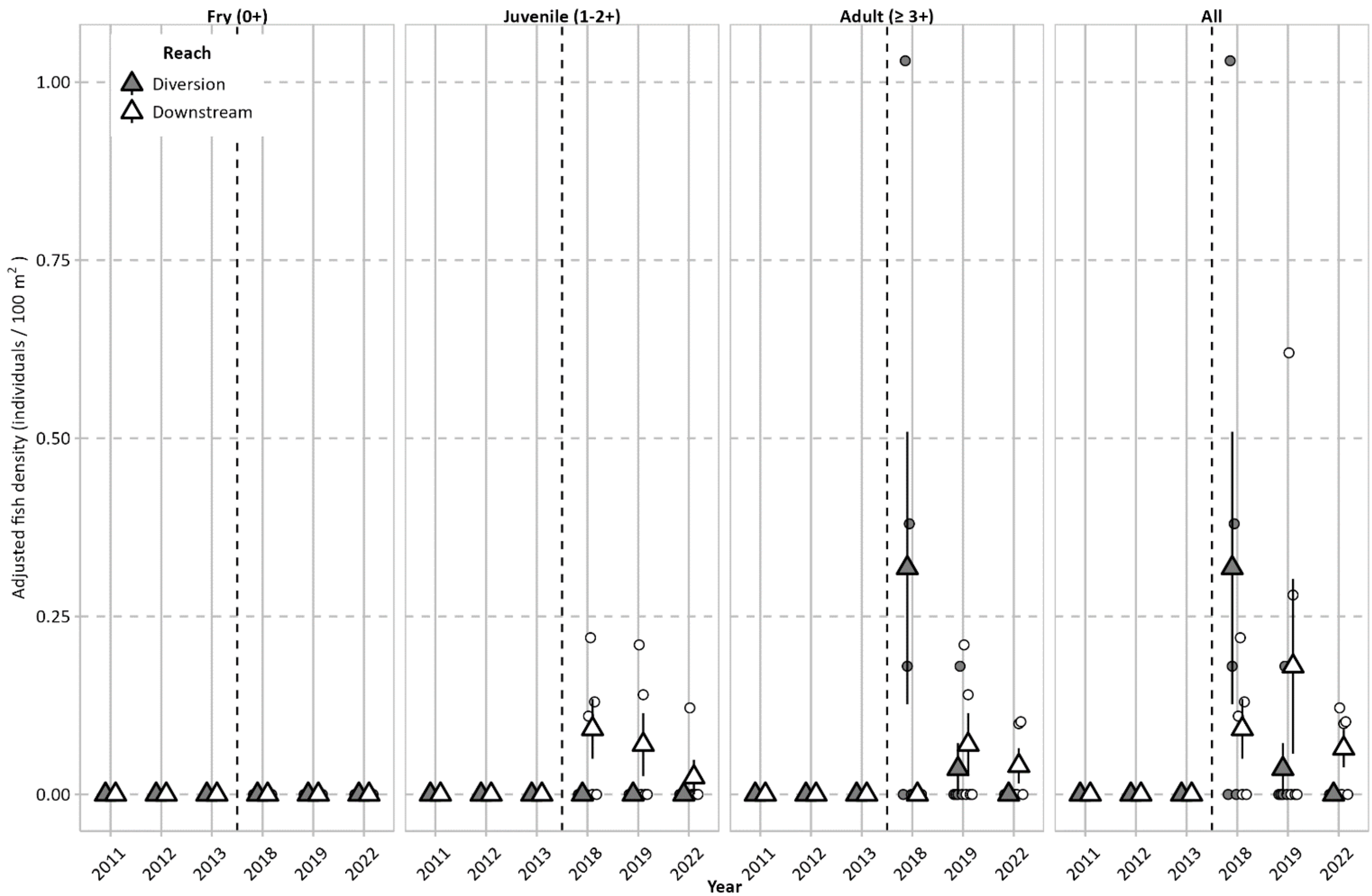
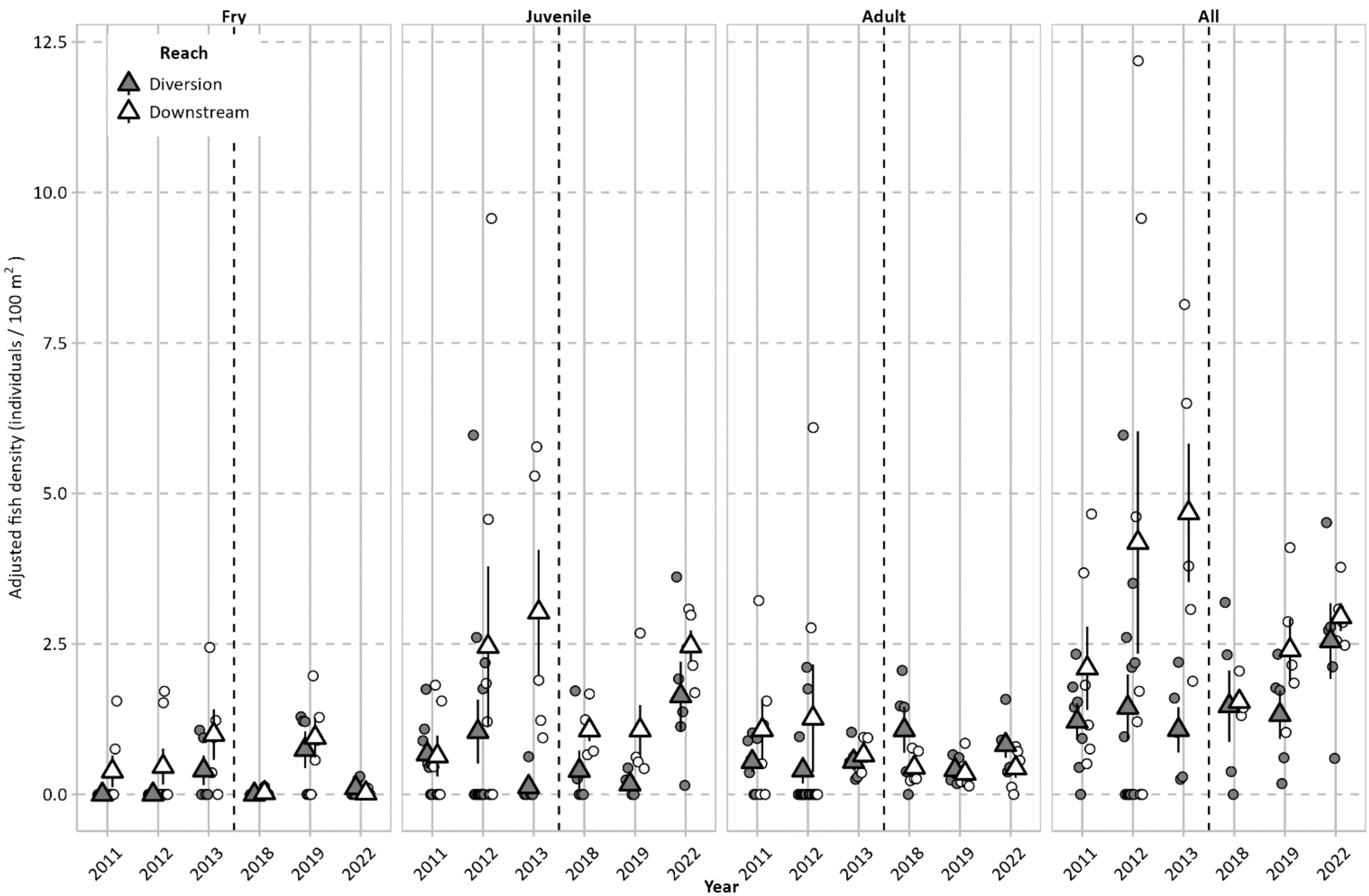


Figure 30. Average observer efficiency adjusted densities (± standard error) of all Trout combined determined from mark re-sight snorkelling in Boulder Creek in 2011, 2012, 2013, 2018, 2019, 2022 for: fry, juveniles, adults, and all age classes combined. Circles represent individual site data, while triangles represent an overall average, flanked by error bars.



Abundance Action Threshold (AAT)

Abundance action thresholds (AAT) were defined by Harwood *et al.* (2021) and in the OEMP for individual age classes and all age classes combined of juvenile Bull Trout within the diversion reach of Boulder Creek. Densities of Bull Trout juveniles observed in Year 5 monitoring (for individual age classes, and all combined) were compared to these AATs, and although variable among years, there were no declines that exceeded AATs in the diversion reach of Boulder Creek that were not mirrored by similar or more severe declines in the downstream control reach. The diversion reach exhibited increases in abundance in all age classes, while the downstream reach exhibited declines.

Fry density relative to the average for the three years of baseline data has increased in the diversion reach by 111% and decreased by 46% in the downstream reach (Table 45). This is an indicator that fry recruitment in the diversion reach has increased. Juvenile densities in the diversion reach were 43% higher than the baseline average, with a 32% decline observed in the downstream reach. Densities of adult Bull Trout have also increased by 89% from the average baseline value in the diversion reach, while there was a decline observed in the downstream reach of 64%. Overall densities of Bull Trout (all age classes combined) are 70% higher than the baseline average in the diversion, compared to a 43% decline in the downstream reach.

Non-operational factors between baseline and Year 5 of operations may have influenced the monitoring results and need to be considered in the assessment. Boulder Creek was subject to a forest fire in the summer of 2015 and large natural flood events during the fall of 2016 and 2017, between the baseline and operational monitoring periods. In particular, the flood event in November 2016 led to large geomorphological changes in the diversion and downstream reaches, which were exacerbated by the large flood event in November 2017. These geomorphic changes affected fish habitat but the degree of influence on the fish community is unknown. Further unprecedented recent weather events (e.g., heat domes and droughts) may have also had unknown influence on the fish community. However, with all age classes combined, there was no evidence of a decline in Bull Trout density in the Boulder Creek diversion reach in 2022 relative to baseline. As prescribed in the OEMP, densities of Bull Trout juveniles within the diversion and control reach will continue to be compared to AATs in the remaining years of operational monitoring, and additional monitoring will be conducted if required.

Table 45. Abundance action threshold for 2022.

Metric	Age Class	Mean Response[1]								Δ % Change[3]
		Downstream				Diversion				
		μ_{CB}	μ_{CO}	ΔC	% Change[2]	μ_{IB}	μ_{IO}	ΔI	% Change[2]	
Density (#/100 m²)	Fry (0+)	0.61	0.33	-0.28	-46.35	0.13	0.28	0.15	110.92	157.3
	Juv (1-2+)	2.04	1.39	-0.65	-31.73	0.61	0.68	0.07	11.09	42.8
	Adult (≥3+)	1.00	0.36	-0.64	-63.75	0.50	0.62	0.13	25.32	89.1
	All	3.65	2.09	-1.56	-42.75	1.24	1.58	0.34	26.95	69.7

[1] μ = mean response, Δ = change between periods, C = control reach, I = impact reach, B = baseline period, O = operational period.

[2] % Change = $(\mu_O - \mu_B)/\mu_B$

[3] Δ % Change = $\%\ Change_I - \%\ Change_C$

4.4.2. Adult Migration and Distribution

4.4.2.1. Bull Trout Angling Surveys

Habitat summaries and representative photographs of angling sites in the ULR, Boulder Creek, and – for comparison - North Creek are presented in Appendix P. The capture results from Year 5 (2023) angling surveys are presented in Table 46 and Table 47, while site-specific results, individual fish data, and monitoring site locations are provided in Appendix P and Map 10.

Upper Lillooet River

Nine Bull Trout were captured during angling surveys in Year 5: two in the diversion reach, two in the tailrace, and five in the downstream reach (Table 46). Captured Bull Trout ranged from 213 mm to 374 mm fork length, with the largest fish captured in the downstream reach (Table 47). Only one of the captured Bull Trout was classified as sexually mature. As in previous years, no barriers to migration were observed in the 500 m of the lower diversion reach immediately upstream of the powerhouse during angling surveys. As in previous years, the presence of Bull Trout detections in the diversion reach suggests that movement into the diversion reach was not inhibited by operations in 2023. No Bull Trout tagged in previous years were recaptured in 2023.

In addition to Bull Trout, two Cutthroat Trout were captured during surveys (204 mm at ULL-DVAG16 and 157 mm at ULL-DSAG08). These fish were not included in CPUE calculations.

Boulder Creek

A total of 54 Bull Trout were captured during angling surveys in Year 5: 29 in the diversion reach, 14 in the tailrace, and 11 in the downstream reach (Table 46). Of these, 17% were sexually mature in the diversion, 36% were sexually mature in the tailrace, and 64% were sexually mature in the downstream reach. Captured Bull Trout ranged from 139 mm to 601 mm fork length, with the largest fish captured in the downstream reach (Table 47). As in previous years, no barriers to migration were observed during assessment of fish passage during angling surveys within the lower 1.3 km of Boulder

Creek. As in previous years, absence of Bull Trout holding below the powerhouse and Bull Trout presence in the diversion reach suggest movement into the diversion reach was not inhibited by operations in 2023. Eighteen Bull Trout were recaptured within the same year; however, there were no recaptures from previous years in Boulder Creek in 2023.

North Creek

For comparison to Boulder and ULR fish populations, fifty-seven Bull Trout were captured in North Creek, of which 11-93% were sexually mature, depending on the sampling date (Table 46). Captured Bull Trout ranged from 182 mm to 544 mm in fork length (Table 47). Eight previously-captured Bull Trout were recaptured in the same year but there were no recaptures of fish tagged in previous North Creek sampling years in 2023.

Table 46. Summary of Bull Trout capture data during angling surveys conducted in the Upper Lillooet River, Boulder Creek, and North Creek in fall of 2023.

Waterbody	Date	Project Area	# of Sites	Effort (rod hrs)	Bull Trout Captures	CPUE [1] (Bull Trout/hr)	% Sexually Mature [2]
Upper Lillooet River	14-Sep	Diversion	2	3.6	1	0.3	0%
		Tailrace	1	1.3	1	0.7	0%
		Downstream	3	6.6	3	0.5	33%
	05-Oct	Diversion	2	1.3	1	0.8	0%
		Tailrace	1	1.1	1	0.9	0%
		Downstream	3	2.7	0	0.0	n/a
	20-Oct	Diversion	2	3.2	0	0.0	n/a
		Tailrace	1	1.0	0	0.0	n/a
		Downstream	3	3.4	2	0.6	0%
2023 Total:	05-Oct	**Diversion**	**6**	**8.1**	**2**	**0.2**	0%
		Tailrace	**3**	**3.5**	**2**	**0.6**	0%
		Downstream	**9**	**12.7**	**5**	**0.4**	20%
Boulder Creek	13-Sep	Diversion	3	4.2	11	2.6	18%
		Tailrace	1	1.1	8	7.0	63%
		Downstream	3	4.9	2	0.4	50%
	03-Oct	Diversion	3	3.0	13	4.3	15%
		Tailrace	1	1.1	2	1.8	0%
		Downstream	3	2.7	7	2.6	86%
	21-Oct	Diversion	3	3.2	5	1.6	20%
		Tailrace	1	1.0	4	4.0	0%
		Downstream	3	4.2	2	0.5	0%
2023 Total:		**Diversion**	**9**	**10.4**	**29**	**2.8**	**17%**
		Tailrace	**3**	**3.2**	**14**	**4.3**	**36%**
		Downstream	**9**	**11.8**	**11**	**0.9**	**64%**
North Creek	15-Sep	N/A	6	8.1	27	3.3	67%
	04-Oct	N/A	6	8.6	21	2.4	90%
	22-Oct	N/A	6	6.0	9	1.5	11%
2023 Total:		**N/A**	**18**	**22.8**	**57.0**	**2.5**	**67%**

[1] Two Cutthroat Trout were captured during surveys. The first Cutthroat Trout was captured on September 14, 2023 at ULL-DSAG08 (157mm, 37 grams). The second Cutthroat Trout was captured October 20, 2023 at ULL-DVAG16 (204 mm, 85 grams). These fish were not included in catch per unit effort calculations.

[2] Sexually maturity was determined based on the presence of gametes upon examination.

Table 47. Summary of fork length, weight, and condition factor for Bull Trout captured during angling surveys in the Upper Lillooet River, Boulder Creek, and North Creek in fall of 2023.

Stream	Project area	Fork Length (mm)				Weight (g)				Condition Factor (K)			
		n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Upper Lillooet River	Diversion	2	223	220	225	2	115	110	119	2	1.04	1.03	1.04
	Tailrace	2	230	226	234	2	110	105	115	2	0.90	0.90	0.91
	Downstream	5	322	213	374	5	345	91	500	5	0.95	0.93	0.96
	Total:	9	279	213	374	9	241	91	500	9	0.96	0.90	1.04
Boulder Creek	Diversion	29	273	139	440	29	233	26	880	29	1.02	0.78	1.42
	Tailrace	14	284	163	510	14	334	97	1,423	14	1.38	0.90	3.90
	Downstream	11	381	213	601	11	725	30	2,000	11	0.89	0.31	1.07
	Total:	54	298	139	601	54	360	26	2,000	54	1.08	0.31	3.90
North Creek	N/A	57	341	182	544	57	474	69	1,572	57	0.98	0.86	1.13
	Total:	57	341	182	544	57	474	69	1,572	57	0.98	0.86	1.13

4.4.2.2. Tributary Bank Walk Bull Trout Spawner Surveys

A summary of effort and fish observations during bank walk spawner surveys in Alena Creek and 29.2 km Tributary in the fall of 2023 are presented in Table 48. Surveyed distances ranged from 1,475 m to 2,300 m in Alena Creek and were 724 m in 29.2 km Tributary. It should be noted that the change in survey distance on Alena Creek is not expected to have a significant effect on total observations as a small percentage of fish are observed in this section due to the high turbidity influence from the ULR and lack of holding habitat. Live Bull Trout were observed in both Alena Creek and 29.2 km Tributary (two Bull Trout were counted in Alena Creek on September 14, 2023, and one on October 20, 2023, as well as five counted in 29.2 km Tributary on October 04, 2023). No Bull Trout carcasses were observed in either Alena Creek or 29.2 km. One Redd was observed in Alena Creek, but zero in 29.2 km. Four Cutthroat Trout were observed in Alena Creek and 10 Cutthroat in 29.2 km Tributary (Table 48).

Table 48. Summary of results from spawner surveys conducted in Alena Creek and 29.2 km Tributary in fall of 2023.

Stream	Date	Survey Time (hh:mm)	Survey Distance (m)	Number Observed[1]					
				Live Adults		Adult Carcasses		Redds	
				BT	CT	BT	CT	BT	CT
Alena Creek	14-Sep-2023	1:49	2,300	2	3	0	0	0	0
	05-Oct-2023	1:08	1,475	0	1	0	0	0	0
	20-Oct-2023	0:57	1,475	1	0	0	0	1	0
	Total:	**3:54**	**5,250**	**3**	**4**	**0**	**0**	**1**	**0**
29.2 km Tributary	15-Sep-2023	0:55	724	0	8	0	0	0	0
	04-Oct-2023	0:52	724	5	0	0	0	0	0
	22-Oct-2023	0:51	724	0	2	0	0	0	0
	Total:	**2:38**	**2,172**	**5**	**10**	**0**	**0**	**0**	**0**

[1] BT = Bull Trout, CT = Cutthroat Trout

4.4.2.3. Comparison Among Years

Angling Catch per Unit Effort (CPUE)

Upper Lillooet River

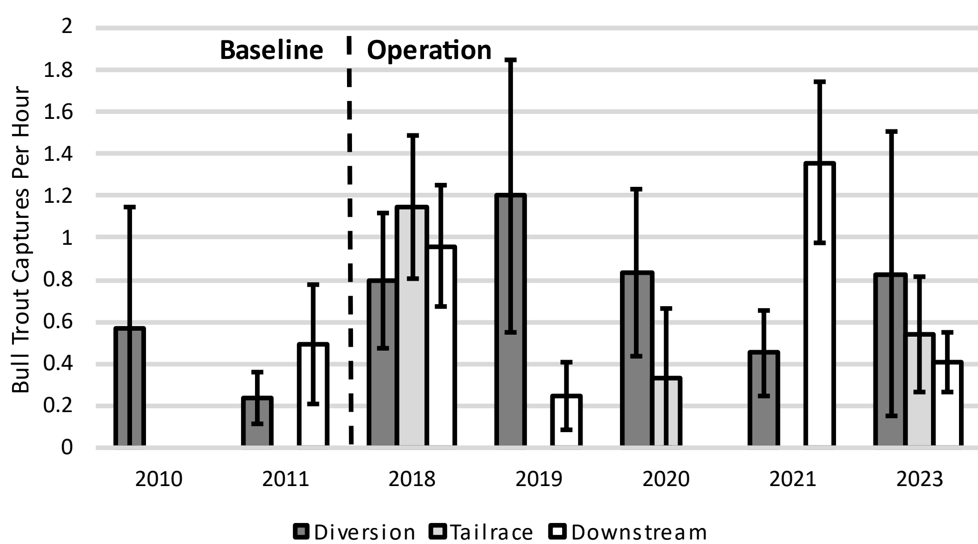
Average CPUE in the diversion reach has remained relatively consistent during operations (ranging 0.45 – 1.20 fish per hour within Year 1 to Year 5) and to date has generally been higher than during baseline surveys (0.23 – 0.57 fish per hour) (Table 49; Figure 31). Average CPUE in the tailrace ranged from zero to 1.15 fish per hour during operations. Average CPUE in the downstream reach was variable in both baseline (0 – 0.49 fish per hour) and operational years (0 – 1.36 fish per hour). There is no observable trend in CPUE during operational monitoring between Project reaches or over time.

The continued captures of Bull Trout in the diversion reach and lack of congregation below the tailrace during the spawning period throughout the operational monitoring period provide evidence that movement into the reach has not been inhibited by operations.

Table 49. Comparison of Bull Trout captures and mean catch per unit effort (CPUE) between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on the Upper Lillooet River.

Metric	Reach	Baseline		Operational				
		2010	2011	2018	2019	2020	2021	2023
Sites Sampled	Diversion	3	10	6	6	6	6	6
	Tailrace	-	-	3	3	3	3	3
	Downstream	2	4	9	8	9	9	9
Captures	Diversion	4	3	6	7	5	3	2
	Tailrace	-	-	4	0	1	0	2
	Downstream	-	2	10	2	0	13	5
Effort (hr)	Diversion	3.9	11.2	8.0	7.1	6.0	6.4	8.1
	Tailrace	-	-	3.6	3.4	3.0	3.1	3.5
	Downstream	2.1	4.0	11.0	8.0	9.0	9.4	12.7
Mean CPUE (fish/hr)	Diversion	0.57	0.23	0.80	1.20	0.83	0.45	0.83
	Tailrace	-	-	1.15	0.00	0.33	0.00	0.54
	Downstream	0.00	0.49	0.96	0.25	0.00	1.36	0.41

Figure 31. Comparison of Bull Trout mean catch per unit effort between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on the Upper Lillooet River. Error bars shown are standard error.



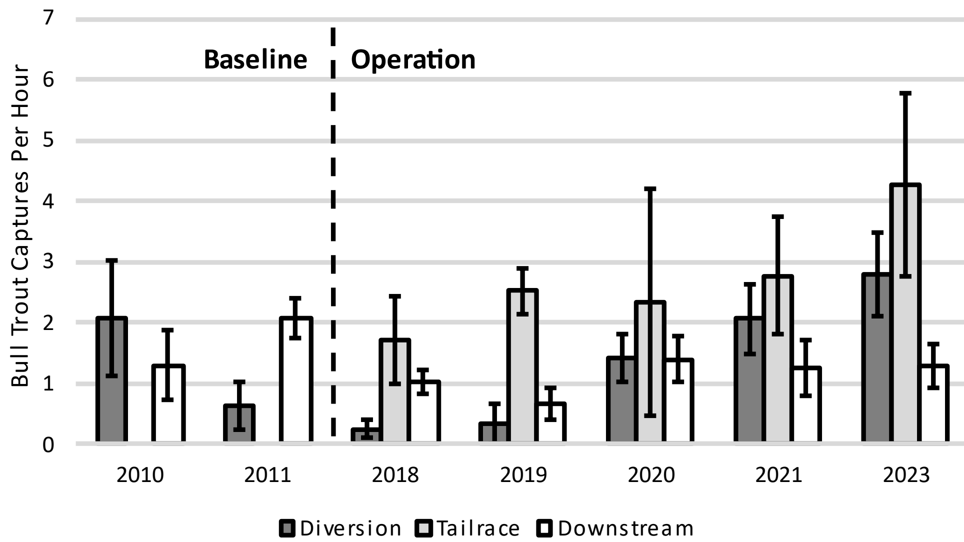
Boulder Creek

Average CPUE in the Boulder Creek diversion reach fluctuated throughout the monitoring period. During the operational monitoring years (years 1 to 5), CPUE in the diversion ranged between 0.25 and 2.80 (Table 50; Figure 32). In the diversion, there has been an increasing trend in average CPUE annually during the operational period, with a maximum obtained during 2023 sampling (2.80 fish per hour) being the highest since the baseline year (2.08 fish per hour in 2010). The CPUE in the tailrace ranged from 1.72 to 4.28 fish per hour during operations, showing an increasing CPUE trend. Fourteen fish were captured in the tailrace, eight of which were captured during the first survey occurring September 13, 2023. The CPUE in the downstream reach was slightly higher during baseline (1.30 to 2.06 fish per hour) compared to operational monitoring to date (0.65 to 1.28 fish per hour). Similar to observations in the ULR, captures in the diversion reach during the operational monitoring years suggest that access to the diversion was not inhibited.

Table 50. Comparison of Bull Trout captures and mean catch per unit effort (CPUE) between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on Boulder Creek.

Metric	Reach	Baseline		Operational				
		2010	2011	2018	2019	2020	2021	2023
Sites Sampled	Diversion	2	6	11	9	12	9	9
	Tailrace	-	-	3	3	3	3	3
	Downstream	4	7	12	11	10	9	9
Captures	Diversion	8	4	4	3	17	22	29
	Tailrace	-	-	6	8	7	9	14
	Downstream	5	17	16	8	14	11	11
Effort (hr)	Diversion	6.6	7.8	12.9	9.1	12.0	10.4	10.4
	Tailrace	-	-	3.3	3.2	3.3	3.2	3.2
	Downstream	4.1	8.9	15.5	11.6	9.9	9.2	11.8
Mean CPUE (fish/hr)	Diversion	2.08	0.63	0.25	0.33	1.42	2.06	2.80
	Tailrace	-	-	1.72	2.52	2.33	2.77	4.28
	Downstream	1.30	2.06	1.02	0.65	1.39	1.26	1.28

Figure 32. Comparison of Bull Trout captures and mean catch per unit effort (CPUE) between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on Boulder Creek. Error bars shown are standard error.



North Creek

Angling in North Creek was conducted for comparison in both years of the baseline sampling period (i.e., 2010 and 2011) and in years 2, 3, 4 and 5 of Upper Lillooet HEF and Boulder HEF operations (i.e., 2019, 2020, 2021, and 2023[2]). CPUE in in North Creek in OEMP Year 5 (2023) was 1.86 fish per hour, making the average CPUE notably higher than baseline years (Table 51;

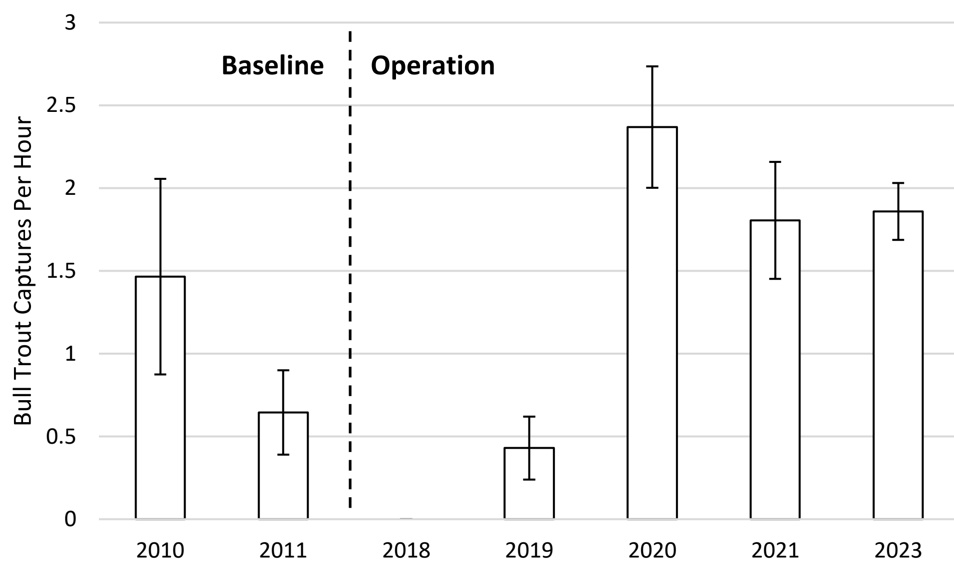
Figure 33). Average CPUE was lowest in 2019 and intermediate during the two baseline years (1.47 and 0.64 fish per hour in 2010 and 2011, respectively). Low Bull Trout captures also occurred in ULR and Boulder Creek in 2019.

[2] Angling in North Creek was included following recommendations in Year 1 to avoid confusion on sampling requirements due to discrepancy in the OEMP text and tables (Harwood *et al.* 2021).

Table 51. Comparison of Bull Trout captures and mean catch per unit effort (CPUE) between baseline years and HEF operational years to date, at monitoring sites on North Creek.

Metric	Reach	Baseline		Operational				
		2010	2011	2018	2019	2020	2021	2023
Sites Sampled	N/A	5	7	-	12	18	17	18
Captures	N/A	9	5	-	4	43	34	57
Effort (hr)	N/A	10.9	7.7	-	11.1	18.1	18.1	22.8
Mean CPUE (fish/hr)	N/A	1.47	0.64	-	0.43	2.37	1.80	1.86

Figure 33. Comparison of Bull Trout captures and mean catch per unit effort (CPUE) between baseline years and HEF operational years to date, at monitoring sites on North Creek. Error bars shown are standard error.



Tributary Bank Walk Spawner Surveys

Tributary bank walk spawner surveys were conducted on Alena Creek (the habitat offsetting location) and on the 29.2 km Tributary in September and October during the Bull Trout spawning period in one baseline year (2011) and five operational years (2018 to 2023). Nine Bull Trout were observed over 700 m during a single survey on Alena Creek in 2011 (Table 52). Two surveys were conducted in Year 1 (2018), and three surveys were conducted in years 2 through 5 of operational monitoring. Peak counts in these years were two, one, zero, five, and three Bull Trout, respectively. Survey distances were notably longer during operational years than during the single baseline survey (700 m), ranging from 1,475 to 2,300 m in Year 1 to Year 5.

A single spawner survey was conducted on 29.2 km Tributary in 2011, during which eight Bull Trout were observed over 560 m (Table 53). Three surveys were completed each year from Year 1 through Year 5 of operational monitoring. Peak counts in these years were two, zero, one, three and five Bull Trout, respectively. Survey distance in Years 1 to 5 was 724 m, which is slightly greater than the 560 m survey distance during baseline.

Peak counts observed in operational Year 1 to 5 on Alena Creek and 29.2 km Tributary were lower than baseline counts, even though the distances surveyed during baseline surveys were shorter. It should be noted that the change in survey distance on Alena Creek is not expected to have a significant effect on total observations as a small percentage of fish are observed in this section due to the high turbidity influence from the ULR and lack of holding habitat.

Table 52. Comparison of adult Bull Trout observed during tributary bank walk spawner surveys between baseline (2011) and operational years (2018 to 2023) to date on Alena Creek.

Date	Survey Time (hh:mm) [1]	Survey Distance (m)	Adult Bull Trout Observed		
			Live	Carcasses	Redds
04-Oct-11	n/c	700	9	0	0
14-Sep-18	1:28	1,631	0	0	0
11-Oct-18	4:07	1,719	2	0	0
17-Sep-19	1:30	1,750	0	0	0
01-Oct-19	1:53	2,300	1	0	1
22-Oct-19	2:00	2,300	0	0	0
16-Sep-20	1:30	1,750	0	0	0
02-Oct-20	1:27	2,300	0	0	0
21-Oct-20	1:31	2,300	0	0	0
15-Sep-21	1:40	1,750	0	0	0
07-Oct-21	1:35	2,300	0	0	0
21-Oct-21	2:38	2,300	5	0	0
14-Sep-23	1:49	2,300	2	0	0
05-Oct-23	1:08	1,475	0	0	0
20-Oct-23	0:57	1,475	1	0	1

[1] n/c = not collected

Table 53. Comparison of adult Bull Trout observed during tributary bank walk spawner surveys between baseline (2011) and operational years (2018 to 2023) to date on 29.2 km Tributary.

Date	Survey Time (hrs:mm) [1]	Survey Distance (m)	Adult Bull Trout Observed		
			Live	Carcasses	Redds
04-Oct-11	n/c	560	8	0	0
13-Sep-18	1:19	724	0	0	0
28-Sep-18	0:45	724	0	0	0
09-Oct-18	0:45	724	2	0	0
18-Sep-19	0:56	724	0	0	0
29-Sep-19	0:58	724	0	0	0
23-Oct-19	0:55	724	0	0	0
17-Sep-20	1:03	724	0	0	0
30-Sep-20	0:55	724	1	0	1
19-Oct-20	0:55	724	0	0	0
14-Sep-21	1:12	724	0	0	0
06-Oct-21	1:25	724	0	0	0
21-Oct-21	0:09	724	3	0	0
15-Sep-23	0:55	724	0	0	0
04-Oct-23	0:52	724	5	0	0
22-Oct-23	0:51	724	0	0	0

[1] n/c = not collected

4.4.3. Assessment of Entrainment at the Upper Lillooet River Intake

4.4.3.1. Closed-Site Electrofishing in Tributary

Closed-site electrofishing was completed within the unnamed tributary at 87.0 km on the ULR (87.0 km Tributary; located upstream of the ULR intake) on October 6 and 7, 2023. A total area of 416 m^2 was surveyed, and the total electrofishing effort for all sites combined was 7,269 seconds (Table 54 and Table 55). Numbers of captured fish ranged from 24 to 52 Cutthroat Trout per site, and a total of 127 individuals were captured at all sites combined (Table 55). No other species were captured during sampling, which is consistent with the known baseline fish distribution upstream of Keyhole Falls, where only Cutthroat Trout have been detected.

Table 54. Summary of closed-site electrofishing site characteristics and conditions during sampling in 87.0 km Tributary in 2023.

Site	Sampling Date	Conductivity (µS/cm)	Water Temp. (°C)	Turbidity	Sampling Length (m)	Sampling Area (m²)
ULL-HPTB87.0EF01	2023-10-06	65	7.9	Clear	40	153
ULL-HPTB87.0EF02	2023-10-06	62	6.5	Clear	43	107
ULL-HPTB87.0EF03	2023-10-07	62	6.2	Clear	54	156
Tributary Total					**137**	**416**

Table 55. Summary of closed-site electrofishing effort and fish captures in 87.0 km Tributary in 2023.

Site	Sampling Date	Total Electrofishing Effort (sec)				CT Capture (# of fish)			
		Pass 1	Pass 2	Pass 3	Total	Pass 1	Pass 2	Pass 3	Total
ULL-HPTB87.0EF01	2023-10-06	1,000	801	603	2,404	36	9	6	51
ULL-HPTB87.0EF02	2023-10-06	1,008	827	611	2,446	11	8	5	24
ULL-HPTB87.0EF03	2023-10-07	1,007	807	605	2,419	31	13	8	52
Tributary Total:		**3,015**	**2,435**	**1,819**	**7,269**	**78**	**30**	**19**	**127**

4.4.3.2. Age Analysis

The length-frequency distribution, length-weight relationship, and length-at-age relationship of Cutthroat Trout captured during closed-site electrofishing surveys in 87.0 km Tributary in 2023, as well as data on individual captured fish (including length, weight, and marks/tags applied) are provided in Appendix M. Based on a review of aging data and length-frequency distributions, discrete fork length ranges were defined for age classes fry (0+), juveniles (1-2+), and adults (≥3+) of Cutthroat Trout (Table 56).

Table 56. Fork length ranges used to define age classes of Cutthroat Trout captured in 87.0 km Tributary in 2023.

Age Class	Fork Length Range (mm)
Fry (0+)	26 - 41
Juvenile (1-2+)	62 - 124
Adult (≥3+)	≥127

4.4.3.3. Fish Metrics and Condition

Fork length, weight, and condition factor for all captured Cutthroat Trout are summarized by age class in Table 57. Weights were assigned to all fish not weighed in the field from the established length-weight relationships (Appendix M).

Table 57. Summary of fork length, weight and condition of Cutthroat Trout captured in 87.0 km Tributary in 2023.

Age Class	Fork Length (mm)				Weight (g)				Condition Factor (K)			
	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg
Fry (0+)	36	26	41	34	36	0.2	0.8	0.4	36	0.7	2.1	1.1
Juvenile (1-2+)	57	62	124	90	57	2.9	19.9	9.2	57	0.9	1.6	1.1
Adult (≥3+)	34	127	208	154	34	20.9	97.8	41.3	34	0.9	1.3	1.1
Total	**127**	**26**	**208**	**92**	**127**	**0.2**	**97.8**	**15.3**	**127**	**0.7**	**2.1**	**1.1**

4.4.3.4. Density and Biomass Estimates

Observed and habitat-adjusted density and biomass estimates of Cutthroat Trout determined from closed-site electrofishing in 87.0 km Tributary are summarized by age class in Table 58. Observed fish densities (FPUobs; #/100 m^2) and biomass (BPUobs; g/100 m^2) are the focus of the results below, with habitat-adjusted values (FPUadj and BPUadj) provided in Table 59. Observed densities and biomass of Cutthroat Trout are compared by age class in Figure 34 and Figure 35. Density was highest for 1–2+ juveniles at approximately 13 fish/100 m^2, while fry and adult densities were approximately 11.4 fish/100 m^2 and 7.0 fish/100 m^2 respectively. Although densities of adults were lower than those of juveniles, biomass was greater for adults than other age classes, reflecting their greater size.

Table 58. Density and biomass of Cutthroat Trout determined per sampling site from closed-site electrofishing in 87.0 km Tributary in 2023.

A) Fry (0+)

Site	Usability (%)	Observed Densities[1,2]		Adusted Densities[3,4]	
		FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)	FPU_{adj} (#/100 m^2)	BPU_{adj} (g/100 m^2)
ULL-HPTB87.0EF01	73	5.9	4.8	8.1	6.5
ULL-HPTB87.0EF02	67	12.2	12.0	18.3	18.0
ULL-HPTB87.0EF03	44	16.0	11.9	36.2	26.9

B) Juvenile (1-2+)

Site	Usability (%)	Observed Densities[1,2]		Adusted Densities[3,4]	
		FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)	FPU_{adj} (#/100 m^2)	BPU_{adj} (g/100 m^2)
ULL-HPTB87.0EF01	17	21.6	219.1	125.2	1,270.0
ULL-HPTB87.0EF02	67	9.4	79.8	14.1	119.7
ULL-HPTB87.0EF03	17	9.0	117.3	52.1	681.5

C) Adult (≥3+)

Site	Usability (%)	Observed Densities[1,2]		Adusted Densities[3,4]	
		FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)	FPU_{adj} (#/100 m^2)	BPU_{adj} (g/100 m^2)
ULL-HPTB87.0EF01	17	5.9	188.0	34.1	1,089.4
ULL-HPTB87.0EF02	17	2.8	93.4	16.3	541.3
ULL-HPTB87.0EF03	17	12.2	597.3	70.6	3,462.1

D) All

Site	Usability (%)	Observed Densities[1,2]		Adusted Densities[3,4]	
		FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)	FPU_{adj} (#/100 m^2)	BPU_{adj} (g/100 m^2)
ULL-HPTB87.0EF01	17	34.0	419.9	197.2	2,433.9
ULL-HPTB87.0EF02	17	27.2	213.0	158.0	1,237.3
ULL-HPTB87.0EF03	15	36.5	793.3	239.4	5,199.7

[2] FPU_{obs} = Observed fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[3] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[4] $FPU_{adi} = FPU_{obs}$/Usability (%)

[5] $BPU_{adi} = BPU_{obs}$/Usability (%)

Table 59. Observed and habitat-suitability-adjusted average Cutthroat Trout densities and biomass by age class determined from closed-site electrofishing in 87.0 km Tributary in 2023.

Age Class	FPUobs (#/100 m^2)[1]		BPUobs (g/100 m^2)[2]		FPUadj (#/100 m^2)[3]		BPUadj (g/100 m^2)[4]	
	Average	SE [5]	Average	SE	Average	SE	Average	SE
Fry (0+)	11.4	3.0	9.6	2.4	20.9	8.2	17.1	5.9
Juvenile (1-2+)	13.3	4.1	138.7	41.6	79.5	22.9	834.2	235.0
Adult (≥3+)	7.0	2.8	292.9	154.6	43.4	18.9	1,849.1	1,045.1
All	32.6	2.8	475.4	169.8	143.8	27.4	2,700.4	1,077.4

[1] FPU_{obs} = Observed fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[2] BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using the removal (K-pass) function in the FSA package in R.

[3] $FPU_{adj} = FPU_{obs}$/Usability (%)

[4] $BPU_{adj} = BPU_{obs}$/Usability (%)

[5] SE = Standard Error

Figure 34. Observed densities by age class of Cutthroat Trout in 87.0 km Tributary determined from closed-site electrofishing presented as fish density per 100 m² (FPUobs) in 2023.

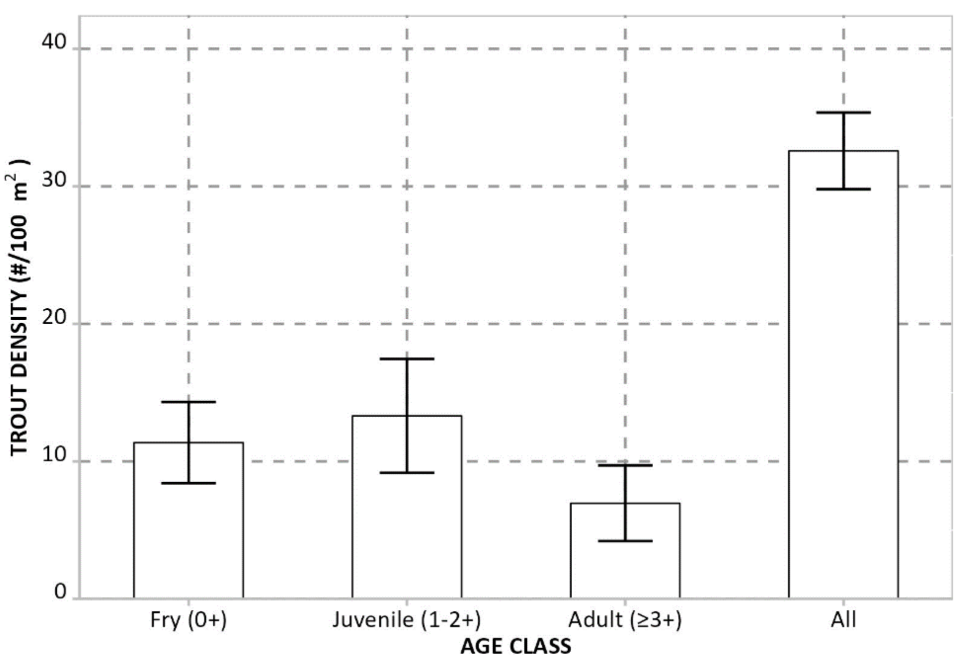
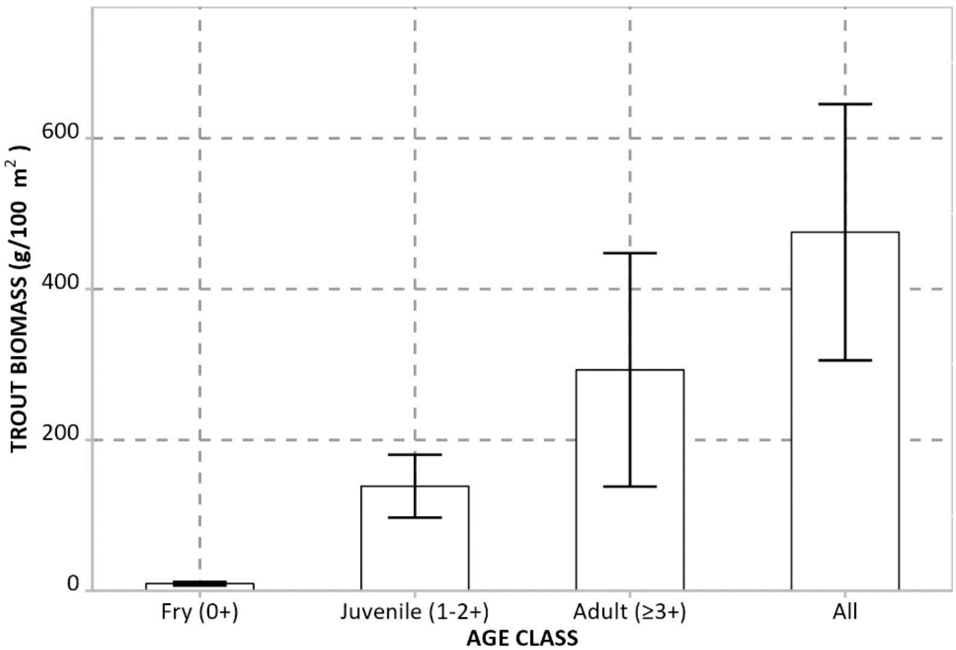


Figure 35. Observed biomass densities by age class of Cutthroat Trout in 87.0 km Tributary determined from closed-site electrofishing presented as fish biomass per 100 m² (BPUobs) in 2023.



4.4.3.5. Comparison Among Years

Observed densities and biomass of Cutthroat Trout by age class and among years are compared in Figure 36 and Figure 37, respectively. Density of Cutthroat Trout in the tributary in 2023 was higher compared to densities in 2013, 2018, and 2019 when all age classes were combined, although there were some larger differences among years for individual age classes (Figure 36). Biomass of Cutthroat Trout in 2023 was slightly higher than in 2018 and 2019 but still lower than in 2013 for all age classes combined (Figure 37). Fry densities in 2023 were almost triple of those in 2018 and 2019 and more than double in 2013. Fry biomass in 2023 was approximately double fry biomass in 2019 and was almost ten times higher than 2018 and 2013. Density and biomass of juveniles (1-2+) were slightly lower in 2023 than in 2019 but higher than in 2013. Adult density and biomass values showed a different trend, with 2023 values being relatively similar to 2019 but lower than 2013.

The removal of sampling in the upstream reach following Year 2 does not allow comparisons to the upstream control to be made. Continued monitoring of the headpond tributary has allowed for an ongoing assessment of this population to infer potential Project effects. Overall, there is no evidence indicating a decline in Cutthroat Trout in the tributary after four years of monitoring and the risk of entrainment in the ULR HEF intake is therefore considered low. Accordingly, we recommend the removal of this component in subsequent monitoring years.

Figure 36. Average observed Cutthroat Trout density (FPUobs; ± standard error) determined from closed-site electrofishing in 87.0 km Tributary in 2013, 2018, 2019, and 2023 presented by age class for: A) fry (0+); B) juveniles (1-2+); C) adults (≥3+); and D) all age classes combined.

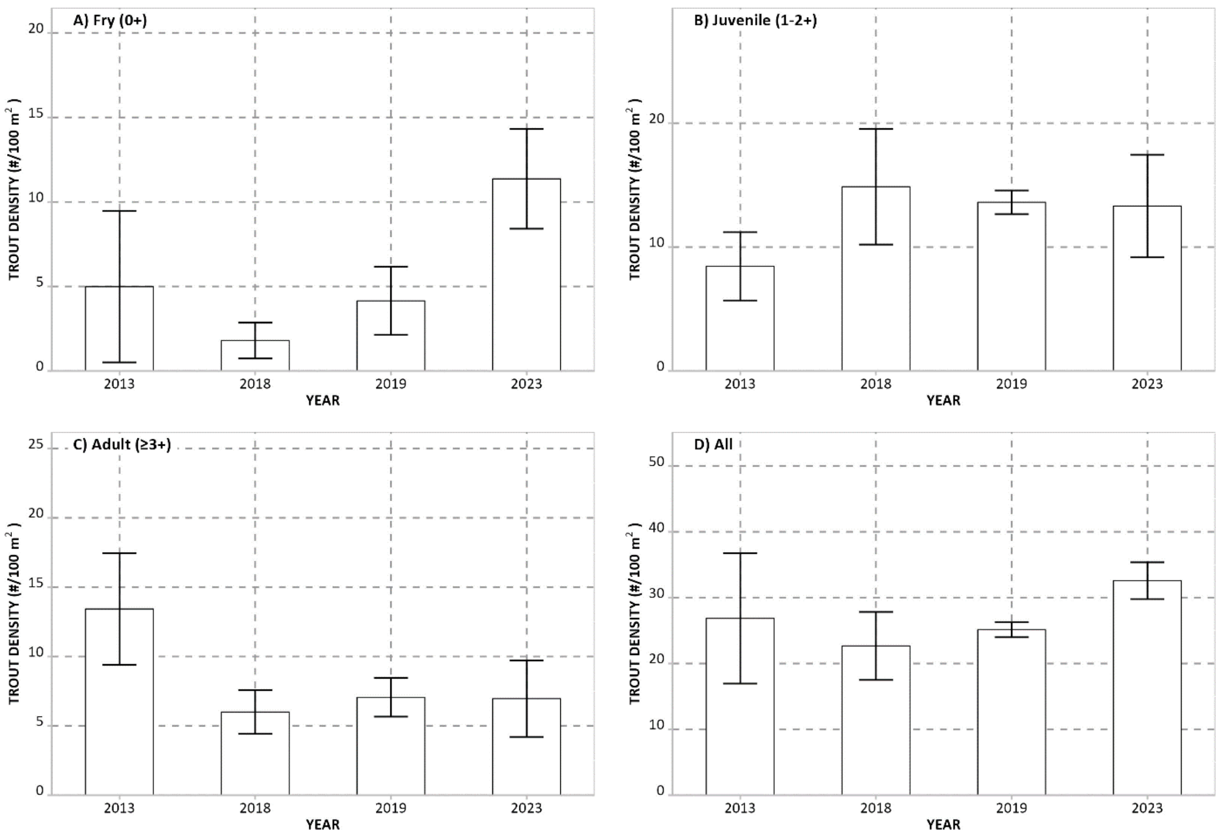
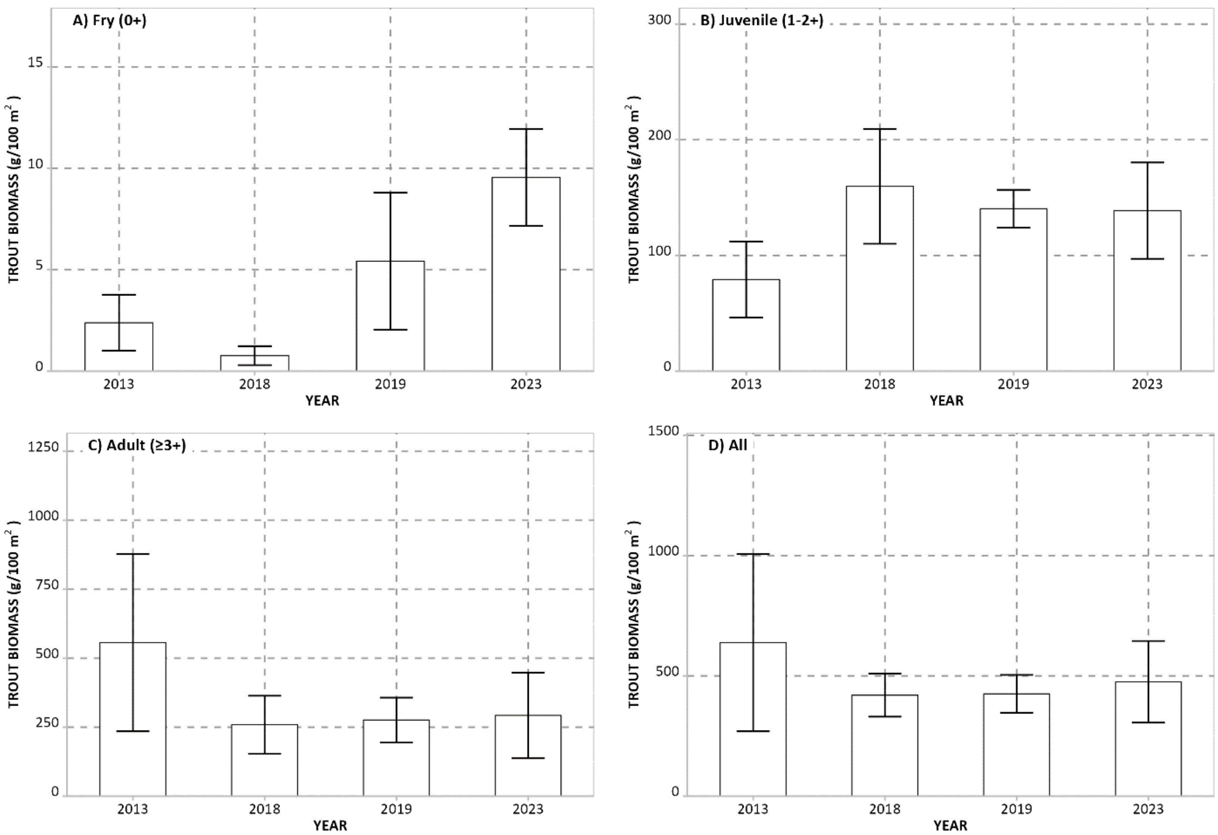


Figure 37. Average observed Cutthroat Trout biomass (BPUobs; ± standard error) determined from closed-site electrofishing in 87.0 km Tributary in 2013, 2018, 2019, and 2023 presented by age class: A) fry (0+); B) juveniles (1-2+); C) adults (≥3+); and D) all age classes combined.



ECOFISH RESEARCH

4.5. Wildlife Species Monitoring

4.5.1. Harlequin Ducks

No Harlequin Ducks were observed in Year 5 of the monitoring program, either during surveys (Table 60) or incidentally (Table 61). When considering all monitoring years, Harlequin Ducks have not been observed in the last four of five monitoring years, though six were observed in Year 1 and four ducks that were not identified to species were observed in Year 3 (Table 61; Map 15). During baseline years, Harlequin Ducks were seen in two of three years, with one observed in 2009 and six observed in 2011 (Table 61).

Most observations of Harlequin Ducks were near the intake during all years that they were observed (Table 61), where high-quality habitat had been identified during the EA (Regehr *et. al.* 2016). Similarly, most

Harlequin Duck sightings have been in the spring during the pre-incubation period (when pair surveys are done rather than the summer/fall (when brood surveys are done). Detection of Harlequin Ducks during spring is more likely because males leave breeding areas once females begin incubation, and females that fail at breeding also leave breeding areas thus no individuals may be present at breeding streams during the brood-rearing period even if breeding was attempted that season. Males (which are only present in spring) are also more conspicuous than females and are less likely to be missed if present.

There are a number of uncertainties regarding interpretation of the data, including small sample sizes and potential for non-detection (i.e., individuals not detected when they are present). These limitations limit the potential for rigorous comparison of Harlequin Duck use of the Project area pre and post-construction (e.g., comparisons of numbers). However, the approach is reasonable for comparison of use (i.e., presence/not detection) in accordance with the objective of the response monitoring prescribed in the OEMP, which is to address uncertainty around potential Project effects identified during the EA by evaluating continued use of the Project area by the species. Although surveys were done with surveillance cameras in some cases post-construction rather than in person as required by protocols (discussed in Faulkner *et al.* 2021), most camera surveys were during the brood period when Harlequin Duck detections are generally less likely (discussed above). Uncertainties such as non-detection apply to both pre and post-construction periods.

In summary, continued use of the Project area by Harlequin Ducks, as per monitoring objectives, could not be confirmed for the last four years of operational monitoring, although the lack of detection does not necessarily indicate lack of presence.

Table 60. Results of Harlequin Duck spot check surveys at the ULR HEF intake and powerhouse in Year 5 (2022).

Survey Type	Date	Infrastructure	Spot Check Vantage Point UTM Coordinates (Zone 10U)		Harlequin Ducks Observed	Other Waterbirds Observed
			Easting	Northing		
Pair	1-May-2022	intake	466156	5614170	0	0
		powerhouse	468416	5611634	0	0
	6-May-2022	intake	466156	5614170	0	0
		powerhouse	468416	5611634	0	0
	14-May-2022	intake	466156	5614170	0	0
		powerhouse	468416	5611634	0	0
Brood	10-Aug-2022	intake[1]	466156	5614170	0	0
		powerhouse	468416	5611634	0	0
	15-Aug-2022	intake[1]	466156	5614170	0	0
		powerhouse	468416	5611634	0	0
	21-Aug-2022	intake	466156	5614170	0	0
		powerhouse	468416	5611634	0	0

[1] The surveys were conducted using the remote camera from inside the powerhouse to view the headpond because access was not possible.

Table 61. Harlequin Duck observations recorded at the ULR HEF intake/headpond and powerhouse in spring and summer/fall during surveys and incidentally, during baseline (2009, 2010, and 2011) and monitoring (2018 through 2022) years.

Year	Time of Year[1]	Infrastructure	Harlequin Ducks Observed during Surveys[2,3]	Harlequin Ducks Observed Incidentally[3]
Baseline (2009)	spring[4]	powerhouse	1 (adult female)	–
Baseline (2010)	spring	intake/headpond	0	–
		powerhouse	0	–
	summer/fall	intake/headpond	0	–
		powerhouse	0	–
Baseline (2011)	spring	intake/headpond	4 (2 pairs)	2 (pair)
		powerhouse	0	–
	summer/fall	intake/headpond	0	–
		powerhouse	0	–
Year 1 (2018)	spring	intake/headpond	2 (adult female)	2 (pair)
		powerhouse	0	–
	summer/fall	intake/headpond	–	2 (2 female-like)
		powerhouse[5]	0	–
Year 2 (2019)	spring	intake/headpond	0	–
		powerhouse	0	–
	summer/fall	intake/headpond	0	–
		powerhouse	0	–
Year 3 (2020)	spring	intake/headpond[6,7]	0	–[8]
		powerhouse[7]	0	–
	summer/fall	intake/headpond[7]	0	–
		powerhouse[7]	0	–
Year 4 (2021)	spring	intake/headpond	0	–
		powerhouse	0	–
	summer/fall	intake/headpond[9]	0	–
		powerhouse	0	–
Year 5 (2022)	spring	intake/headpond	0	–
		powerhouse	0	–
	summer/fall	intake/headpond[10]	0	–
		powerhouse	0	–

[1] For targeted surveys, pair surveys were conducted in spring (May) and brood survey were conducted in summer/fall (late July to early September); June observations are included with spring. Incidental observations (observations opportunistically recorded outside of targeted surveys) are also presented by season.

[2] In monitoring years (2018 to 2022), two pair surveys were conducted in spring and two brood surveys were conducted in fall. During baseline years 2010 and 2011, two pair surveys were done in spring and one brood survey was done in fall. In baseline year 2009, Fremlin and Gebauer (2009) conducted an aerial/ground-based survey.

[3] Pair is one male and one female; sex recorded as female in late summer/fall is considered female-like because at this time of year females are difficult to distinguish from juveniles.

[4] The 2009 survey was conducted on June 10 (Fremlin and Gebauer 2009), which is outside of the recommended timing for pair surveys (in June, males have left breeding areas and females are incubating, making detection difficult).

[5] In 2018, one of the three brood surveys at the powerhouse was conducted with zoomable surveillance camera due to landslide risk.

[6] In 2020, the headpond was drained between May 22 and July 20 (i.e., during the third pair survey, but not for first two pair surveys).

[7] All surveys in 2020 were conducted with the use of zoomable surveillance cameras from a room inside the powerhouse.

[8] Four unidentified ducks were observed in the headpond on April 20, 2020.

[9] In 2021, two of the three brood surveys at the intake were done by remote camera from inside the powerhouse due to landslide risk.

[10] In 2022, two of the three brood surveys at the intake were done by remote camera from inside the powerhouse due to landslide risk.

4.5.2. Species at Risk & Regional Concern

Species at risk and of regional concern incidentally observed and recorded by Ecofish personnel and Project operators in the Project area in Year 5 (2022) are summarized in Appendix Q. Most of the wildlife species observed incidentally in Year 5 have also been recorded in previous years (e.g., Moose, Mule Deer, Grizzly Bear, American Black Bear (*Ursus americanus*), Grey Wolf (*Canis lupus*), and Bald Eagle (*Haliaeetus leucocephalus*)). However, a Red Fox (*Vulpes vulpes*) was also detected (recorded at km 39 along the Lillooet River FSR on July 23); this species had not been recorded previously.

As discussed in previous monitoring years, to reduce the potential for human-wildlife conflict, observations of large mammals, especially Grizzly Bears and Moose along the Lillooet River FSR, and Elk (also sighted along the FSR in Year 4), are given special consideration by Project operations (i.e., sightings are recorded and shared among Project operators to raise awareness of where these large mammal species are more likely to be encountered when working outdoors and driving).

Incidental observations have met the objective of informing Project operations related to management of species at risk and of regional concern (e.g., minimize risks of wildlife-vehicle interactions) and contributing to the provincial database.

4.6. Wildlife Habitat Monitoring

4.6.1. Habitat Restoration - Amphibian Habitat

The spot check conducted on July 27, 2023, at ULL-ASTR04, where geotextile had been found exposed in Year 1 and Year 3, indicated that a small portion (~ 0.75 m long) of geotextile had once again become exposed at the edge of river right (Figure 38), in the same location where it had become exposed in 2020. This small section was again re-covered (with cobble found on site) on the day of the spot check (Figure 39). As also noted in Year 3, it was apparent that the extra cobble that had been added to the substrate in 2019 to cover the geotextile found exposed in Year 1 continued to be functional, since most of the geotextile that had been exposed in 2018 (see Figures 33 and 34 in Regehr *et al.* (2019)), and that had been covered in fall of 2019, remained covered. Abundant regeneration of riparian vegetation in this location, consisting of alder, willow, and cottonwood, was noted.

Figure 38. Exposed geotextile within the stream channel at ULL-ASTR04 on July 27, 2023.

Figure 39. Location where geotextile had been exposed adjacent to the stream channel, after covering exposed section with cobble by hand, on July 27, 2023.

4.6.2. Habitat Restoration - Mammal Habitat

Results of mammal habitat restoration compliance monitoring for Grizzly Bear, Moose, and Mule Deer at restoration monitoring sites that were reassessed in Year 5 are presented in Table 62 and the details of compliance monitoring results, along with photographs, are presented in Appendix R. Locations of restoration monitoring sites are shown on Map 11.

Most of the 18 vegetated screens required for Grizzly Bear, Moose, and Mule Deer habitat that were monitored in Year 5 had attained height and width requirements (Table 62). Specifically, most vegetated screens for Grizzly Bear (11 of 15) and Mule Deer (5 of 7) habitat, and half of the vegetated screens for Moose habitat (1 of 2), that were reassessed in Year 5 were found to have met height and width requirements. Estimated percent coverage of visibility through the screens ranged from 16% to 100%.

Overall, all screens except one had attained widths greater than 5 m (widths ranged from 8 m to 50 m) and 12 of the 18 screens had heights ≥ 5 m (Table 62). The single screen that had not reached the width requirement (ULH-MAMCM02) had been destroyed in the 2015 Boulder wildfire and is slow to recover. Given its height above the road, measurements were not recorded for this screen after Year 1, though the screen was visually assessed (Table 62) and photographs taken in Year 5 (2023). The remaining screens that did not meet height requirements had heights of at least 3 m, good natural regeneration, and were evaluated to be on track for meeting the 5 m height requirement in the near future. Specifically:

- At ULH-MAMCM04B, little revegetation progress had been observed in Year 3 and planting had been recommended in areas where growth was restricted by wood chips (Faulkner *et al.* 2021); however, in Year 5 vegetation width and height had improved (in Year 3, average width and height were 3 m and 2 m, respectively (Faulkner *et al.* 2021), whereas in Year 5 (2023) average width and height were 10 m and 3 m, respectively (Table 62)), and vegetation was starting to grow through the wood chips.
- At ULH-MAMCM09, the potential need for planting had been identified in Year 1 (Regehr *et al.* 2019) but the potential for natural regeneration had looked more promising by Year 3 (Faulkner *et al.* 2021). Although screen height was still inadequate at this location in Year 5 (average height of 3 m), vegetation height has improved since Year 3 (when average screen height was 2 m; Faulkner *et al.* 2021).
- At ULH-MAMCM10, ULH-MAMCM12, and ULH-MAMCM22, Year 3 monitoring results predicted that the screens would achieve sufficient size naturally because woody plants were present. Year 5 monitoring results support these predictions, given that heights for all three screens have increased relative to Year 3 (from 2 m to 4 m, from 2 m to 3 m, and from 1 m to 3 m for ULH-MAMCM10, ULH-MAMCM12, and ULH-MAMCM22, respectively).

Based on Year 5 monitoring results at the 18 vegetated screens reassessed in Year 5, all these vegetated screens except ULH-MAMCM02, which had been destroyed in the 2015 Boulder wildfire, are on trajectory to meet the height requirements and growth of existing vegetation is expected to create an adequate screen in the near future. It is anticipated that ULH-MAMCM02 will also revegetate naturally over time, and it is not considered a critical screen given its location high above the road, which means that wildlife is less likely to be visible from the road and traffic along the road is less likely to disturb wildlife. The vegetated screen at one other site (ULH-MAMCM07) did not achieve required height and width requirements by Year 3 but was not recommended for additional monitoring at that time (Faulkner *et al.* 2021) and was therefore not visited in Year 5. A 70 m wide scree slope is present at this site, which prevents vegetation growth.

Table 62. Summary of vegetated screen assessments within high value mammal habitat along the transmission line in Year 5 (2023). Grey highlighting identifies monitored sites that had not attained height requirements.

Site	Species and Habitat[1]	Date	Vegetated Screen Metrics[2]			Requirements Met in 2023	Comments
			Average Width (m)	Average Height (m)	Average % Cover (Visibility)		
ULH-MAMCM01	Grizzly Bear - High Value	27-Jul-2023	11	5	35	Yes	Some sections with low heights, good natural regeneration; recovering from the Boulder Creek forest fire. On trajectory to meet 5 m height requirement.
ULH-MAMCM02	Grizzly Bear - High Value	27-Jul-2023	–	–	–	–	Site is burnt; located very high above the road; slow to recover.
ULH-MAMCM04B	Grizzly Bear - High Value	27-Jul-2023	10	3	18	No	Excellent natural regeneration; vegetation is growing through the wood chips; increased vegetation along the road; vegetation is on track for height requirement.
ULH-MAMCM06	Grizzly Bear - High Value Mule Deer - UWR	27-Jul-2023	28	6	90	Yes	Excellent regeneration; dense vegetation with good cover.
ULH-MAMCM08	Mule Deer - UWR	27-Jul-2023	22	5	77	Yes	Excellent regeneration; abundant cover above the road.
ULH-MAMCM09	Grizzly Bear - High Value Mule Deer - UWR	27-Jul-2023	8	3	16	No	Increased vegetation cover; good natural regeneration; sections of rock and boulders; On trajectory to meet 5 m height requirement.
ULH-MAMCM10	Mule Deer - UWR	27-Jul-2023	14	4	22	No	Good natural regeneration; vegetation is expected to grow taller than 5 m over time.
ULH-MAMCM12	Moose - UWR	27-Jul-2023	18	3	38	No	Site was previously disturbed in 2020; good regeneration along the road with increased cover.
ULH-MAMCM14	Grizzly Bear - WHA 2-399 Moose - UWR	28-Jul-2023	17	6	100	Yes	Abundant natural regeneration, dense bushes; dense vegetation along the road.
ULH-MAMCM17	Grizzly Bear - South Lillooet River FSR	28-Jul-2023	13	6	93	Yes	Abundant natural regeneration; dense vegetation along the road.
ULH-MAMCM19	Grizzly Bear - South Lillooet River FSR	28-Jul-2023	32	6	53	Yes	Excellent regeneration; dense vegetation; the tower access road appears to be inactive.
ULH-MAMCM21	Grizzly Bear - High Value Mule Deer - UWR	28-Jul-2023	20	5	72	Yes	Site was previously disturbed in 2020; excellent regeneration along the road; dense shrubs.
ULH-MAMCM22	Grizzly Bear - High Value	28-Jul-2023	14	3	62	No	Site was previously disturbed in 2020. Good regeneration with increased heights; dense shrubs; On trajectory to meet 5 m height requirement.
ULH-MAMCM23	Grizzly Bear - High Value	28-Jul-2023	20	5	73	Yes	Roadside vegetation has grown tall; dense shrubs; excellent regeneration.
ULH-MAMCM24	Grizzly Bear - High Value Mule Deer - UWR	28-Jul-2023	15	5	68	Yes	Roadside vegetation has grown tall; dense shrubs; increased heights.
ULH-MAMCM26	Grizzly Bear - High Value Mule Deer - UWR	28-Jul-2023	47	5	68	Yes	Excellent regeneration along the road; dense shrubs.
ULH-MAMCM27	Grizzly Bear - High Value	27-Jul-2023	57	5	93	Yes	Excellent regeneration; good mix of conifers and deciduous trees; dense vegetation; good cover.
ULH-MAMCM28	Grizzly Bear - High Value	27-Jul-2023	50	5	38	Yes	Excellent regeneration; increased vegetation along the road.

[1] High value Grizzly Bear habitat is considered as Class 1 or Class 2 as identified by habitat suitability modelling (Leigh-Spencer *et al.* 2012) and confirmed in the field (Leigh-Spencer *et al.* 2013).

[2] Averages were generated for each site from three sets of measurements (width and height) or estimates (percent cover). At ULH-MAMCM02, vegetated screen measurements could not be taken due to height of the screen above the road.

5. SUMMARY AND RECOMMENDATIONS

5.1. Aquatic and Riparian Habitat

5.1.1. Riparian Revegetation Assessment

Year 5 of revegetation monitoring results indicate that riparian revegetation continues to be successful, and vegetation is on track to provide key riparian functions. The average estimated vegetation stem density targets were met for both trees and woody shrubs, and established individuals appeared healthy and continued to grow. Survival of planted stock could not be assessed, but overall high stem densities and low observed mortalities support the conclusion that the 80% survival target has been met. Although there were areas of exposed soils in most plots, percent vegetation cover consistently increased over the monitoring period, and the high stem densities of woody vegetation and lack of observed erosion suggest that riparian vegetation can provide adequate soil stabilization and other riparian functions.

Ultimately, the continued natural development of riparian vegetation is expected to be sufficient for providing riparian functions, and the riparian revegetation effectiveness monitoring component of the OEMP is considered complete.

5.2. Water Temperature and Air Temperature

Temperature metrics recorded during Year 1 to Year 5 were not substantially different from the baseline monitoring results. However, the warmest months on record to date, considering both water and air temperature, occurred in June/July of 2018 and 2019 (ULR only), and in June to August of 2021 and 2023 (both ULR and Boulder Creek). Of note, in late June and early July 2021, BC experienced a prolonged period of unusually high pressure associated with an unprecedented heat wave (Environment and Climate Change Canada 2021). In addition, May through September 2023 were BC's warmest five months on historical record, with the highest temperatures recorded during a prolonged heat wave in mid-August 2023 (Environment and Climate Change Canada 2024). Some of the coolest periods on record were also observed during winter 2019, 2021, and 2022 in both the water and air temperature data sets.

The water and air temperature operational period of record spans five and a half calendar years (March 2018 to October 2023) and meets the monitoring requirements prescribed in the OEMP (Harwood *et al.* 2021). Therefore, the ULR and Boulder Creek water and air temperature monitoring program is considered complete. No additional monitoring requirements are recommended at this time, although this will be confirmed following a BACI analysis that will be completed as part of the final program summary report.

5.2.1. Frazil Ice

The frazil ice assessment protocol has been implemented since December 2017, and crews have responded to two alarms (prolonged cold periods) since this date. Per the OEMP (Harwood *et al.* 2021), our understanding of the effect of flow on frazil ice development and the effects of frazil ice on fish habitat is now informed by data collected from five operational years. The OEMP stated that the effectiveness and suitability of the frazil ice monitoring and management protocol would be evaluated annually as there was uncertainty in conditions that may lead to frazil ice. Frazil ice monitoring associated with the OEMP is considered complete; however, Innergex will continue to monitor temperature and frazil ice for the life of the Project as required in Schedule B of the Project's EAC. Given observations and monitoring to date, we recommend this continued monitoring in each of the ULR and Boulder Creek diversions reflects the updated protocol with a threshold of three consecutive days of -12°C average daily temperature recorded at the Callaghan Valley or Pemberton Airport weather stations.

5.3. Stream Channel Morphology

The qualitative geomorphic assessment described in Section 4.3 fulfills the OEMP requirement to complete this type of assessment following a five-year monitoring period (Harwood *et al.* 2021). The effects observed during this geomorphic assessment were minimal between the baseline (2008 to 2013) and operational (2018 to 2023) monitoring periods and were determined to have negligible impact to fish habitat. The stream channel morphology monitoring component of the OEMP is considered complete.

5.4. Fish Community

5.4.1. Juvenile Density and Biomass

Juvenile fish densities and biomass monitoring were successfully implemented in Year 5 using closed-site electrofishing surveys in the diversion reach of the ULR and through mark re-sight snorkeling surveys within the diversion and downstream reaches of Boulder Creek. Based on results to date (e.g., 2022 representing the lowest density and biomass of Bull Trout and combined Bull Trout and Cutthroat Trout in the diversion reach of ULR), we recommend that additional juvenile abundance monitoring should occur in the ULR and Boulder Creek in Year 7 (2024) following OEMP monitoring requirements (Harwood *et al.* 2021).

5.4.2. Adult Migration and Distribution

Year 5 (2023) marked the fifth year of operational monitoring of adult Bull Trout migration and distribution. Sampling included a combination of angling surveys conducted in the diversion and downstream reaches of the ULR, Boulder Creek, and North Creek (a reference stream), and tributary bank walk spawner surveys conducted in 29.2 km Tributary and Alena Creek (both are reference streams). Fish capture numbers in the diversion reaches of both projects during the operational monitoring years show that upstream migration access into the diversion reach is not inhibited. Further, there was no decreasing trend in CPUE in the diversion reach for either project. Results from bank walk spawner surveys in both tributaries resulted in low observations and one or less spawning redds in each year with no overall trend.

No negative project-related effects were observed and the monitoring requirements of the OEMP were achieved. Thus, no further action or monitoring is recommended for the adult migration and distribution monitoring component.

5.4.3. Assessment of Entrainment at the Upper Lillooet River Intake

The third year of operational monitoring of the Headpond tributary at km 87.0 on the ULR was successfully implemented in 2023. Closed-site electrofishing surveys were conducted in support of an assessment of fish entrainment at the ULR HEF intake in Year 5 (2023). The removal of sampling in the upstream reach following Year 2 does not allow comparisons to the upstream control to be made. Continued monitoring of the headpond tributary has allowed for an ongoing assessment of this population to infer potential Project effects. Overall, there is no evidence indicating a decline in Cutthroat Trout in the tributary after four years of monitoring and the risk of entrainment in the ULR HEF intake is therefore considered low. Accordingly, we recommend the removal of this component in subsequent monitoring years.

5.5. Wildlife Species Monitoring

5.5.1. Harlequin Ducks

Response monitoring (Table 2) was recommended in the OEMP to address uncertainty around potential Project effects identified during the EA given the presence of high-quality habitat in the Project area. As such, Harlequin Duck monitoring was prescribed to confirm whether Harlequin Ducks continue to use the Project area post-construction. Continued use of the Project area by Harlequin Ducks, as per monitoring objectives, was documented for Year 1 but could not be confirmed for the last four years of operational monitoring, although the lack of detection does not necessarily indicate lack of presence.

5.5.2. Species at Risk & Regional Concern

Incidental wildlife observations have provided valuable information on the timing and locations of species at risk and of regional concern within the Project area. Wildlife continues to use the project areas, as confirmed by incidental sightings of Moose, Mule Deer, Grizzly Bear, American Black Bear, Grey Wolf, and Bald Eagle in Year 5. We recommend that Project personnel continue to record and share wildlife sightings with other Project personnel, especially of Grizzly Bear, Moose, and Elk, to raise awareness of the locations where these species occur to minimize risk of human-wildlife conflict.

5.6. Wildlife Habitat Monitoring

5.6.1. Habitat Restoration - Amphibian Habitat

Several years of monitoring have indicated that the geotextile installed at ULL-ASTR04 tends to become exposed over time, at least in one specific problem location, reducing habitat suitability for Coastal Tailed Frog. The exposed geotextile was covered with rocky substate in 2019 and 2020;

however, it was exposed again in Year 5 (2023). We therefore recommend that Innergex completes periodic inspections of the streambed at ULL-ASTR04 and recovers the geotextile if needed.

5.6.2. Habitat Restoration - Mammal Habitat

Mammal habitat restoration compliance monitoring for Grizzly Bear, Moose, and Mule Deer indicated that 6 of the 18 vegetated screens assessed in Year 5 had not yet met the required dimensions specified in the OEMP. Five of these screens had attained the required 5 m width but had not attained the required 5 m height. However, all five are expected to achieve requirements naturally in the near future, given that woody plants are growing well, and that for all screens, heights had reached a minimum of 3 m and an increase in height had been observed since Year 3. At one site, ULH-MAMCM02, vegetation was destroyed in the 2015 Boulder wildfire is slow to recover. This site is anticipated to also revegetate naturally over time and is not considered a critical screen given its location high above the road. Given these results, further monitoring is not recommended for sites at which vegetated screens have not yet achieved the required dimensions. Thus, no further action or monitoring is recommended for the mammal habitat restoration monitoring component.

6. CLOSURE

Monitoring objectives for Year 5 (2022, 2023) were achieved in accordance with the requirements of the Project's OEMP, which was revised in 2021 (Harwood *et al.* 2021). Several components were postponed to 2023 due to access restrictions to the Project area caused by landslide risk and associated safety for field personnel.

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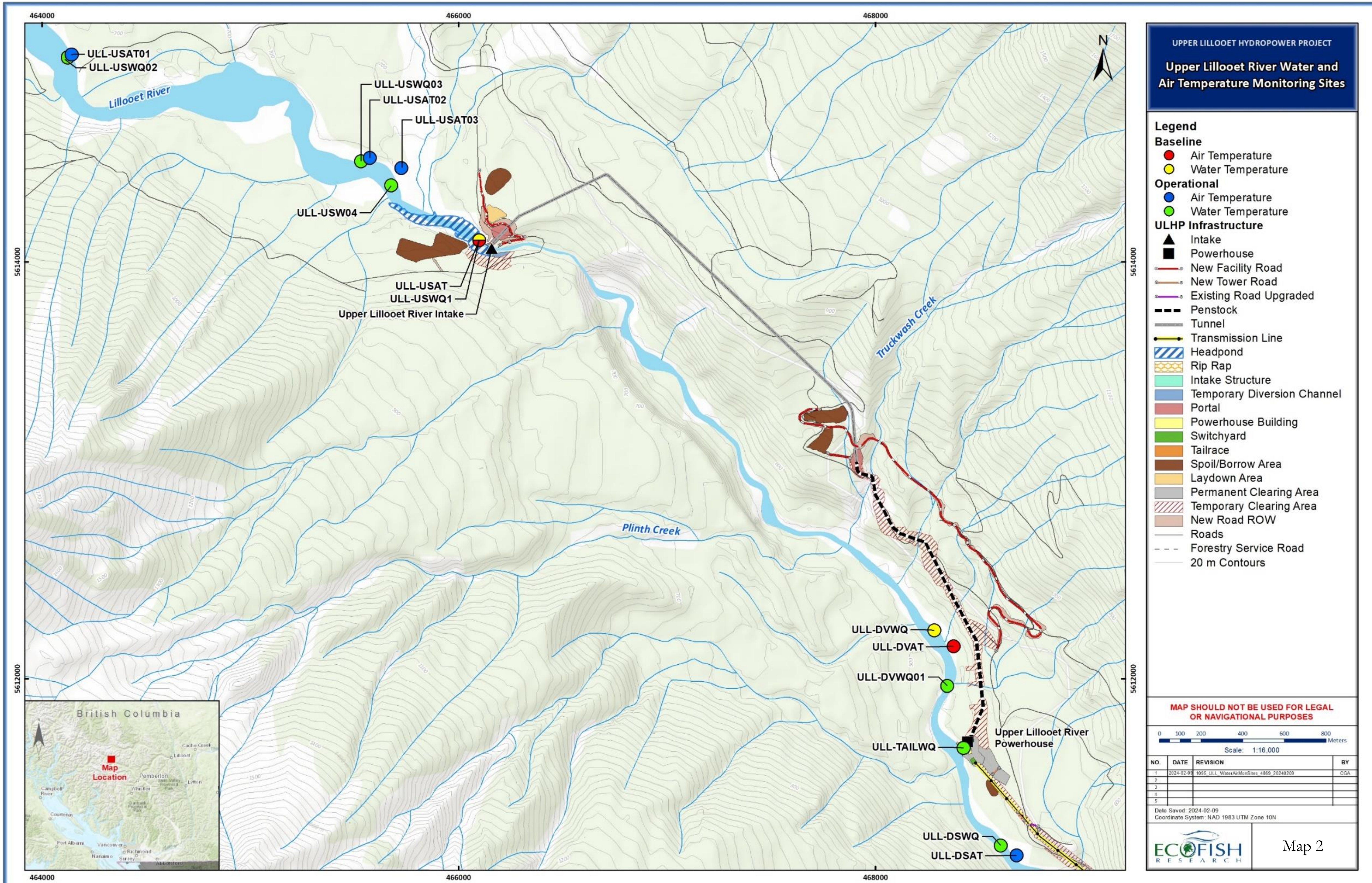
PROJECT MAPS



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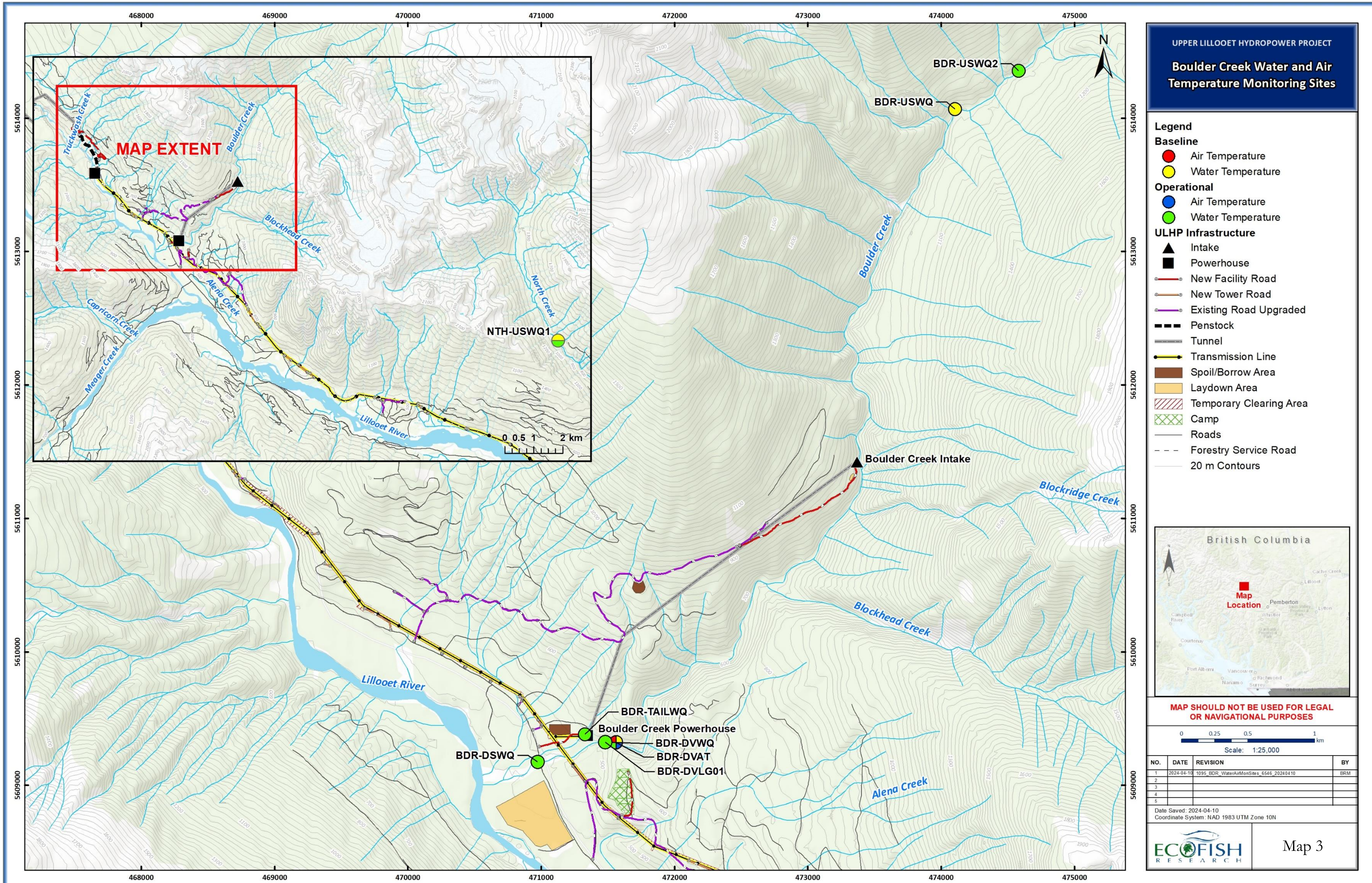

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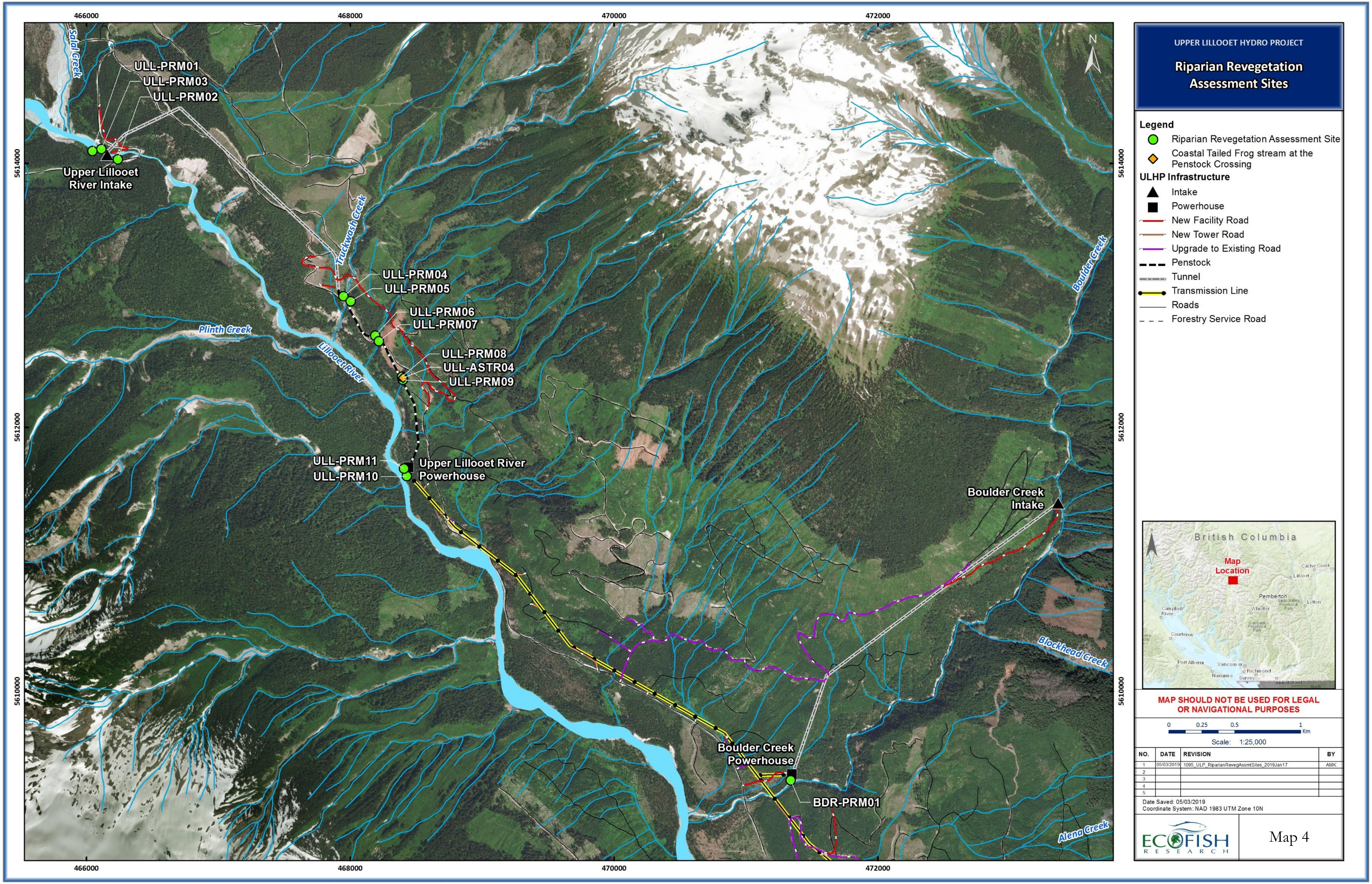

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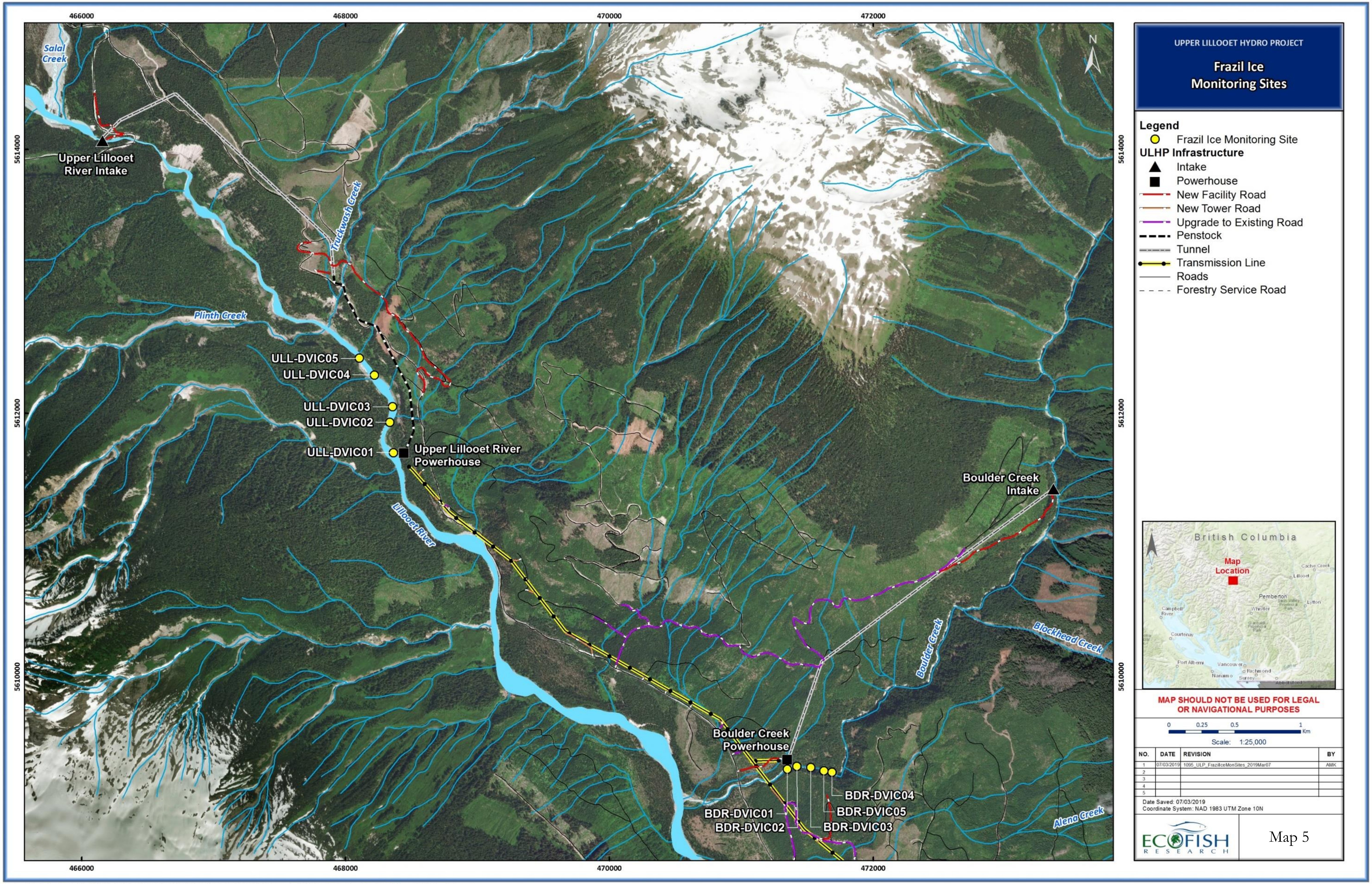

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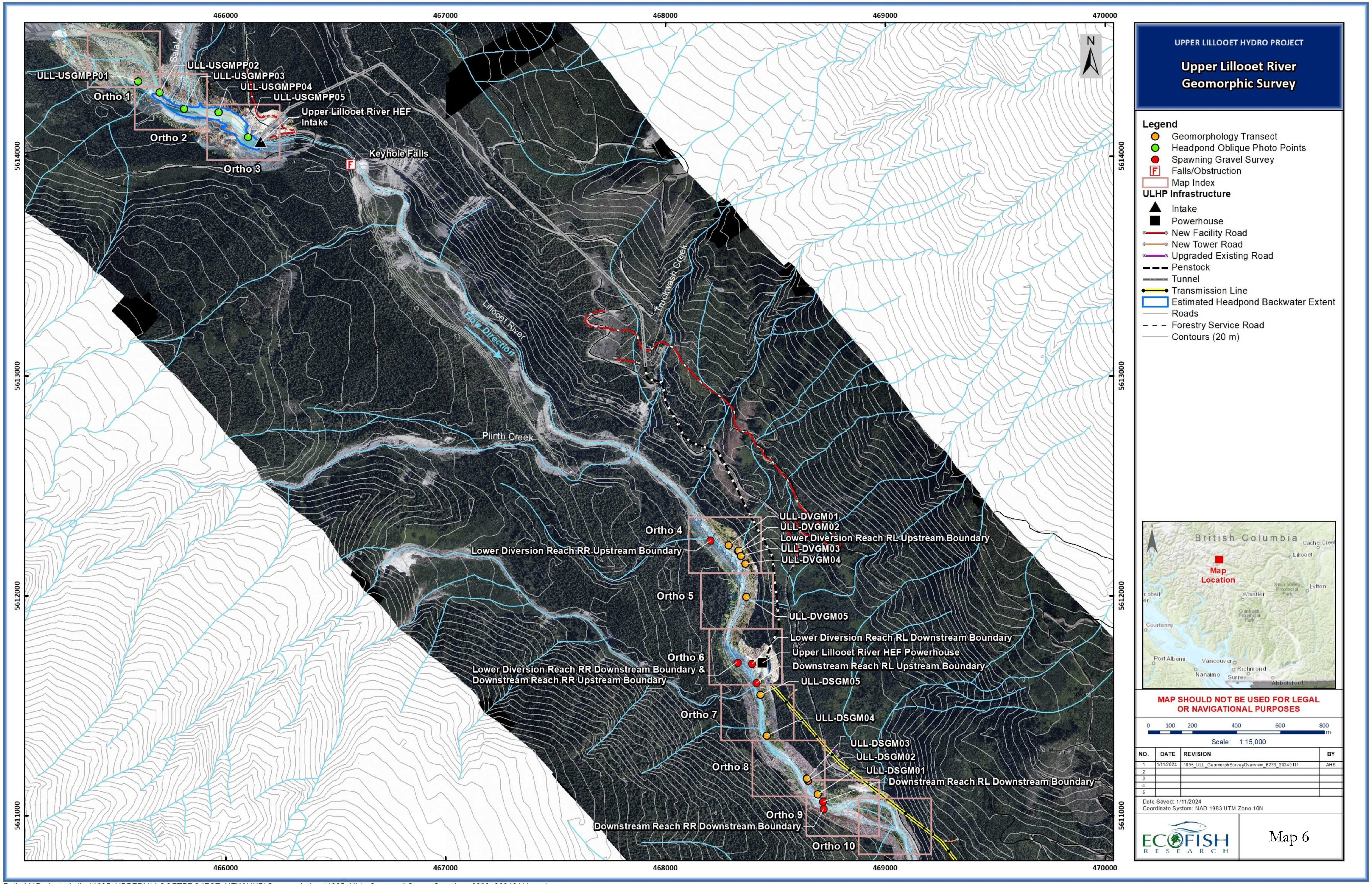

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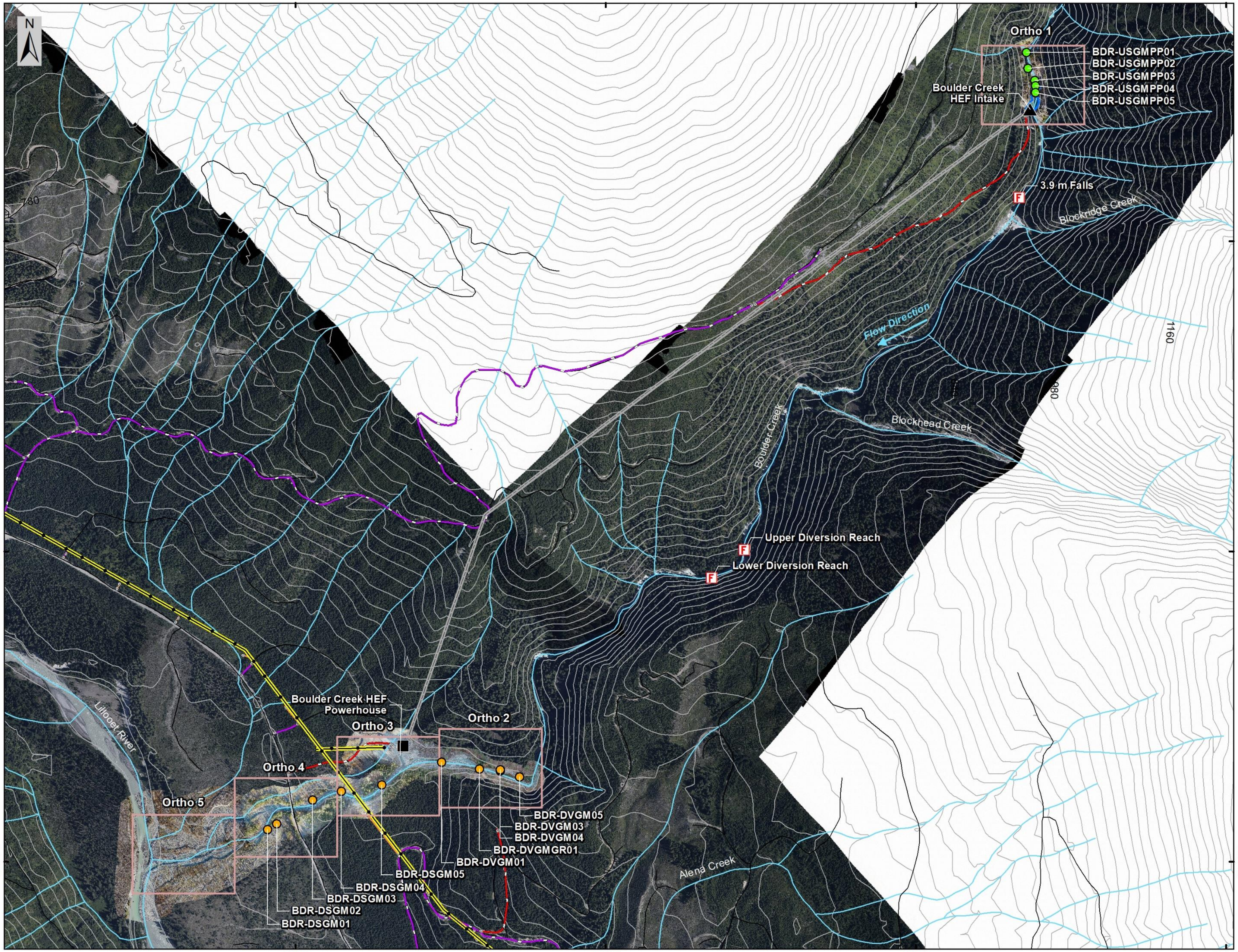

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey

Legend

- Geomorphology Transect
- Headpond Oblique Photo Points
- Falls/Obstruction
- Map Index

ULHP Infrastructure

- Intake
- Powerhouse
- New Facility Road
- New Tower Road
- Upgraded Existing Road
- Tunnel
- Transmission Line
- Estimated Headpond Backwater Extent
- Roads
- Forestry Service Road
- Contours (20 m)

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 100 200 400 600 m

Scale: 1:12,000

NO.	DATE	REVISION	BY
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Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 7

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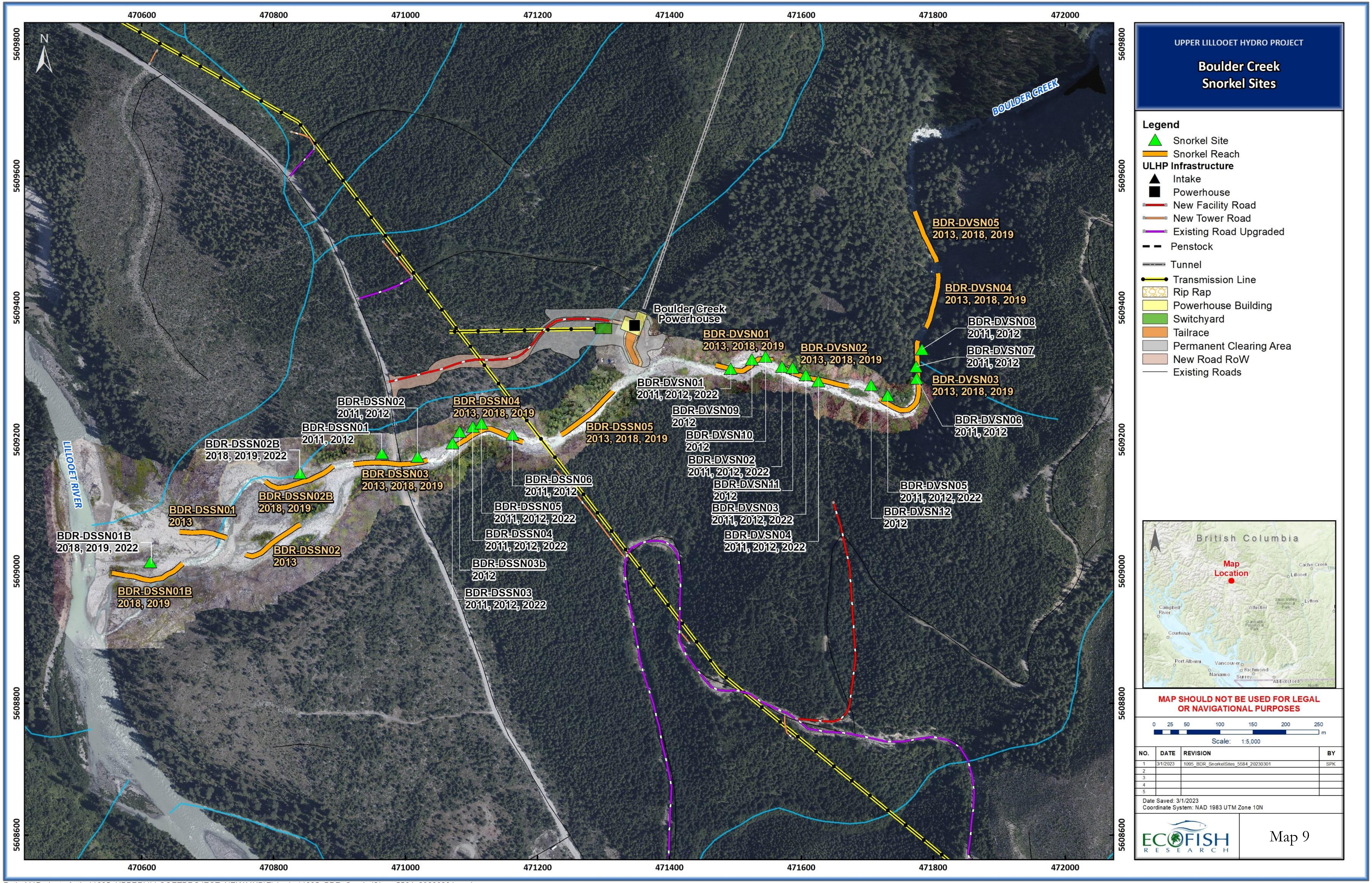

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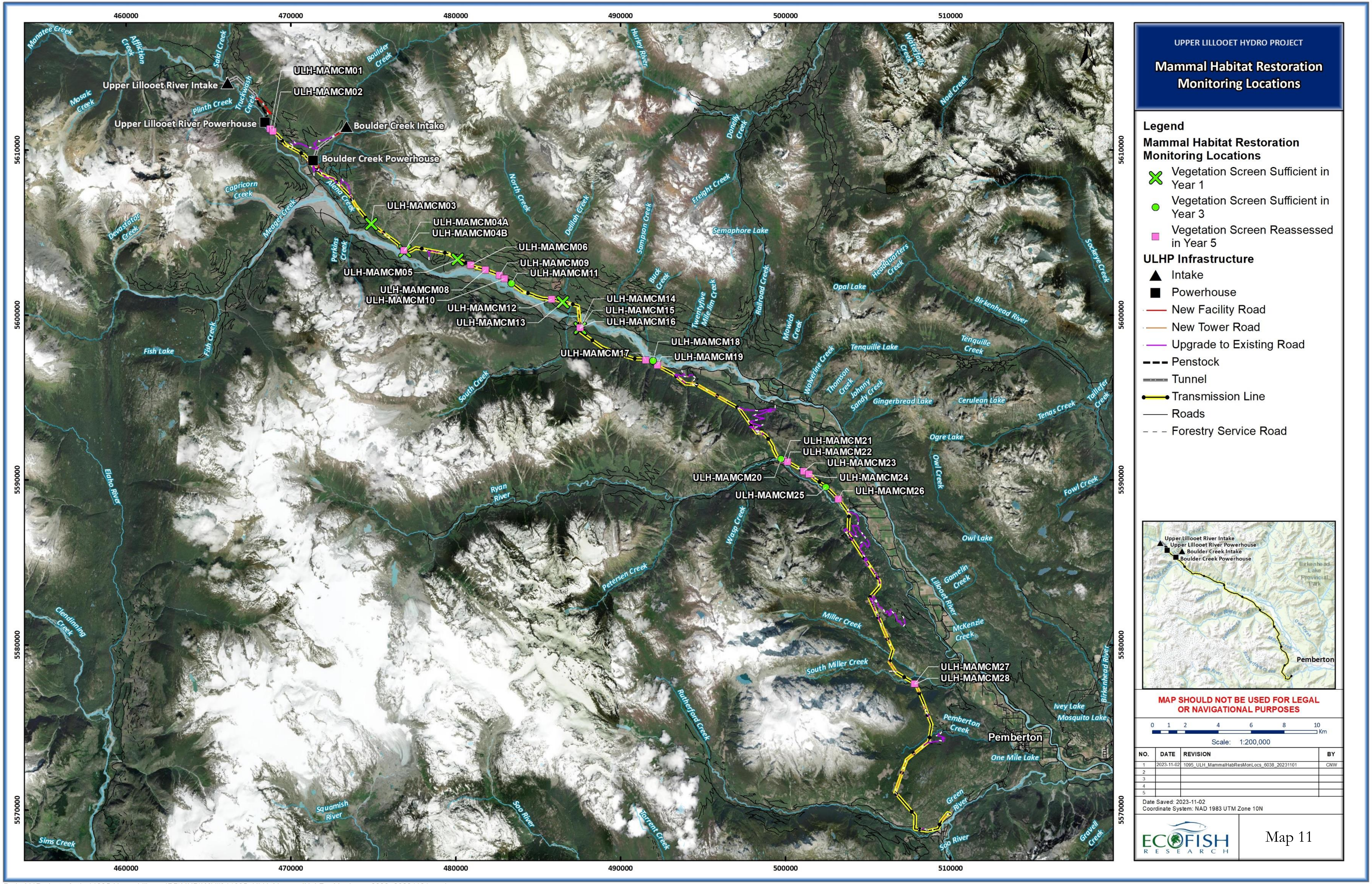

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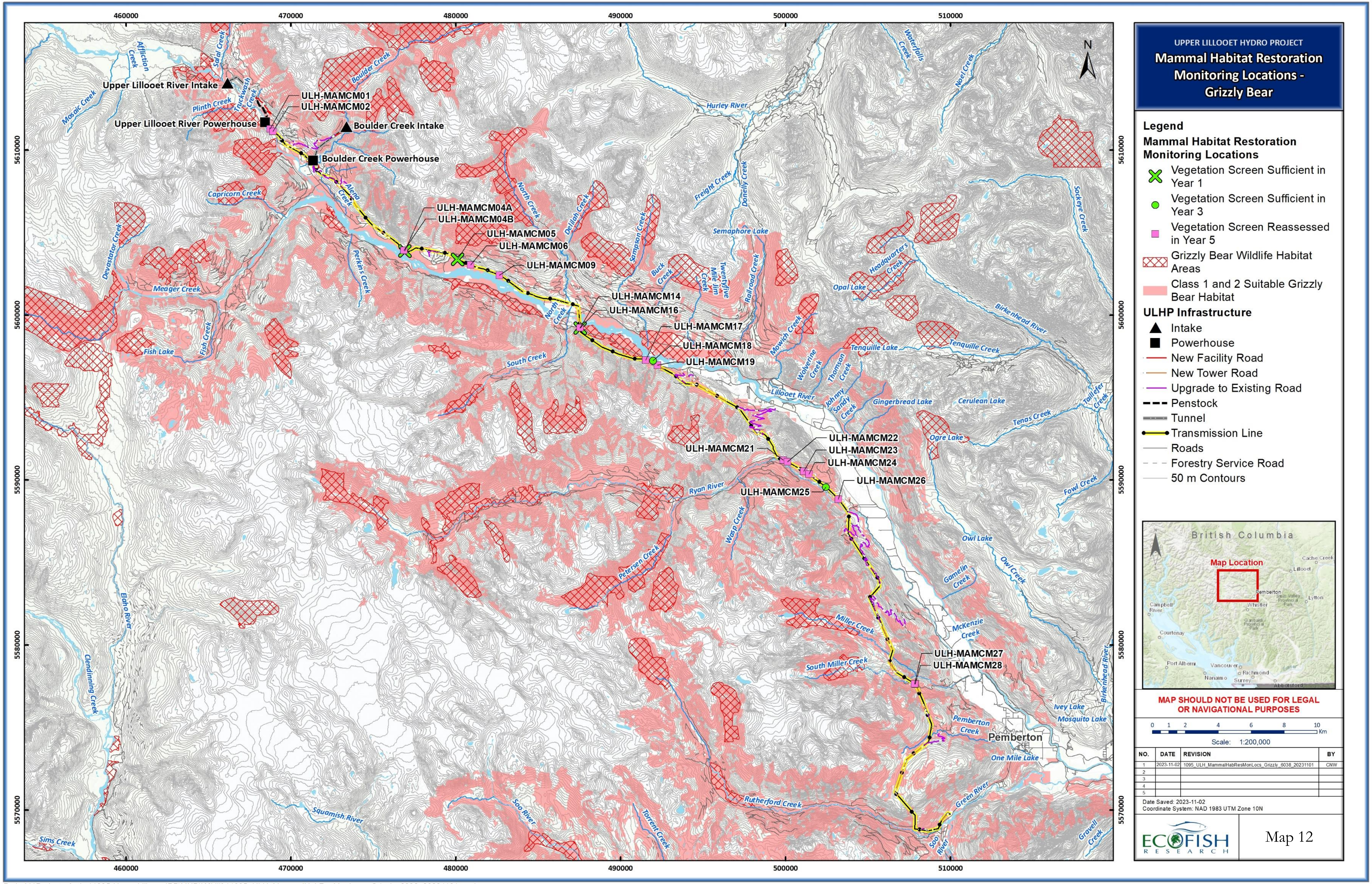

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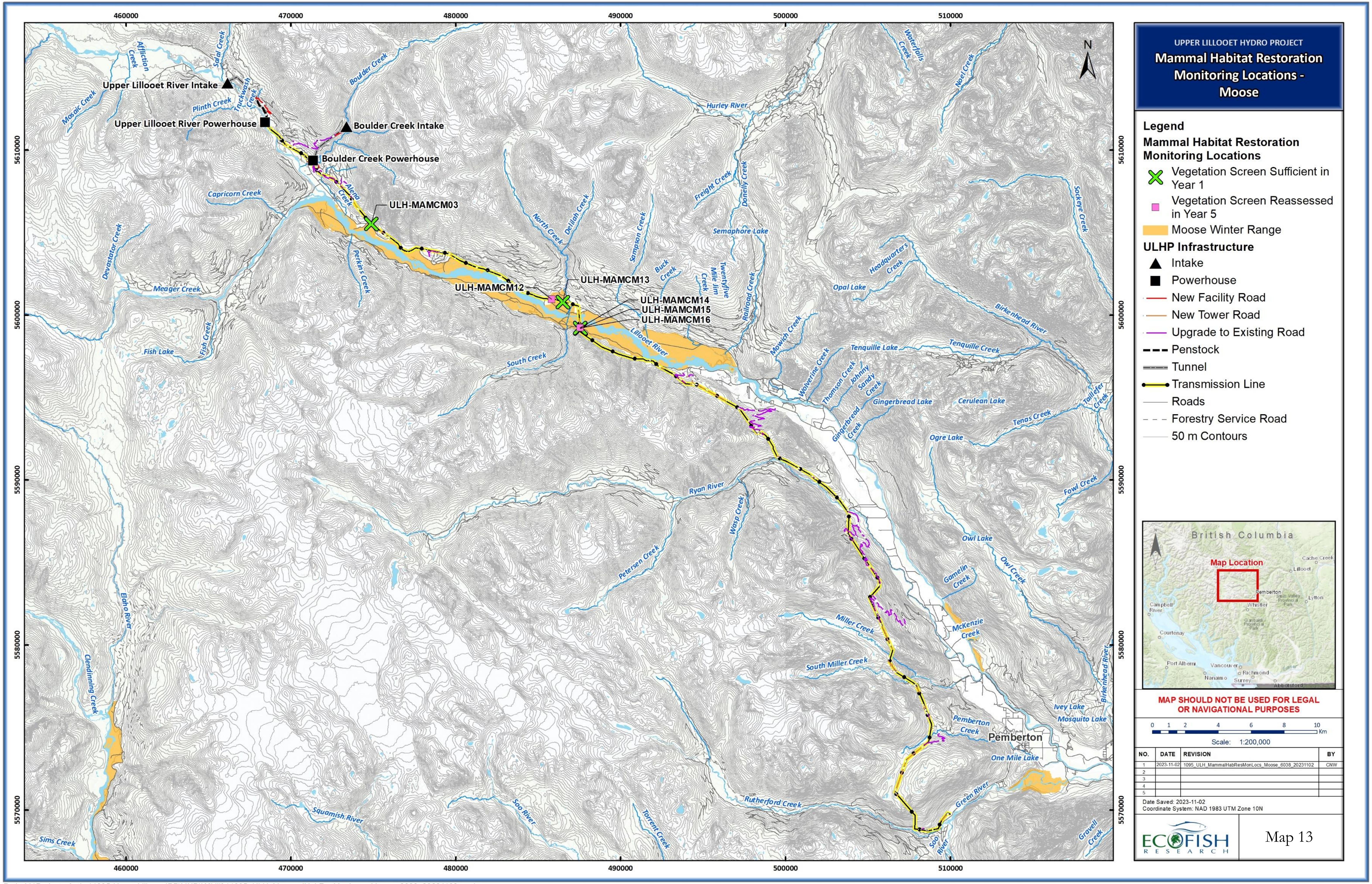

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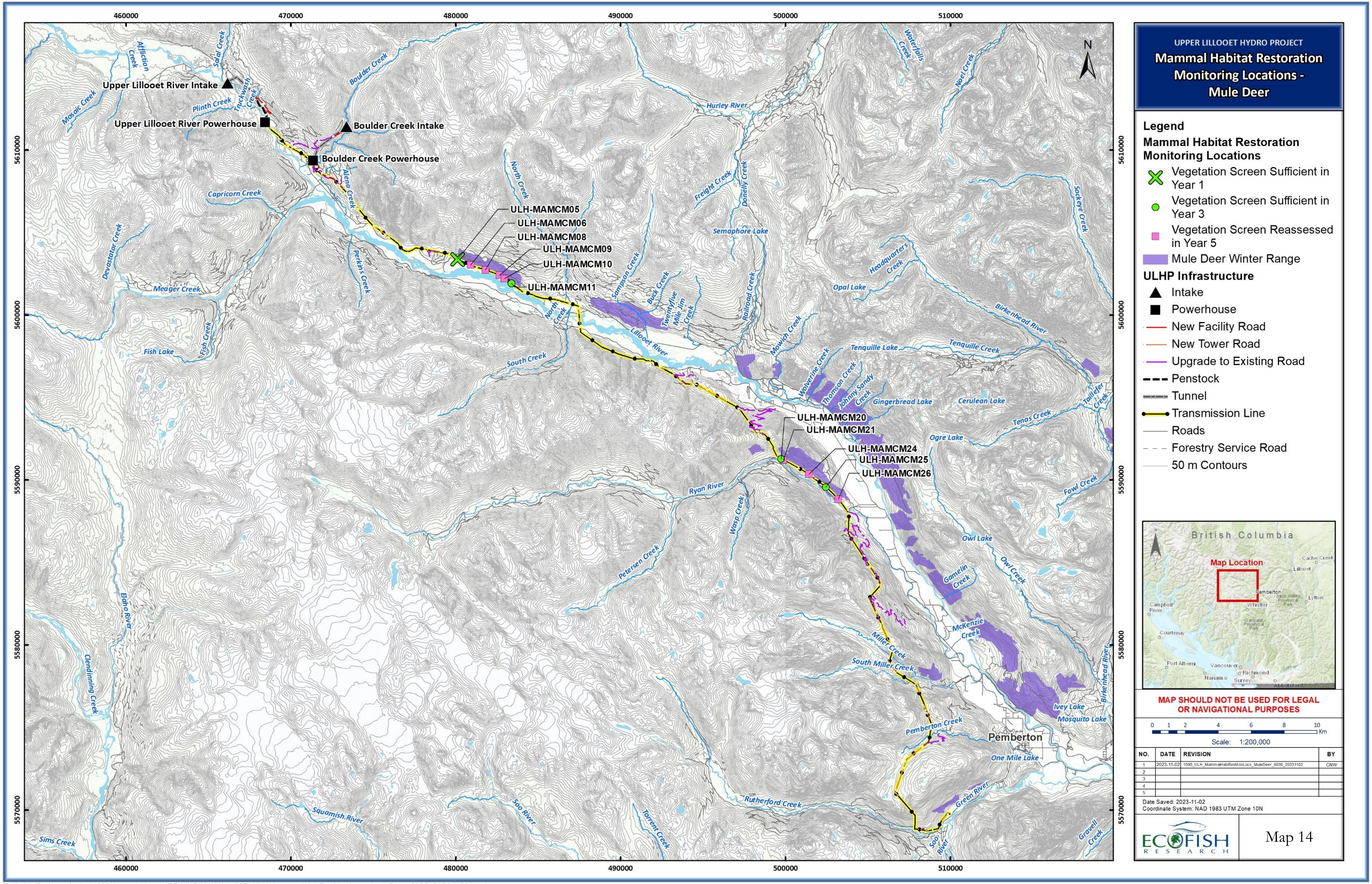

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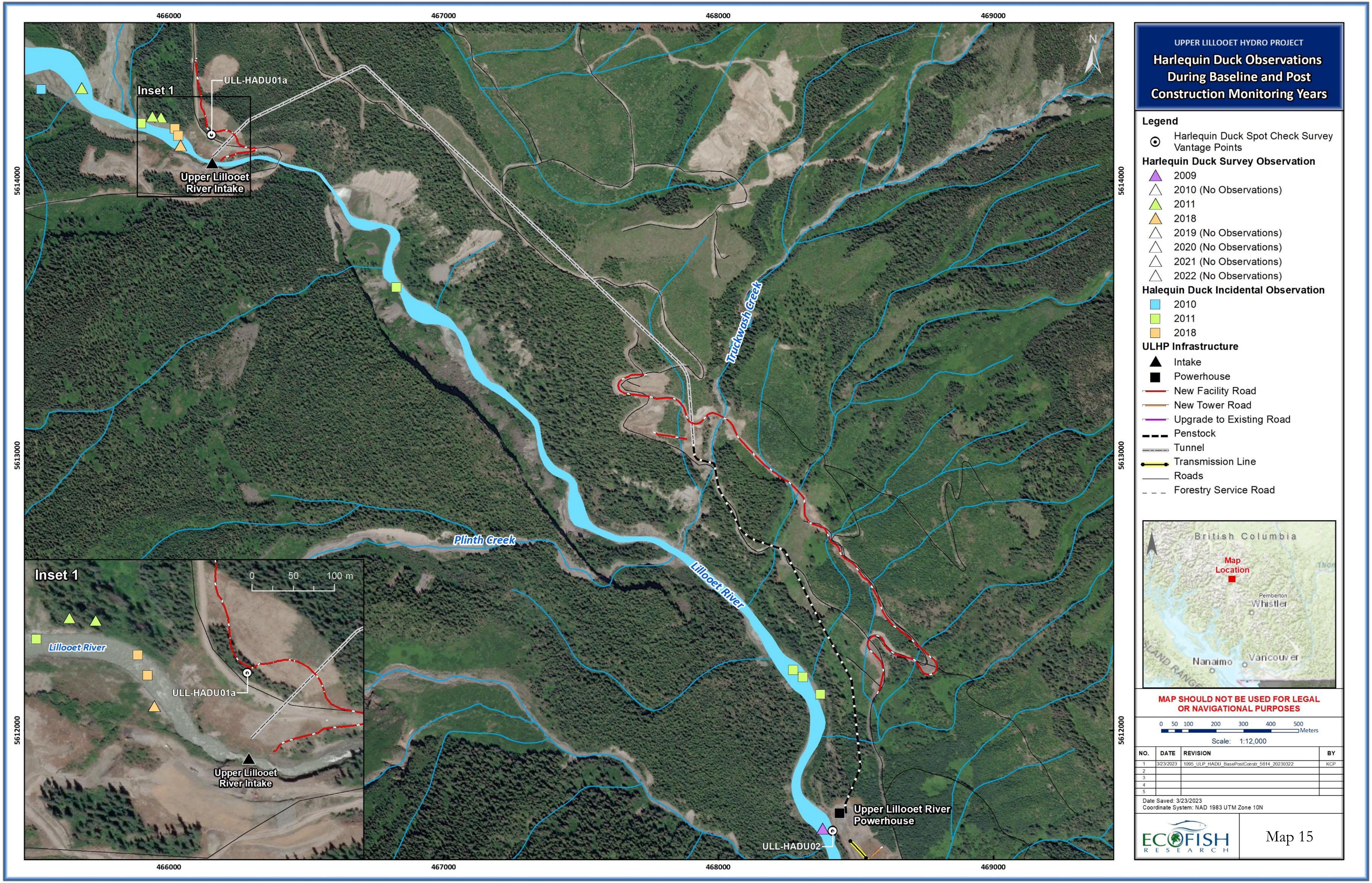

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APPENDICES

Appendix A. Upper Lillooet Hydro Project Revegetation Assessment Report – Year 5

Upper Lillooet Hydro Project
Revegetation Assessment Report for the Operational Environmental Monitoring Plan (OEMP)
Year 5 - 2023 Monitoring Year

Prepared for:
Upper Lillooet River Power Limited Partnership and
Boulder Creek Limited Partnership
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December 1, 2023

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Codie Johnston, RFT #2007

Michael Hedberg RPF #2912

Senior Review

Disclaimer:

Chartwell Resource Group Ltd. (CRGL) prepared this report for Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership. The material within reflects the professional judgment of Chartwell Resource Group in light of the information available to Chartwell Resource Group at the time of report preparation. Judgment has been applied in developing the recommendations in this report. No other warranty is made, either expressed or implied to our clients, third parties, and any regulatory agencies that may be impacted by the recommendations. Any use which a Third Party makes of this report, or any reliance on decisions based on it, is the responsibility of such Third Parties. Chartwell Resource Group accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

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1. Introduction

The Upper Lillooet Hydro Project (ULHP) is owned and operated by the Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership (collectively, the Partnerships). The project is comprised of two run-of-river hydroelectric facilities, the largest of which is located on the mainstem of the Upper Lillooet River, with a subsequent facility located on Boulder Creek. The two partnerships share a transmission line that is linked to the Rutherford substation.

As a stipulation of the Project's Conditional Water License, Environmental Assessment Certificate, General Wildlife Measure Exemption Approval and *Fisheries Act* Authorization, an Operational Environmental Management Plan (OEMP) was finalized in March 2017 (Harwood et al, 2017) and amended in 2018. One of the requirements of the OEMP was to complete long-term vegetation monitoring of all sites that were disturbed and rehabilitated following project construction.

Chartwell Resource Group Ltd. (CRGL) was being retained by the Partnerships to complete the vegetation monitoring requirements of the OEMP. The requirements pertaining to revegetation works are described in Section 3.3 of the OEMP and are the basis for the works described in this report (see also Section 2 below).

This report summarizes the results of the revegetation assessment program for the 2023 monitoring year (Year 5 - 2023).

This report contains the following sections:

- the scope of the revegetation monitoring program (Section 2)
- a summary of source documents pertaining to restoration works (Section 3)
- the objectives of the revegetation program (Section 4)
- the 2023 data collection methods and field program details (Section 5)
- the results of the data collection from the 2023 monitoring program (Section 6)

2. Scope of the Revegetation Monitoring Program

The scope of work for the 2023 (Year 5) revegetation monitoring program has followed the requirements of the OEMP (Harwood *et al.*, 2017). This includes the data collection, analysis, and reporting of Section 3.3 "Vegetation Monitoring Requirements" of the OEMP. This report summarizes and compares the data collected in 2018 (Year 1 of the OEMP program) and 2020 (Year 3 of the OEMP program) to the data collected in 2023 (year 5 of the OEMP program).

Monitoring for the 2018,2020, and 2023 programs were conducted throughout two types of revegetation sites: transmission line sites and civil works sites. This will be discussed in greater detail below. The scope of work for this report includes the data collection, analysis and reporting of the following components outlined in Section 3.2.1 Habitat Restoration and Section 3.3 Vegetation Monitoring Requirement of the ULHP OEMP (Harwood et al, 2017):

- Section 3.3 - Vegetation Monitoring Requirements (including Table 27 and 28)
    - Vegetation Restoration Monitoring
    - Invasive Plant Monitoring
- Subcomponent of Section 3.2.1.3 - Wildlife Habitat Restoration, specifically the requirement to ensure the following:
    - Grizzly Bear habitat (subcomponent of Table 14 & 20)
        - At least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs (Appendix A of the OEMP);
        - temporary roads or access tracks within WHA 2-399 are deactivated and non-drivable with an ATV.
    - Moose habitat (subcomponent of Table 14 & 21)
        - At least 50% of the planted stems within the revegetated portion of the Moose UWR, away from road verges, are preferred Moose forage species (Appendix A of the OEMP).
    - Mule Deer habitat (subcomponent of Table 14 & 22)
        - Revegetated portion of the Deer UWR were planted with native species.

Note: Other vegetation and/or habitat restoration assessments such as Aquatic and Riparian Habitat (Revegetation Assessment) (Section 2.3 of the OEMP) and the larger Wildlife Habitat Restoration (Section 3.2 of the OEMP), except for what is noted above, are outside the scope of this report.

The OEMP (Harwood *et al*., 2017) requires that vegetation and invasive plants be monitored annually for the first five years of the Project, except for riparian vegetation monitoring, which is only required in Years 1, 3 and 5. A revised OEMP recommended reducing the frequency of the non-riparian vegetation monitoring and invasive plants to match the frequency of the riparian vegetation monitoring (i.e. Years 1, 3 and 5 instead of Years 1 through 5) in their letter titled "Upper Lillooet Hydro Project Updated Operational Environmental Monitoring Plan" (Faulkner *et al*. 2018). Specifically, the letter states the following regarding the proposed change to vegetation monitoring frequency:

"This change is recommended based on our monitoring of revegetation succession on similar projects and the observation that progress does not change substantially in a single year. Monitoring revegetation success can therefore be effectively determined by monitoring in the beginning, middle and end of a monitoring program." Furthermore, "frequency and/or duration of vegetation restoration monitoring will vary depending on revegetation success. Hence, if concerns are identified additional monitoring and/or management actions may be required" (Faulkner et al. 2018, p 10-11). Similar to the vegetation restoration component, Ecofish also recommends changing the frequency of "the invasive plants monitoring program [to] years 1,3, and 5 concurrent with the vegetation restoration component" (Faulkner et al. 2018, p. 11).

The letter along with a revised version of the OEMP (dated February 8, 2018) was submitted to MFLNRORD for review in February, 2018 and approval to reduce the frequency of monitoring was received by MFLNRORD on Sept 26, 2019 (T. Katamay-Smith).

3. Revegetation/ Restoration Works Source Documents

Revegetation and restoration work for the ULHP were completed between 2016 and 2018 by the subcontractors for the ULHP civil works and transmission line by CRT-ebc and Westpark Electric Ltd., respectively, as well as by the Partnerships. In general, restoration works consisted of a variety of treatments including soil rehabilitation/ decompaction, topsoil replacement, slope re-contouring, coarse woody debris placement, grass seeding and replanting with a variety of shrub and/or trees. This report does not detail the restoration measures that have been implemented, but for reference, restoration works, and post-revegetation inspections can be found in the following reports:

- Upper Lillooet Hydro Master Reclamation Work Plan, BC unpublished report prepared for Ian McKeachie, Environmental Manager, CRT-EBC Construction, Upper Lillooet Hydro Project (McKeachie, 2016)
- Restoration Progress at Upper Lillooet Power Project (Polster, 2016)
- Works Plan for Transmission Line Access Roads Deactivation and Rehabilitation - North Zone, March 10, 2016 (Barker & Guilbride 2016)
- Works Plan for Transmission Line Access Roads Deactivation and Rehabilitation - South Zone (Barker & Guilbride 2016)
- Memorandum prepared for Julia Mancinelli by Sartori Environmental, October 27, 2017, Re: Final Update on the Status of Reclamation Efforts (Sartori 2017)
- Memorandum prepared for Robert Taylor, Westpark Electric Ltd. October 13, 2017, Re: Inspection of completed deactivation and rehabilitation works, Upper Lillooet Power Project transmission line, North Zone (Guilbride 2017)
- Memorandum prepared for Robert Taylor, Westpark Electric Ltd. August 7, 2017, Re: Inspection of completed deactivation and rehabilitation works, Upper Lillooet Power Project transmission line, North Zone (Guilbride 2017)
- Memorandum prepared for Robert Taylor, Westpark Electric Ltd. October 3, 2017, Re: Inspection of completed deactivation and rehabilitation works, Upper Lillooet Power Project transmission line, South Zone (Guilbride 2017)
- Memorandum prepared for Tanya Katamay-Smith, the Partnerships. March 26, 2019, Re: Reforestation summary of October 2018 tree planting for civil works sites at the Upper Lillooet Hydroelectric Project (Barker 2019)

4. Objectives of Revegetation Program

4.1 Long-term Revegetation Goals

As per Section 3.3 of the OEMP, the objectives of the long-term vegetation monitoring program are to “qualify and quantify the re-growth of vegetation in terrestrial and riparian areas to mitigate the short-term habitat loss and to prevent the introduction of invasive species that may occur through site disturbance” (Harwood et al. 2017).

An additional project objective is:

“to assist the recovery of disturbed areas towards reaching a desired future condition that is self-sustaining and capable of supporting soils, soil function and vegetation communities and processes similar to the adjacent undeveloped areas with no subsequent management inputs required” (Soil Salvage, Site Reclamation and Landscape Restoration Plan, Barker 2012).

Lastly, during the Environmental Assessment process, it was identified that the ULHP will affect forest resource values, and in this case, the Timber Harvesting Land Base (Hedberg Associates, 2011). To minimize the loss of mature timber due to the construction of the ULHP hydro electric project, it was identified in the forestry baseline assessment that reforestation plans would be developed to return the land base, wherever practicable, “*similar to the adjacent undeveloped areas*” by replanting with coniferous species or mixed forests to achieve forest objectives.

This monitoring program was designed to ensure that the revegetation/ reforestation goals outlined in the OEMP are met. It is designed in accordance with the OEMP and all ULHP related documentation.

4.2 Short-term Revegetation Goals

In the first 5 years following planting, during the OEMP monitoring period, the goal is to have a diverse and well-established population of natural and planted herb, shrub, and tree species. The community is expected to begin with relatively few pioneering plant species that will develop an increasing complexity, until it becomes stable or self-sustaining over time.

A successfully restored site shall consist of vigorous and healthy plant communities, that contain diversity of herb, shrub, and tree species. Additionally, site indicators such as a stable slope shape, the presence of coarse woody debris of various sizes, and no siltation or major erosion issues will be used to assess the success of the restoration efforts.

Following the implementation of the revegetation treatment in combination with natural recovery processes, it is expected that the following will occur over the next decade:

- Continued growth and infill of planted and naturally seeded vegetation.
- Continued soil development, as well an increase in the soil's moisture holding capacity.
- Restoration of wildlife habitat that will provide wildlife forage areas, and thermal cover areas; and
- Increased habitat connectivity between adjacent undisturbed areas and treated areas.

4.3 Site-specific Revegetation Goals

As mentioned above, there are some additional project specific OEMP requirements (Harwood et al. 2017) and includes:

1. At least 50% of the planted stems within the revegetated portion of the grizzly bear Wildlife Habitat Area (WHA) 2-399 are native fruit bearing shrubs.
2. Temporary roads or access tracks within WHA 2-399 are deactivated and non-drivable with an ATV.
3. At least 50% of the planted stems within the revegetated portion of the moose Ungulate Winter Range (UWR), away from road verges, are preferred moose forage species.
4. The revegetated portion of the deer UWR are planted with native species.

5. 2023 Revegetation Monitoring Program and Data Collection Methods

To evaluate the areas that were revegetated and restored by the Partnerships or their subcontractors, revegetation monitoring plots were permanently established throughout the treated areas. The treated areas consist of both the civil works sites and transmission line sites. On the transmission line sites, the post-construction revegetation works were completed prior to the initial 2018 survey; however, throughout the civil works sites, most sites were planted with additional conifers in October 2018.

Plot data collection and reporting methods were adapted from the BC silviculture stocking procedure – FS658. Each permanent plot area that was surveyed measured 3.99 m in radius, representing a total area of 50 m^2. Plots were pre-selected using a random GPS grid to avoid surveyor bias. See the maps in Appendix A for permanent monitoring plot locations. Each site had a minimum of 1 plot per hectare.

Within each plot, the surveyors counted the number of stems of each species of native perennial woody plant species. Perennially woody plant species include both shrubs and trees but excludes herbs and mosses. Each plant was identified and input into a computer program called "SNAP". Shrub and tree density values are then calculated in the office based on the number of live stems counted for each species multiplied over the given area.

No division was made between trees and/ or shrubs that were planted as opposed to those regenerated naturally; all planted, and naturally regenerated species were counted in the same tally to measure overall vegetation growth. For accuracy and for repeatability of the process between years, stems were counted, as opposed to individual plants. Only stems that were rooted immediately adjacent to the soil surface were counted, as opposed to counting individual plants species with multiple stems. Individual shrubs are difficult to identify in the early phases of growth, as many shrubs have multiple stems from the soil surface interface (e.g. falsebox (*Paxistima myrsinites)*, salal *(Gaultheria shallon),* and many shrubs in the raspberry family (*Rubus spp.*)). Only live stems were counted in each plot in Year 1 (2018), Year 3 (2020), and Year 5 (2023). Where present invasive species were identified and recorded at each plot. Invasive species and treatments are discussed in Section 6.5 of this report.

A combination of professional judgement and the quantifiable results of the data collected throughout the 5 years of revegetation monitoring was utilized to determine if revegetation objectives have been met in Year 5, the final year of monitoring. The results of the revegetation project will be described in Sections 6 of this document.

For areas greater than one ha, one plot/ha was used to evaluate a given site (sites have been also been referred to as "stratums" throughout the data collection cards in Appendix B,C and D. These two words can be used interchangeably for the remainder of this report.) A minimum of one plot per site was established on sites smaller than one hectare (ha). Each fixed radius plot measured 3.99 m in radius or 50 m^2 in area. Plots were established at sites that will not be subject to future vegetation management efforts (i.e. areas outside of the limits of approach of the transmission line) to represent areas that will remain stable throughout all the monitoring years.

The monitoring used to evaluate the growth and survivorship of the natural and planted vegetation was achieved through three approaches:

1. sampling of permanent revegetation monitoring plots to quantify the stem densities of trees and shrubs.
2. placing quadrats to assess the percentage of vegetation ground cover in each layer (herb, shrub, and tree layer); and
3. comparison of photographs taken at a similar angle and location to qualitatively document changes in vegetation and site conditions over time.

Additional information collected at each monitoring plot and inspection site included descriptions of:

- erosion or siltation issues;
- coarse woody debris presence;
- whether wildlife-specific requirements were being met;

evidence of disease or damage to

- plants;
- evidence of moss growth as an indicator of soil development processes; and
- invasive species presence.

All plots were monitored as summarize above, however there were a few exceptions. For very small road spurs (less than 0.4 hectares) that had high levels of early revegetation success, inspection points were taken as opposed to setting up permanent monitoring plots. Typically, these exceptions were along spur roads where no major clearing efforts occurred, but rather a low impact machine (small excavator with wheels as opposed to tracks) was used to access the transmission line pole. This resulted in very low overall impacts to soils and/or existing plants on those areas. The inspection sites were revisited in 2023 and all have continued to increase in diversity and stems per hectare. Many of the sites have completely recovered and are no longer identifiable as access points.

On the rare occasion that a plot could not be found the plot was not reestablished. The GPS equipment used for the sake of these surveys are not precise enough to give an accurate plot center. Thus, it was determined that it would be inaccurate to collect data in a new spot as the data could not be replicated in previous years if the location had changed.

5.1 Revegetation Targets

5.1.1 Success Targets for Stem Densities

Stem density measurements were collected at the revised frequency proposed by Faulkner et al. (2018): Years 1, 3 and 5. The data collected regarding the density of each perennial woody species found will contribute the following critical information to the program:

1. Whether perennial woody species (shrubs and trees) are becoming more dense or less dense over time.
    a. The ULHP site is characterized by a Coastal Western hemlock biogeoclimactic zone with moderate soil moisture and nutrients, in sites such as these, it is typical that shrub growth will increase rapidly over the first few years but may decrease once the later successional species start to take hold at the site. The planted and natural plant species present at the ULHP sites exhibit tree growth that is often slower than shrub growth. Additionally, both tree and shrub species can be expected to increase in density in the 5-20 years after disturbance.. In the first few years, it one would expect to see a high rate of conifer natural regeneration, but typically by 5 years, small conifer seedlings will start to establish. It is expected that this site will follow a similar pattern, beginning with the rapid establishment of early successional shrub species, that will give way to the less rapid succession of conifer species, or other naturally occurring tree species. Monitoring of perennial wood species will provide insight into restoration success in addition to providing

evidence that can further inform additional management that may be needed to ensure that all restorative obligations are being fulfilled.

2. A list of the number and type of species found at each site.
    a. The number and type of species present at each site throughout the course of the restoration process can be used to quantitate the site's plant species diversity as well as any changes in diversity that may occur throughout the course of the monitoring project. Additionally, a high amount of species diversity indicates a more resilient and ecologically productive plant community. A successful restoration effort will be characterized by a diverse plot that increases or maintains consistent amounts of species diversity throughout the course of the 5-year study.

The following stem density comparisons will be included:

1. increase or decrease in shrubs and deciduous tree species densities.
2. increase or decrease in conifer tree species densities.
3. the total number of species found.
4. the types of species found in each year (seral stage and climax species)

5.1.1.1 Shrubs and Deciduous Trees (Density Targets)

Because ideal shrub and deciduous tree densities will vary throughout the course of the monitoring project, no quantitative stem density targets are recommended. However, it is important that shrub and deciduous tree densities be monitored. This is because the desired end goal for this variable is not linear, sites can be healthy at a variety of stem densities. In some stages of site regeneration, it may be desirable for areas to become denser, while at later stages, less dense sites are preferred. In addition, quantitative targets do not account for variation in site specific biotic and abiotic variables. Instead, it is recommended that a site-specific approach be used to assess the appropriate density at each site. Each site will be assessed on a site-by-site basis to understand site trends and dynamics. Using this information, a Qualified Professional will determine on a site-specific basis whether treatments are required to meet overall project goals. Results from previous long-term vegetation monitoring programs have shown that using professional judgement is a valuable method of incorporating a dynamic and broad range of health factors when assessing vegetation establishment.

5.1.1.2 Conifer Tree Species (Density Targets)

For the conifer tree component, the recommended density target will be 1,000 stems per hectare (sph). Most sites were planted at densities above 1,000 sph due to anticipated mortality. Final densities are expected to vary from site to site as survival rates will differ along with natural ingress, and initial planted densities. These densities have been recommended by the Registered Professional Forester (Wes Staven, RPF) assigned to this project. This target was informed by the ecology of the area, the bio geoclimatic zone, results observed throughout similar project and additional site-specific variables.

5.2 Percentage of Vegetation Cover Estimate (Quadrat monitoring)

For this project, total percentage of ground cover was measured by plant layer: tree, shrub, and herb layer. To collect this metric, the surveyor placed a 1 by 1 m quadrat (a square frame with measured gradations) on the ground surface to measure the percentage of ground cover that is occupied by a given plant layer (herb, shrub, and tree layer). Herb is a general term that includes any forb (non woody plants with broader leaves and distinct flowers), ferns and fern allies, grasses, and sedges. The quadrat was marked at regular intervals; each square of the quadrat represented 1% of the total area. In this case, each 10cm by 10cm of marked off area represented 1% of the total quadrat. For example, if there were five squares covered by shrub species (3% of ground covered by thimbleberry and 2% of falsebox), then the surveyor would note that there was 5% cover in the shrub layer. This data was then input into the "SNAP" program on the iPad.

Two quadrat surveys were taken at each site. Each quadrat was placed on the north and east axis of the plot, 2.0 m away from the plot centre to avoid bias and increase repeatability between years. Each plant layer was grouped and measured as one unit. The layers are identified as 1) the herb layer, 2) the shrub layer and 3) the tree layer.

The average height for every species within each category (tree/shrub/herb) was completed through in-plot measurements of identified species.

Where present, total ground cover occupancy by moss species also was noted. For the moss layer an ocular estimate of total ground cover was completed. The cover attributed to moss does not contribute to the total cover calculations, rather it's provided to present evidence of ongoing soil development processes.

5.2.1 Success Targets for Percent Vegetation Cover

The percent vegetation cover is measured by quantifying the percentage of ground cover of the late successional species (shrubs and trees) in each quadrat survey. Success will be characterized by a steady increase of late successional species throughout the monitoring period, that may reach a steady state in which late successional species will not be increasing or declining over time. Collecting percentage vegetation cover by layer will provide valuable data that can demonstrate that ecological succession processes are being carried out successfully. Growth trends for the later successional species will be used as the target as they are string indicators of productive succession.

Targets for this measure will be met if the trend in each subsequent monitoring year for the shrub and tree layer is greater or equal to the previous monitoring year's percentage cover. If the trend is that the percent cover for the later successional species amounts are declining, then additional remedial measures will be considered.

5.3 Inspection Points

As explained in Section 5, for very small road spurs (less than 0.4 hectares) that had high levels of early revegetation success, inspection points were taken as opposed to setting up permanent monitoring plots. At each inspection point, the following data was collected:

- health and vigour of plant communities;
- erosion or siltation issues;
- coarse woody debris presence;
- notes on whether wildlife specific requirements were being met;
- evidence disease or damage to plants;
- evidence of moss growth as an indicator of soil development processes; and
- invasive species presence.

5.3.1 Success Targets for Inspection Points

Successful rehabilitation for each inspection point is defined in this report as a site that requires no further treatment to sustain plant growth and meet the long-term objectives of the OEMP and all project documentation. This will be based on qualitative observations of the data collected at each site (Section 5.3 above) and professional judgement of the surveyor.

5.4 Wildlife Specific Revegetation Requirements

As part of this monitoring program, there were additional wildlife-specific requirements associated with the revegetation program. The method used to evaluate compliance with the wildlife specific requirements included a field visit to each site located within designated Wildlife Habitat Areas (WHAs) and Ungulate Winter Ranges (UWR) and consisted of at least 1 visual plot per hectare. The visual plot entailed an ocular estimate that evaluated compliance within an area the size of a 3.99 m fixed radius plot. The plot was then assessed for compliance with the wildlife specific targets discussed below.

It is important to note that for the deer and moose UWRs, most sites were under the transmission line and will be subject to future vegetation management efforts. Those sites were visited even if they were under the transmission line to evaluate compliance, however, to maintain line security, those sites will be subject to alterations (e.g. thinning, pruning, tree felling, etc.) in the future. The sites found within grizzly bear WHA 2-399 were located adjacent to the forest service road (Upper Lillooet FSR South) and were evaluated for compliance with OEMP requirements; although, berry bushes were not planted within the 5m vegetative screen around all active roads, prescribed by the Grizzly Bear Suitable Habitat Verification Areas Overlapping the Upper Lillooet Hydro Project Infrastructure and Ancillary Components Memorandum, as the berry shrubs planted presented a high risk of attracting Grizzy bears to roadside areas (OEMP, 2018). This was done in an effort to mitigate human disturbances caused by the viewsheds and soundscapes around to roads, as well as the risk imposed by cars if bears do enter roadways. This will be discussed further in Results: Section 6.3.8 and 6.3.15 below. It is important to note that these areas are expected to be colonized by many native berry shrubs as a result of natural succession, however no efforts were made to plant additional berry shrubs as it was deemed potentially hazardous and disruptive to the bears.

5.4.1 Success Targets within Grizzly Bear Wildlife Habitat Areas (WHA)

Within Grizzly Bear Wildlife Habitat Area (WHA 2-399), as mentioned above, the requirement is as follows: "*at least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs*" (Appendix A of the Long-Term Monitoring Program Report (OEMP)). This will be measured in each monitoring year (years 1, 3 and 5) to ensure that the fruit-bearing shrub component for each revegetated portion on any upland areas meets or exceeds this requirement. Additionally, temporary roads or access tracks within WHA 2-399 are required to be deactivated and non-drivable with an ATV. See Section 6.3.5 for the 2023 results.

5.4.2 Success Targets within Moose Ungulate Winter Range (UWR)

Within moose UWR, as per the OEMP, the following success target will be used within government established moose habitat: that "*at least 50% of the planted stems within the revegetated portion of the Moose Ungulate Winter Range (UWR) away from road verges, are preferred moose forage species*" (Appendix A of the OEMP). This requirement was field verified by the Surveyor in Year 1 and does not require future monitoring because it is a planting requirement not a long-term monitoring requirement.

5.4.3 Success Targets within Deer Ungulate Winter Range (UWR)

Within deer UWR, any revegetated portions of Deer Ungulate Winter Range will be measured for the following success target, that "the revegetated portion of the Deer UWR were planted with native species" (Appendix A of the OEMP). This was an ocular estimate carried out in the initial monitoring year (Year 1) to determine if this target has been met. This requirement was field verified by the Surveyor in Year 1 and does not require future monitoring because it is a planting requirement not a long-term monitoring requirement.

6. Results

The 2023 monitoring program was carried out by team lead Codie Johnston RFT. Codie Johnston is a BC Certified Accredited Silviculture Surveyor #AA2006008 with 17 years of plant identification experience. Other staff members of Chartwell Resource Group who worked on the data collection phase of the project are Brieanna Van Loon and Savanna Dayton. Brieanna is a Certified Accredited Silviculture Surveyor #AA202256 and has 5 years of plant identification experience. Savanna Dayton has 2 years of plant identification experience. Both Brieanna and Savanna's roles included the identification of conifer, deciduous, shrub and herbaceous species as well as collecting percent cover of trees, shrubs and herbs in the quadrat surveys. When Brieanna and Savanna were available to collect field data they worked as a team with Codie Johnston. The fieldwork for the 2023 monitoring program was carried out in September and October of 2023.

In 2023 an issue arose with SNAP! after an automatic update was released to ensure that the app was compatible with iOS17 that impacted the behavior of the app on any devices with iOS16 or later. SNAP! informed CRGL that they were not aware of the issues when the update was released. This caused multiple issues; however, the survey was only affected by a photo processing error within SNAP! that caused photos to be both under and over exposed. Despite efforts to correct the photo processing errors it can be noted that the 2023 photos remain compromised.

The civil works site plot data collected in Year 5 (2023) has been separated into two categories. The first category includes all sites that had permanent sample plots established in 2018. Data for these sites was collected in Year 1 (2018), Year 3 (2020), and Year 5 (2023). This data set is further separated by zones (see Appendix A: Maps of Project Revegetation Sites). At the end of each zone summary are photos from 2018, 2020 and 2023 taken at each plot to show visual vegetation changes on the site. Plot data tables are also included, that compare the vegetation density (by stems per hectare) onsite in 2018, 2020 and in 2023. The tables display coniferous, deciduous and shrub diversity as well as the number of species present in the three monitoring years.

The second category includes all the sites that were planted in the fall of 2018. Permanent sample plots were established on these sites in 2019 and 2020. In 2019 survey data was collected to assess seedling survival one year after planting. These sites are summarized separately as a complete data set was collected in 2020 and 2023.

6.1 Results for Civil Works Sites with 2018, 2020 and 2023 Data

6.1.1 Zone 1 Results Summary

Zone 1 includes two sites - the 36 Km Borrow Pit and the Boulder Powerhouse, Spoil and Operators Residence. The 36 Km Borrow Pit and part of the Boulder Powerhouse sites were planted in 2017 with a mix of conifers and shrubs. The Boulder Powerhouse Spoil area in front of the operator's residence was planted in the fall of 2018. A second plot was established here in 2020 and is summarized with the civil works sites that were established in 2020.

The 36 km Borrow Pit:

The 36 km Borrow Pit is located on a gentle slope with sandy soils that are not too compact. The soils were fluffed up and coarse woody debris was scattered across the site. The area was planted with a mix of conifers in 2017. In 2018 there were 800 sph of Douglas fir growing onsite. Other conifer species were noticed when walking through the site, but they were not picked up in our long-term monitoring plot. The number of Douglas fir increased to 1,200 sph in 2020 but decreased to 1,000 sph in 2023. There are two possible reasons for the decrease in Douglas fir sph. The first reason was that some Douglas fir were germinates in 2020 and did not survive. The second reason is that the increase in the number and size of hardwood stems resulted in competition for light, moisture, and nutrients that young Douglas fir could not withstand. Additionally, the irregularly dry and hot summers between 2020-2023 must be considered as a source of added stress that may have inhibited successful establishment while also exacerbating any competition for limited resources such as moisture. The planted and natural conifers that have successfully established are of good form and vigour and are free from any forest health concerns. The planted and natural Douglas fir ranged from 40 to 70 cm, as opposed to an average height of 35 cm in 2020. The number of deciduous sph increased from 2,200 sph in 2018 to 9,600 sph in 2020 and then up to 10,000 sph in 2023. The deciduous trees are growing vigorously onsite and are competing with the conifers but are currently not supressing them. In 2018 200 sph of shrub species were found in the plot. In 2020 this number increased to 600, and in 2023 the number of shrubs per ha decreased to 400 sph.

This site meets the target of 1,000 sph of conifers and the increase in sph of deciduous species indicates the site is successfully recovering. The reduction in shrubs is attributed to the increase in density and crown closure from the conifers and hardwood stems, which outcompete the shrubs in available sunlight, moisture, and nutrients. Moss cover is developing and is dependent on microtopography but will likely continue to increase. No evidence of erosion or siltation was noted.

The Boulder Powerhouse, Spoil and Operators Residence site:

The Boulder Powerhouse, Spoil and Operators Residence site has coarse gravel soils and is well drained. The original area, adjacent to the powerhouse, was planted with a mix of berry shrubs and conifers in 2017. When the operator's residence was built in 2018 further civil works were required, and the size of the site was increased to accommodate the building activities. Both areas were planted with conifers in 2018. The number of conifers has increased from 600 sph in 2018 to 7,000 in 2020 and has decreased to 6,000 sph in 2023. There has been lots of natural conifer ingress on this site from the adjacent mature stands and it is likely that some of the smallest conifer seedlings died out. The number of black cottonwoods sph has increased from zero in 2018 to 24,000 in 2020 and has almost decreased by half in 2023 down to 10,400 sph. Many of these trees are still very small at less than 10 cm in height. The cottonwoods are currently not impeding conifer establishment. The number of sph of shrubs and species diversity has increased significantly on this site. In 2018 there were 1,000 sph and three species of shrubs present. In 2020 there were 11,400 sph and six species of shrubs. The number of shrub species has remained the same from 2020 to 2023 but the number of sph had decreased slightly. Red raspberry and thimbleberry had the greatest increase in number of sph but have remained stable since 2020. Moss cover is developing and is dependent on microtopography but will likely continue to increase. No evidence of erosion or siltation was noted. This site continues to meet the target of 1,000 sph of conifers and increases in sph of deciduous species indicates the site is successfully recovering.

Figure 1 depicts the pictures taken at each site within Zone 1. Table 1 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Civil Work
Stratum: 2018 36Km Borrow Pit/Plot: S/Comments
Overview photo looks South towards plot center. Oct 16, 2018 11.58.04 AM.jpg

Card: Civil Work
Stratum: 2020 36 Km Borrow Pit/Plot: S/Comments
Overview photo looks South from plot S.jpg

Card: Civil Works Sites
Stratum: 36 Km Borrow Pit/Plot: S/Plot Name
Overview photo looks South from plot S.jpeg

Figure 1A. Zone 1: 36 Km Borrow Pit Plot S Photos from 2018, 2020 and 2023

Card: Civil Work
Stratum: 2018 Boulder Powerhouse and Spoil/Plot: Q/Comments
Overview photo looks South towards plot center. Oct 15, 2018 12.07.35 PM.jpg

Card: Civil Work
Stratum: 2020 Boulder Powerhouse and Spoil/Plot: Q/Comments
Overview photo looks South from plot Q.jpg

Card: Civil Works Sites
Stratum: 2023 Boulder Powerhouse and Spoil/Plot: Q/Plot Name
Overview photo looks South from plot Q.jpeg

Figure 2B. Zone 1: Boulder Powerhouse and Spoil Plot Q Photos from 2018, 2020 and 2023

Table 1. Zone 1 – Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Douglas fir			Lodgepole Pine			Western Hemlock			Western Red Ceder			Western White Pine			Target SPH	**Total SPH Conifers**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023		**2018**	**2020**	**2023**
36 Km Borrow Pit	0.5	1	800	1,200	1,000	0	0	0	0	0	0	0	0	0	0	0	0	1000	**800**	**1,200**	**1,000**
Boulder Powerhouse and Spoil/ Operators residence	1.4	1	0	5,200	4,100	0	600	1,000	200	600	500	400	400	200	0	200	200	1000	**600**	**7,000**	**6,000**

Deciduous Diversity from Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood			Red Alder			**Total SPH Deciduous**		
			2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
36 Km Borrow Pit	0.5	1	1,800	9,200	9,600	400	400	400	**2,200**	**9,600**	**10,000**
Boulder Powerhouse and Spoil/ Operators residence	1.4	1	0	24,000	10,400	0	0	0	**0**	**24,000**	**10,400**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Falsebox			Kinnikinnick			Red Osier Dogwood			Red Raspberry			Sitka Mountain-Ash			Thimbleberry		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
36 Km Borrow Pit	0.5	1	0	400	200	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0
Boulder Powerhouse and Spoil/ Operators residence	1.4	1	0	800	700	200	200	0	200	200	100	400	7,200	7,400	0	0	0	400	2,800	2,600

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Vaccinium Species			Willow			Blackcap Raspberry			False Azelea			**Total SPH Shrubs**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
36 Km Borrow Pit	0.5	1	200	0	0	0	0	200	200	0	0	200	0	0	**200**	**600**	**400**
Boulder Powerhouse and Spoil/ Operators residence	1.4	1	0	0	0	0	200	0	0	0	200	0	0	100	**1,000**	**11,400**	**11,100**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
36 Km Borrow Pit	1	1	1	2	2	2	1	2	2	**4**	**5**	**5**
Boulder Powerhouse and Spoil/ Operators residence	2	5	5	0	1	1	3	6	5	**5**	**12**	**11**

6.1.2 Zone 2 Results Summary

Zone 2 includes two sites - Boulder Spoil #2 and the Explosive Magazine.

Boulder Spoil #2:

Boulder Spoil #2 is located on a steep slope with compact soils and numerous rocky patches. This site is difficult to reforest due to compact soils. The site was planted in 2017 and had poor survival of the planted conifers and shrubs. The target of 1,000 sph for conifers has not been met at this site and is not expected to be met in the immediate future. The number of conifers increased slightly from 2018 to 2020, increasing from zero to 100 conifer sph but had reduced back to zero in 2023. The Douglas fir mostly likely succumbed to drought mortality during the 2021 heat dome as no evidence of a dead conifer was found. There are no deciduous species growing in the plot. The number of shrubs per ha has decreased from 2020 to 2023. The diversity of the site has remained stable and shrub cover is expected to increase as the established shrubs continue to grow in size. Grass cover and moss cover has also increased.

Replanting this site is not recommended due to the sites limiting soils and topography. Large boulders and limited soil were compacted and contoured by machinery to create a stable slope below the active Boulder Intake Road. The slope side is rapidly draining in addition to being located on a hot southern slope that further limits the restorative capacity of this site. Conifer ingress may increase over time as the shrub and herbaceous species add more biomass to the soils and shade to the site. Adjacent to the site there are live mature Douglas fir and Western hemlock that will provide a viable seed source. Despite steep slopes and compact soils no erosion or siltation was noted on this site.

Explosive Magazine:

The Explosive Magazine site is one of the more natural looking sites. A good mix of mineral soil and organics has created an ideal growing medium for all the species on site. This area was planted at a low density of 600 sph in 2018 as it was accidentally planted in 2017 by the Ministry of Forests, Lands and Natural Resource Operations and Rural Development (MFLNRORD) during their reforestation project of the Boulder Creek fire. Species diversity and total number of sph had increased from 2020 to 2023. There is some fluctuation on the total sph for this site, but overall, the density and diversity continue to increase. All conifers are growing well, and the plots are free of any forest health concerns or pests. Outside of the plots, approximately 20 Douglas fir had vole damage, with girdling around the base and up the stem causing mortality of the tree. This damage is not widespread and is not anticipated to be a major issue moving forward. The number of sph of black cottonwood has almost doubled since 2020 while the number of bigleaf maple has decreased and red alder has completely disappeared from the plots. The deciduous component will add to the seral stage diversity of the stand and is increasing inputs of biomass to the soils. Shrub cover in the Explosive Magazine area is high and will remain high until the conifers emerge from the shrub cover and begin to shade them out. Moss cover has increased significantly on this site since 2018. Overall, this site exceeds the revegetation targets for the project and no further revegetation activities are required. No erosion or siltation was noted while on site.

Figure 2 depicts the pictures taken at each site within Zone 2 and Table 2 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Civil Works
Stratum: 2018 Boulder Spoil #2/Plot: K/Comments
Overview photo looks South towards plot center. Sep 26, 2018 12.53.38 PM.jpg

Card: Civil Works
Stratum: 2020 Boulder Spoil #2/Plot: K/Comments
Overview photo looks South from plot K.jpg

Card: Civil Works Sites
Stratum: 2023 Boulder Spoil #2/Plot: K/Plot Name
Overview photo looks South from plot K.jpeg

Figure 3A. Zone 2 Boulder Spoil #2 Plot K Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Boulder Spoil #2/Plot: L/Comments
Overview photo looks South towards plot center. Sep 26, 2018 01.10.41 PM.jpg

Card: Civil Works
Stratum: 2020 Boulder Spoil #2/Plot: L/Comments
Overview photo looks South from plot L.jpg

Card: Civil Works Sites
Stratum: 2023 Boulder Spoil #2/Plot: L/Plot Name
Overview looks S from L.jpeg

Figure 4B. Zone 2 Boulder Spoil #2 Plot L Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 001/Comments
Overview photo looks North towards plot center. Sep 05, 2018 11.22.20 AM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 001/Comments
Overview photo looks South from plot 001.jpg

Card: Civil Works Sites
Stratum: 2023 Explosive Magazine/Plot: 001/Plot Name
Overview photo looks S from 001.jpeg

Figure 5C. Zone 2 Explosive Magazine Plot 001 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 002/Comments
Overview photo looks North towards plot center. Sep 05, 2018 12.20.55 PM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 002/Comments
Overview photo looks South from plot 002.jpg

Card: Civil Works Sites
Stratum: 2023 Explosive Magazine/Plot: 002/Plot Name
Overview photo looks South from plot 002.jpeg

Figure 6D. Zone 2 Plot Explosive Magazine Plot 002 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 003/Comments
Overview photo looks North toward plot center. Sep 05, 2018 11.47.35 AM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 003/Comments
Overview photo looks South from plot 003.jpg

Card: Civil Works Sites
Stratum: 2023 Explosive Magazine/Plot: 003/Plot Name
Overview photo looks S from 001.jpeg

Figure 7E. Zone 2 Plot Explosive Magazine Plot 003 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 004/Comments
Sep 05, 2018 12.02.37 PM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 004/Comments
Overview photo looks South from plot 004.jpg

Card: Civil Works Sites
Stratum: 2023 Explosive Magazine/Plot: 4/Plot Name
IMG20230926113242.jpeg

Figure 8F. Zone 2 Plot Explosive Magazine Plot 4 Photos from 2018, 2020 and 2023

Table 2. Zone 2 – Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Douglas fir			Lodgepole Pine			Western Red Ceder			Target SPH	**Total SPH Conifers**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023		**2018**	**2020**	**2023**
Boulder Spoil #2	1.25	2	0	100	0	0	0	0	0	0	0	1000	**0**	**100**	**0**
Explosive Magazine	2.5	4	400	1,300	1,650	50	100	100	50	250	150	1000	**500**	**1,650**	**1,900**

Deciduous Diversity from Plot Data (SPH)

Site	Area (Ha)	# Plots	Bigleaf Maple			Black Cottonwood			Red Alder			**Total SPH Deciduous**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Boulder Spoil #2	1.25	2	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Explosive Magazine	2.5	4	50	150	50	250	500	900	100	100	0	**400**	**750**	**950**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Ceanothus			Faslebox			Mountain Ash			Red Raspberry			Rose Species		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Boulder Spoil #2	1.25	2	0	0	0	700	900	700	0	0	0	0	0	0	100	200	100
Explosive Magazine	2.5	4	50	100	200	0	0	0	0	0	100	3900	11,650	14,500	0	0	0

Shrub Diversity From Plot Data (SPH) continued

Site	Sitka Alder			Thimbleberry			Vaccinium Species			Willow			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Boulder Spoil #2	0	0	0	1,400	2,000	1,100	0	300	200	0	0	0	**2,200**	**3,400**	**2,100**
Explosive Magazine	0	0	50	2,250	2,150	4,100	0	0	0	8,650	9,050	4,350	**14,850**	**22,950**	**23,300**

Number of Species by Site

Site	Total Number of Coniferous			Total Number of Deciduous			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Boulder Spoil #2	0	1	0	0	0	0	3	4	4	**3**	**5**	**4**
Explosive Magazine	3	3	3	3	3	2	4	4	6	**10**	**10**	**11**

6.1.3 Zone 3 Results Summary

Zone 3 includes two sites - the 41.7 Km Laydown and the Upper Lillooet Penstock. The portion of the laydown located on the West side of the Lillooet River Forest Service Road (FSR) was planted in 2017 with berry shrubs to meet the requirements of the grizzly bear management strategy and was subsequently planted in 2018 with a mix of conifer species. This site had two plots established in 2018, only one of these plots could be found in 2023. A portion of the laydown site located on the East side of the FSR was planted in 2019, in 2020 there was only one year of data collected so this area was discussed in section 6.2 of the 2020 report. The plot data for the East side of the FSR has been included with this dataset to offset the loss of the missing plot. The terrain in this site is mainly flat and was mounded when the site was reclaimed. Soils contain a good mix of mineral and organics. The area currently exceeds the conifer density target of 1,000 sph with a total of 1,650 sph. The planted conifers are of good form and vigour with strong leader growth. Natural ingress of Douglas fir, Western hemlock and yellow cedar continues to establish with heights ranging from 25 to 120cm. Cottonwood numbers continue to increase and add to the biomass and are not out competing the conifers. The diversity of shrub species and corresponding sph has decreased but overall cover of trees and berry shrubs has increased. Moss cover continues to increase and is dependent on microtopography. Moss cover is expected to increase as more shading is created by the growing herbs, shrubs, and trees. This site continues to meet the revegetation targets and no further planting is required. No soil erosion or siltation was noted at the time of the survey. For reference a photo was taken near where plot N should have been located.

The Upper Lillooet Penstock is a long linear site that follows the buried penstock. This area was not planted with trees, however it was planted with shrubs and has no wildlife specific planting requirements. The penstock has good distribution of coarse woody debris and soils are not compacted. Four plots were established in 2018. The plot at the north end of the penstock was partially disturbed since plot data was collected in 2018 (Year 1). The disturbance was caused by machine blading as it is along a right-of-way for the adjacent transmission line, this affected approximately one quarter of the plot. The disturbed area has started to recover, and it was determined that the disturbance was not significant enough to drop the plot from the data set. In 2023 two of the four plots could not be located as the area was used for helicopter staging and wildfire (V31300) fighting efforts, and may have been removed. The number of conifers and species diversity has decreased since 2020 and is likely due to the reduction in plot numbers, decreasing sample size. The number of deciduous stems is less than half of what was counted in 2020. The conifer and deciduous species will eventually need to be manually brushed to protect the integrity of the penstock, which will not be required for another 3 to 6 years. Shrub diversity has remained constant from 2020 to 2023 and the number of sph has increased significantly from 8,850 in 2020 up to 22,900 in 2023 with red raspberry having the largest increase in sph. No erosion or siltation issues were noted during the survey. The moss cover is increasing slowly and is dependent on microtopography. No forest health issues were noted to be affecting any of the species. No further revegetation treatments are required for this site. No soil erosion or siltation was noted at the time of the survey.

Figure 3 depicts the pictures taken at each site within Zone 3 and Table 3 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Civil Works
Stratum: 2018 41.7km Laydown/Plot: M/Comments
Overview photo looks South towards plot center. Sep 26, 2018 02.04.09 PM.jpg

Card: Civil Works
Stratum: 2020 41.7 Km Borrow Pit/Plot: M/Comments
Overview photo looks South from plot M.jpg

Card: Civil Works Sites
Stratum: 2023 41.7 Km Borrow Pit/Plot: M/Plot Name
Overview photo near plot M.jpeg

Figure 9A. Zone 3. 41.7 Km Borrow Pit Plot M Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 41.7km Laydown/Plot: N/Comments Overview photo looks South towards plot center. Sep 26, 2018 02.15.33 PM.jpg

Card: Civil Works
Stratum: 2020 41.7 Km Borrow Pit/Plot: N/Comments Overview photo looks South from plot N.jpg

Card: Civil Works Sites
Stratum: 2023 41.7 Km Borrow Pit/Plot: N/Plot Name Plot N looking south .jpeg

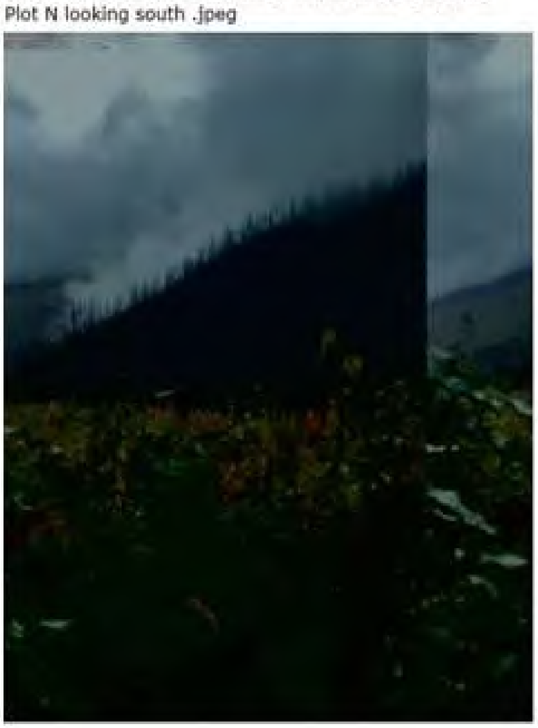


Figure 10B. Zone 3. 41.7 Km Borrow Pit Plot Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Lillooet Penstock/Plot: O/Comments
Overview photo looks South towards plot center. Sep 26, 2018 02.48.28 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Lillooet Penstock/Plot: O/Comments
Overview photo looks South from plot O.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Lillooet Penstock/Plot: O/Plot Name
South on plot O.jpeg

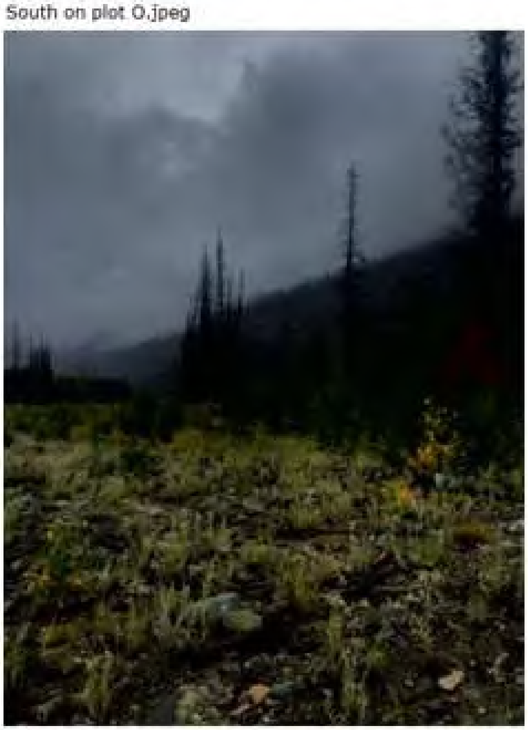


Figure 11C. Zone 3. Upper Lilooet Penstock Plot O Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Lillooet Penstock/Plot: I/Comments
Overview photo looks South towards plot center. Sep 18, 2018 02.11.15 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Lillooet Penstock/Plot: I/Comments
Overview photo looks South from plot I.jpg

Card: Civil Works
Stratum: 2018 Upper Lillooet Penstock/Plot: H/Comments
Overview photo looks South towards plot center. Sep 18, 2018 01.15.06 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Lillooet Penstock/Plot: H/Comments
Overview photo looks South from plot H.jpg

Figure 12D. Zone 3. Upper Lillooet Penstock Plot I and H Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2020 Upper Lillooet Penstock/Plot:
H/Comments
Site has been partially disturbed since 2018.jpg

Figure 13E. Zone 3. Upper Lillooet Penstock Plot H Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Lillooet Penstock/Plot: P/Comments
Overview photo looks South towards plot center. Sep 26, 2018 02.59.52 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Lillooet Penstock/Plot: P/Comments
Overview photo looks South from plot P.jpg

Figure 14F. Zone 3 . Upper Lillooer Penstock Plot P Photos from 2018, 2020 and 2023

Table 3. Zone 3 - Vegetation Density and Species Diversity from 2018 to 2023

Conifer Diversity From Plot Data

Site	Area (Ha)	# Plots	Douglas fir			Spruce			Western Red Ceder			Western White Pine		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
41.7 Km Laydown	1.1	2	0	1,300	1,350	0	600	150	0	0	50	0	0	0
Upper Lillooet Penstock	4.6	4	250	2,900	2,600	0	0	0	0	200	100	0	50	0

Conifer Diversity From Plot Data Continued

Site	Area (Ha)	# Plots	Western Hemlock			Yellow Cedar			Target SPH	**Total SPH Conifers**		
			2018	2020	2023	2018	2020	2023		**2018**	**2020**	**2023**
41.7 Km Laydown	1.1	2	0	0	50	0	0	50	1000	**0**	**1,900**	**1,650**
Upper Lillooet Penstock	4.6	4	0	0	0	0	0	200	1000	**250**	**3,150**	**2,900**

Deciduous Diversity from Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood			Red Alder			**Total SPH Deciduous**		
			2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
41.7 Km Laydown	1.1	2	800	3,400	3,300	0	0	0	**800**	**3,400**	**3,300**
Upper Lillooet Penstock	4.6	4	450	7,800	3,500	0	450	0	**450**	**8,250**	**3,500**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Ceanothus			Douglas Maple			Faslebox			Oregon Grape		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
41.7 Km Laydown	1.1	2	0	0	0	0	0	0	0	0	0	300	200	50
Upper Lillooet Penstock	4.6	4	0	50	100	0	50	0	0	50	100	0	0	0

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Red Osier Dogwood			Red Raspberry			Sitka Alder			Thimbleberry			Willow			**Total SPH Shrubs**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
41.7 Km Laydown	1.1	2	0	0	0	600	3,800	3,250	0	0	100	500	1,400	850	0	0	250	**1,400**	**5,400**	**4,500**
Upper Lillooet Penstock	4.6	4	50	50	100	900	7,850	21,400	0	0	0	250	650	1,200	550	150	100	**1,750**	**8,850**	**22,900**

Number of Species by Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
Site												
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
41.7 Km Laydown	0	2	5	1	1	1	3	3	5	**4**	**6**	**11**
Upper Lillooet Penstock	1	3	3	1	2	1	4	7	6	**6**	**12**	**10**

6.1.4 Zone 4 Results Summary

Zone 4 is composed of one site - Upper Spoil #6. This site has gentle slopes and was mounded when the site was reclaimed. The soils are gravelly but have moderate amounts of organics mixed in and are not too compacted. The site was planted in the fall of 2018 with a mix of coniferous species. This site has decreased in the number of sph and in all layers. As of 2023, there are 1,200 sph of Douglas fir, 200 sph of Spruce and 100 sph of Western red cedar. The remaining crop trees are of good form and vigour and range between 20 to 70 cm in height. This site continues to exceed the target of 1,000 sph with 1,300 sph of conifers. The density of black cottonwoods has decreased from 7,400 sph to 3,200 sph. Many of these stems were quite short (< 5 cm) and did not survive the drought conditions of the last few years. The shrub layer, although not very diverse, is greening up nicely. Shrub diversity has decreased as the fast-growing alder has shaded out other shrub species trying to establish onsite. Counting the number of shrub plants has become more difficult as the plants get larger and grow together which may have contributed to the decrease in number of sph. Moss cover is increasing slowly but cover is still quite minimal. No further revegetation treatments are required for this site. No erosion or siltation was noted during the survey.

Figure 4 depicts the pictures taken at each site within Zone 4 and Table 4 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Civil Works
Stratum: 2018 Upper Spoil #6/Plot: J/Comments
Overview photo looks South towards plot center. Sep 18, 2018 02.23.18 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #6/Plot: J/Comments
Overview photo looks South from plot J.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #6/Plot: J/Plot Name
Overview photo looks South from plot J.jpeg

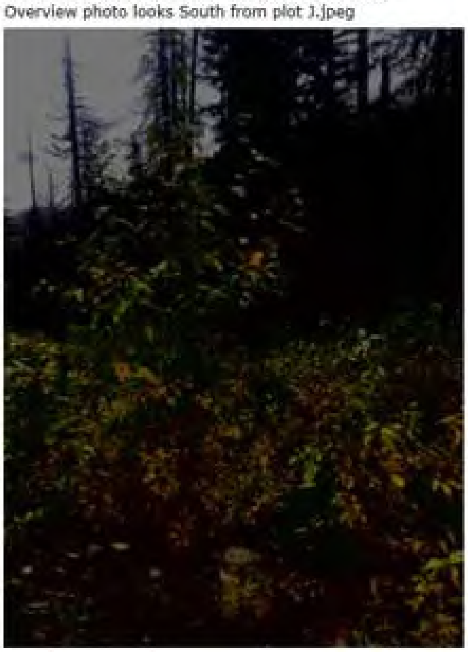


Figure 15.A Zone 4. Upper Spoil #6 Plot J Photos from 2018, 2020 and 2023

Table 4. Zone 4 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Douglas fir			Spruce			Western Red Ceder			Target SPH	**Total SPH Conifers**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023		**2018**	**2020**	**2023**
Upper Spoil #6	1	1	1,200	2,800	1,000	0	400	200	0	800	100	1000	**1,200**	**4,000**	**1,300**

Deciduous Diversity from Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood			**Total SPH Deciduous**		
			2018	2020	2023	**2018**	**2020**	**2023**
Upper Spoil #6	1	1	400	7,400	3,200	**400**	**7,400**	**3,200**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Sitka Alder			Willow			**Total SPH Shrubs**		
			2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Upper Spoil #6	1	1	200	200	200	0	200	0	**200**	**400**	**200**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Upper Spoil #6	1	3	3	1	1	1	1	2	1	**3**	**6**	**5**

6.1.5 Zone 5 Results Summary

Zone 5 is composed of three sites - Upper Spoil #3, Upper Spoil #4 and Upper Spoil #8. All three of these spoil sites were planted in 2017 with berry shrubs to meet the requirements of the grizzly bear management strategy and were subsequently planted in 2018 with a mix of conifer species. The 2023 Salal creek wildfire (V313000) burned around Zone 5 but did not burn into the treatment areas.

Upper Spoil #3 has mostly flat terrain with steeper slopes on the south side of the polygon. The steeper area was contoured to keep the spoil site from raveling onto the mainline. The flatter portion of the site was mounded prior to planting. Soils are mostly coarse and although they are quite compact the planted and natural vegetation has been successful in establishing on site. This site continues to exceed the target of 1,000 sph with 2,700 sph of conifers. In general, the conifers are of good form and vigour with some stems exhibiting minor drought stress in the form of chlorotic or dead needles on the lower half of the tree or leader dieback. The drought damage is negligible and the number of sph is continuing to increase as conifers germinates continue to infill from the surrounding stand. Cottonwoods continue to fill in on site and will add biomass to the coarse soils over time. The number of black cottonwoods has increased from 1,700 in 2020 up to 16,700 in 2023. The biggest increase in sph was from red raspberry. The rest of the shrub counts have stayed the same or increased slightly. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal. This site continues to meet the targets for successful revegetation and no further treatments are required. No erosion or siltation was noted during the survey.

Spoil #4 has moderate to gentle slopes and was mounded prior to planting. Soils are mostly gravelly with some organics and sand mixed in. This site had good survival of the planted trees with Douglas-fir and Western white pine continuing to infill. The number of spruce stems have decreased due to drought conditions. The planted and natural conifers are of good form and vigour with moderate to strong leader growth. The conifers range from 30 to 145 cm in height. This site exceeds the target of 1,000 sph with 3,200 sph of conifers. The number of cottonwoods is also continuing to increase from 500 sph to 1,000 sph. The planted and natural berry shrubs are also growing well and species diversity has increased from three to five with Sitka alder and willow now present on the site. The number of sph has increased from 4,100 sph to 6,300 sph. The increase in the number of sph ensures biomass will be added to the soils annually, thus increasing the organic component of the soils over time. Moss cover is increasing slowly but cover is still quite minimal. No further treatments are required on this site. No erosion or siltation was noted during the survey.

Spoil #8 has concave terrain and is partially mounded. Soils are well drained as they are relatively sandy with a minor component of pumice. The area of Spoil #8 was increased after the berry shrubs were planted and the permanent plots were established. The additional area was planted with conifers. The conifer planting treatment was successful and planted and natural conifers are growing well onsite with nice foliage and good leader growth. Drought mortality has decreased the number of sph from 6,800 in 2020 down to 5,700 in 2023. Despite the drought mortality this site continues to exceed the target of 1,000 sph. Cottonwood numbers continue to increase onsite, from 4,000 sph in 2020 to 4,400 sph in 2023. The cottonwoods are taller than the planted conifers with an average height of 230 cm. The number of berry shrub species on site has decreased with ceanothus and Sitka alder no longer being present on site. Both species seeded in naturally and may not have had large enough root systems to sustain them through the prolonged drought conditions in the summer. The planted and natural shrubs continue to grow and are well established. Due to the extreme drought conditions in 2023 shrub berry production was low, but the plants are still in good condition and are expected to produce berries in years where site conditions are more favourable. In 2018 there was some erosion and settling on the site, likely due to the sandy properties of the soil. No new erosion or settling was noted in 2023. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography. This site continues to meet the revegetation requirements and no further treatments are required.

Figure 5 depicts the pictures taken at each site within Zone 5 and Table 5 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Civil Works
Stratum: 2018 Upper Spoil #3/Plot: D/Comments
Overview photo looks South towards plot center. Sep 18, 2018 10.54.28 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #3/Plot: D/Comments
Overview photo looks South from plot D.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #3/Plot: D/Plot Name
Overview photo looks S from D .jpeg

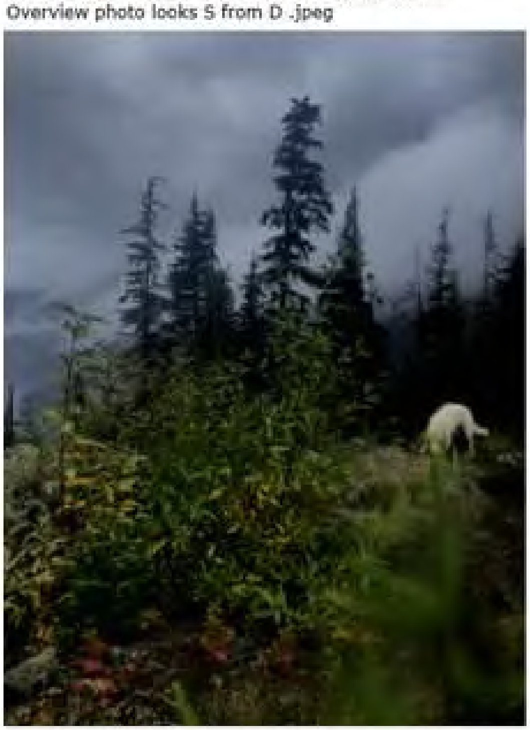


Figure 16A. Zone 5. Upper spoil #3 Plot D Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #3/Plot: E/Comments
Overview photo looks South towards plot center. Sep 18, 2018 11.08.44 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #3/Plot: E/Comments
Overview photo looks South from plot E.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #3/Plot: E/Plot Name
Overview photo looks South from plot E.jpeg

Figure 17B. Zone 5. Upper Spoil #3 Plot E Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #4/Plot: F/Comments
Overview photo looks South towards plot center. Sep 18, 2018 12.00.57 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #4/Plot: F/Comments
Overview photo looks South from plot F.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #4/Plot: F/Plot Name
Overview photo looks South from plot F.jpeg

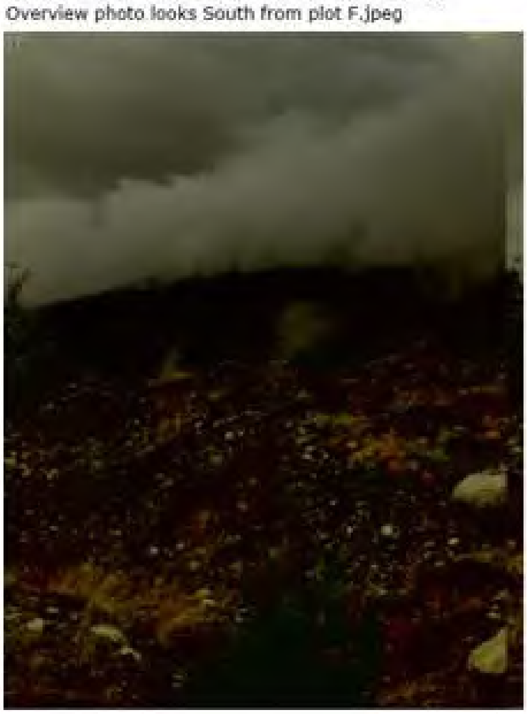


Figure 18C. Zone 5. Upper Spoil #4 Plot F Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #4/Plot: G/Comments
Overview photo looks South towards plot center. Sep 18, 2018 12.20.59 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #4/Plot: G/Comments
Overview photo looks South from plot G.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #4/Plot: G/Plot Name
South from plot G.jpeg

Figure 19D. Zone 5. Upper Spoil #4 Plot G Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #8/Plot: 005/Comments
Overview photo looks North towards plot center. Sep 05, 2018 02.03.09 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #8/Plot: 005/Comments
Overview photo looks South from plot 005.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #8/Plot: 005/Plot Name
Overview photo looks South from plot 005.jpeg

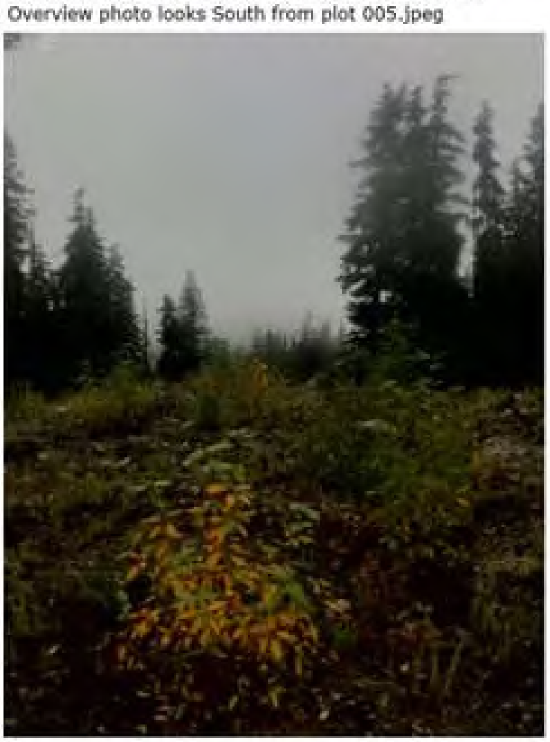


Figure 20E. Zone 5. Upper Spoil #8 Plot 005 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #8/Plot: 006/Comments
Overview photo looks North towards plot center. Sep 05, 2018 02.13.28 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #8/Plot: 006/Comments
Overview photo looks South from plot 006.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #8/Plot: 006/Plot Name
South from plot 006.jpeg

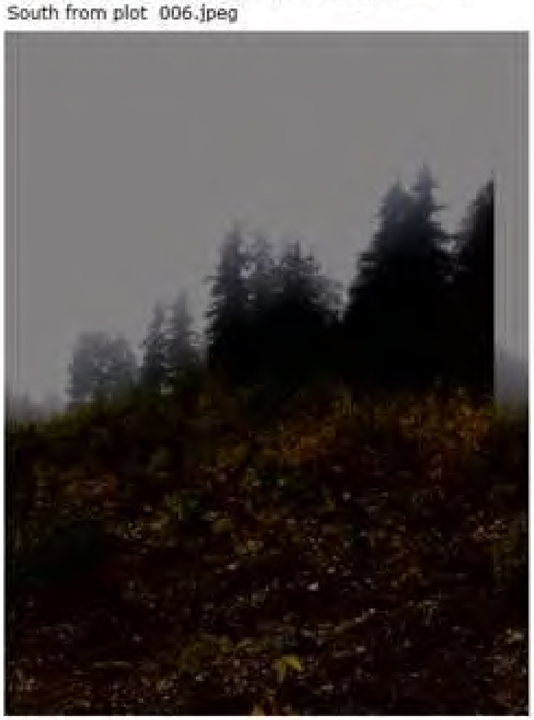


Figure 21. Zone 5. Upper Spoil #8 Plot 006 Photos from 2018, 2020 and 2023

Table 5. Zone 5 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Amabalis fir			Douglas Fir			Mountain Hemlock			Spruce		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Upper Spoil #3	1.1	2	0	300	200	0	1,300	2,300	0	0	0	0	200	200
Upper Spoil #4	1.6	2	0	100	100	0	1,100	2,750	0	0	0	0	700	300
Upper Spoil #8	2.2	2	0	1,100	1,100	100	4,600	3,600	0	200	0	0	100	100

Coniferous Diversity From Plot Data (SPH) continued

Site	Area (Ha)	# Plots	Western Hemlock			Western Red Ceder			Western White Pine			Target SPH	**Total SPH Conifers**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023		**2018**	**2020**	**2023**
Upper Spoil #3	1.1	2	0	0	0	0	0	0	0	0	0	1000	**0**	**1,800**	**2,700**
Upper Spoil #4	1.6	2	0	0	0	0	0	0	0	0	50	100	**0**	**1,900**	**3,200**
Upper Spoil #8	2.2	2	0	400	400	0	300	300	0	100	200	1000	**100**	**6,800**	**5,700**

Deciduous Diversity from Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood			**Total SPH Deciduous**		
			2018	2020	2023	**2018**	**2020**	**2023**
Upper Spoil #3	1.1	2	1,300	2,900	3,800	**1,300**	**2,900**	**3,800**
Upper Spoil #4	1.6	2	300	500	1,000	**300**	**500**	**1,000**
Upper Spoil #8	2.2	2	200	4,000	4,400	**200**	**4,000**	**4,400**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Falsebox			Ceanothus			Red Osier Dogwood			Red Raspberry		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Upper Spoil #3	1.1	2	0	0	0	0	0	0	0	0	0	1,300	1,300	15,700
Upper Spoil #4	1.6	2	0	0	0	0	0	0	100	100	50	800	3,200	4,800
Upper Spoil #8	2.2	2	400	500	0	0	100	0	100	100	200	1,600	12,700	6,800

Shrub Diversity From Plot Data (SPH) continued

Site	Area (Ha)	# Plots	Sitka Alder			Thimbleberry			Willow			**Total SPH Shrubs**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Upper Spoil #3	1.1	2	0	0	0	300	300	900	100	100	100	**1,700**	**1,700**	**16,700**
Upper Spoil #4	1.6	2	0	0	550	300	800	700	0	0	200	**1,200**	**4,100**	**6,300**
Upper Spoil #8	2.2	2	0	100	100	0	0	0	200	500	400	**1,900**	**13,300**	**7,500**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Upper Spoil #3	0	3	3	1	1	1	3	3	3	**4**	**7**	**7**
Upper Spoil #4	0	3	3	1	1	1	3	3	5	**4**	**7**	**9**
Upper Spoil #8	1	7	6	1	1	1	4	6	4	**6**	**14**	**11**

6.1.6 Zone 6 Results Summary

Zone 6 is the largest area surveyed and consists of five sites - the Diversion Channel and Slopes, Keyhole Laydown, Upper Intake and Laydown, Upper Spoil #1 and Upper Spoil #2 and Settling Basin. All the sites in Zone 6 except the Keyhole Laydown site were planted with berry shrubs in 2017.

The Diversion Channel and Slopes has moderate slopes and was roughed up with a machine prior to berry planting, grass seeding and conifer planting. In 2018 a mix of high elevation conifers were planted. Despite having coarse soils and a shorter growing season this site has had good conifer survival and species diversity continues to increase. New coniferous species onsite are Western red cedar, subalpine fir and Western white pine. Some of the natural conifers are still small, with heights ranging from 3 to 15 cm. The planted conifers have moderate leader growth with an average height of 70 cm. Some drought stress was noted but generally the trees look good. This site exceeds the target of 1,000 sph with 4,267 sph. Cottonwood numbers have increased from to 1,933 sph in 2020 to 3,267 sph in 2023. The red alder that had filled in naturally in 2020 was not found during the 2023 survey. The cottonwood will continue to add biomass to the site, increasing organic matter in the coarse soils. The shrub complex on this site is growing well and number of sph continues to increase. This site continues to exceed the revegetation targets and no further planting treatments are required.

Keyhole Laydown is a small site that had minimal soil disturbance and looks natural. This site was planted in 2018 with conifers. The planted and natural amabilis fir are of fair to good form and vigour with moderate leader growth. They are growing a bit slower than some of the adjacent sites and the number of sph has decreased since 2020 from 1,400 sph to 600 sph in 2023. This is due to increased competition from the well-developed shrub complex on site. The shrub community has not increased in diversity and has had a minor decrease in sph, and all species have grown taller since 2018. There is good potential for natural conifer ingress from adjacent mature conifers and no further treatments are required. No erosion or siltation was noted during the survey. Moss cover has started to fill in where there is exposed mineral soil. Despite a reduction in conifers below the 1,000 sph threshold this site continues to grow well with a mix of berry producing shrubs and scattered conifers.

The Upper Intake and Laydown is a large site that was mounded prior to reforestation activities. The portion of the site located above the Lillooet River FSR was contoured and grass seeded to increase slope stability and decrease raveling down to the FSR. Soils are variable on this site, the area above the FSR is slightly compact despite the site prep that was completed. Below the FSR there is an increased component of sand in the soil contributing to reduced compaction and well drained properties. In 2017 the site was planted with a mix of berry shrubs and larger conifers grown in five-gallon pots, in 2018 conifers were planted to increase stem density to meet the stocking target of 1,000 sph. Conifer diversity is good on this site with eight different species up from six in 2020, some planted and some naturals. Density of the conifers has increased from 3,100 sph in 2020 to 3,800 in 2023. The planted and natural conifers on this site are exhibiting signs of drought stress or a lack in nutrients as many of the conifers have chlorotic needles, and a few with leader dieback. Despite these issues, very little mortality was noted. The planted and natural conifers are exhibiting moderate leader growth. The conifers range from 3 cm germinates to 120 cm planted conifers. The average height of the conifers is 45 cm. Deciduous stem counts have decreased slightly from 16,600 sph in 2020 to 15,500 sph in 2023. Black Cottonwood is the only deciduous species on site. Red alder was present in 2020 but was not identified in 2023. Many of the cottonwoods are still quite small but established stems range from 30 to 100 cm in height. The shrub complex has maintained diversity since 2020 with significantly more Sitka alder onsite. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography. This difficult growing site continues to exceed the revegetation targets and no further planting treatments are required.

Upper Spoil #1 is the highest elevation site in the civil works areas. This site was mostly mounded, and the sides of the spoil were contoured for stability and are rockier. Soils are coarse with some boulders mixed in. There are scattered coarse woody debris. The spur road into the site was rehabbed and mounded in 2018 but has been reactivated since then, one of the plots was partially disturbed by the reactivation. Reactivation of the spur road in 2018 and 2023 was completed by Innergex Renewable Energy Inc. Berry shrubs were planted in 2017 and a mix of high elevation conifers were planted in 2018. The tree planting treatment was successful, and the site is stocked with 2,133 sph exceeding the reforestation target of 1,000 sph. Some natural ingress of conifers was noted, the naturals range from 30 to 80 cm in height. The planted conifers have an average height of 55 cm. The conifers are growing well onsite and are free from any forest health issues. The number of deciduous trees has continued to increase from 5,601 sph in 2020 to 8,467 in 2023. The deciduous sph will steadily increase the organic component of the soils with annual leaf fall. The shrub complex has maintained species diversity since 2020, but the total number of shrub plants has decreased from 6,400 sph in 2020 down to 3,734 sph in 2023. This is likely due to the Sitka alder getting larger and shading out some of the smaller shrubs and the individual plants growing into each other making accurate counts more difficult. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography. This site continues to meet the revegetation targets and no further prescriptions are recommended.

The Upper Spoil #2 and Settling Basin site had a large amount of overburden placed on the site creating a large mound with a flat top. The coarse gravel soils were fluffed up by mounding and there is some scattered coarse woody debris. The Southeast portion of the site has more sand mixed into the soil and is a bit less compact than the rest of the site. There is a small area (0.06 ha) area that had a couple of dump truck loads of soil dropped onto the site. Spoil #2 was planted with berry shrubs in 2017 and was planted with a mix of conifers in 2018. The conifers had good survival rates and is currently stocked with 1,700 sph up from 1,550 in 2020. The conifers are of good form and vigour with moderate to strong leader growth. The deciduous component has remained very similar to 2020 with 5,300 up to 5,533 sph in 2023. Black cottonwood is the only deciduous species onsite. The small red alder stems that were found onsite in 2020 are no longer present. The planted shrubs are growing well onsite with a minor decrease in the number of sph. In 2020 there were 700 sph, that number has decreased to 667 sph in 2023. The number of shrub species has remained the same since 2020. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography. This site meets the revegetation requirements, and no further treatments are required.

Figure 6 depicts the pictures taken at each site within Zone 6 and Table 6 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Civil Works
Stratum: 2018 Diversion Channel Slopes/Plot: 008/Comments
Overview photo looks towards plot center from the North side of the plot. Sep 06, 2018 02.54.31 PM.jpg

Card: Civil Works
Stratum: 2020 Diversion Channel and Slopes/Plot: 008/Comments
Overview photo looks South from plot 0p8.jpg

Card: Civil Works Sites
Stratum: 2023 Diversion Channel and Slopes/Plot: 008/Plot Name
IMG20230928092926.jpeg

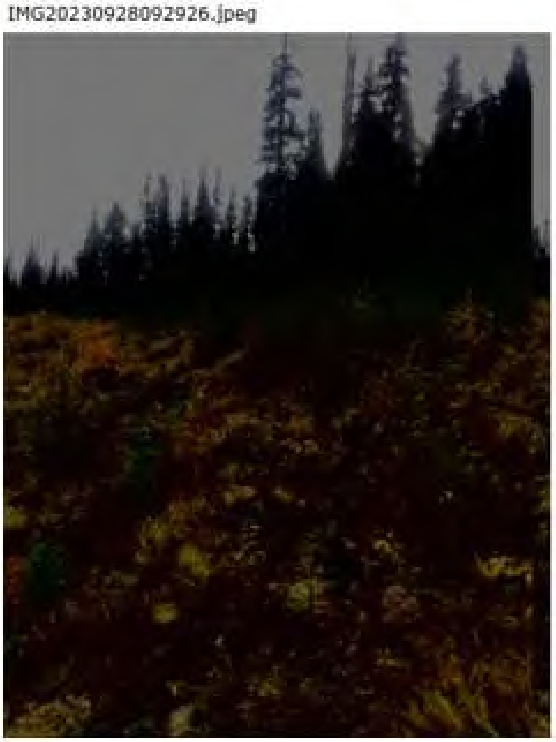


Figure 22A. Zone 6. Diversion Channel and Slopes Plot 008 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Diversion Channel Slopes/Plot: 009/Comments
Overview photo looks at plot from the North side. Sep 06, 2018 03.00.48 PM.jpg

Card: Civil Works
Stratum: 2020 Diversion Channel and Slopes/Plot: 009/Comments
Overview photo looking South from plot 009.jpg

Figure 23B. Zone 6. Diversion Channel Slopes Plot 009 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Diversion Channel Slopes/Plot: 013/Comments
Overview photo looks South towards plot center. Sep 07, 2018 12.01.34 PM.jpg

Card: Civil Works
Stratum: 2020 Diversion Channel and Slopes/Plot: 013/Comments
Overview looking South plot 013.jpg

Card: Civil Works Sites
Stratum: 2023 Diversion Channel and Slopes/Plot: 013/Plot Name
Overview photo looks South from plot 013.jpeg

Figure 24C. Zone 6. Diversion Channel and Slopes Plot 013 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Keyhole Laydown/Plot: 00/Comments
Overview photo looks towards plot center from North side of plot. Sep 06, 2018 02.13.30 PM.jpg

Card: Civil Works
Stratum: 2020 Keyhole Laydown/Plot: 007/Comments
Looking South plot center 007.jpg

Card: Civil Works Sites
Stratum: 2023 Keyhole Laydown/Plot: 007/Plot Name
Overview looks South from 07.jpeg

Figure 25D. Zone 6. Keyhole Laydown Plot 007 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Intake and Laydown/Plot: B/Comments
Overview photo looks South towards plot center. Sep 18, 2018 09.12.42 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Intake and Laydown/Plot: B/Comments
Overview photo looks South from plot B.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Intake and Laydown/Plot: B/Plot Name
Overview photo looks South from plot B.jpeg

Figure 26E. Zone 6. Upper Intake and Laydown Plot B Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Intake and Laydown/Plot: C/Comments
Overview photo looks South towards plot center. Sep 18, 2018 09.24.35 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Intake and Laydown/Plot: C/Comments
Overview photo looks South from plot C.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Intake and Laydown/Plot: C/Plot Name
Looking south from plot C.jpeg

Figure 27F. Zone 6. Upper Intake and Laydown Plot C Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Intake and Laydown/Plot: 014/Comments
Overview photo looks South towards plot center. Sep 07, 2018 02.43.28 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Intake and Laydown/Plot: 014/Comments
Overview photo looks South from plot 014.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Intake and Laydown/Plot: 014/Plot Name
Overview photo looks South from plot 014.jpeg

Figure 28G. Zone 6. Upper Intake and Laydown Plot 014 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Intake and Laydown/Plot: A/Comments
Overview photo looks South towards plot center: Sep 18, 2018 09.00.54 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Intake and Laydown/Plot: A/Comments
Overview looking South from c plot b.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Intake and Laydown/Plot: A/Plot Name
Overview photo looks South.jpeg

Figure 29H. Zone 6. Upper Intake and Laydown Plot A Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #1/Plot: 010/Comments Overview photo looks South towards plot center. Sep 07, 2018 09.44.26 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #1/Plot: 010/Comments OV looking South.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #1/Plot: 010/Plot Name Overview photo looks South from plot 010.jpeg

Figure 30I. Zone 6. Upper Spoil 1 Plot 010 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #1/Plot: 011/Comments
Overview photo looks South towards plot center. Sep 07, 2018 09.55.49 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #1/Plot: 011/Comments
Overview photo looks South from plot 011.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #1/Plot: 011/Plot Name
Overview photo looks South from plot 011.jpeg

Figure 31J. Zone 6. Upper Spoil 1 Plot 011 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #1/Plot: 012/Comments
Overview photo looks South towards plot center. Sep 07, 2018 10.17.17 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #1/Plot: 012/Comments
Overview photo looks South from plot 012.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #1/Plot: 012/Plot Name
Overview photo looks South from plot 012.jpeg

Figure 32k. Zone 6. Upper Spoil #1 Plot 012 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 017/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.27.45 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 017/Comments
Overview photo looks South from plot 017.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #2 and Settling Basin/Plot: 017/Plot Name
Overview photo looks South from plot 017.jpeg

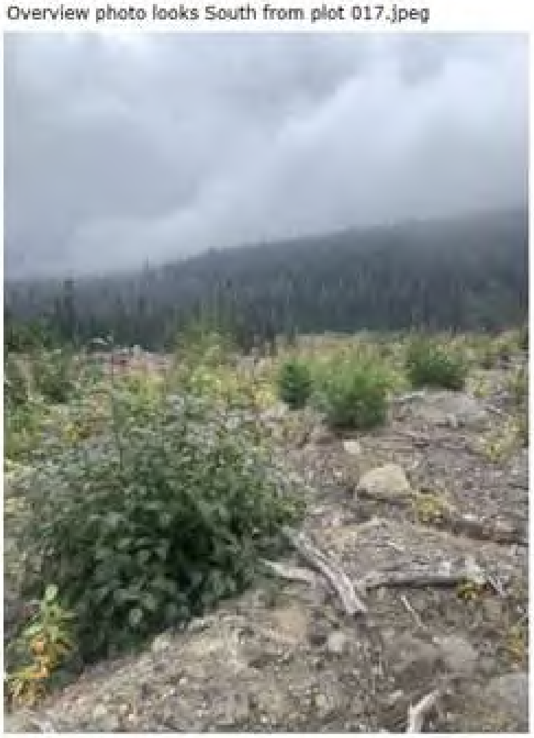


Figure 33L. Zone 6. Upper Spoil #2 Plot 017 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 018/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.37.08 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 018/Comments
Overview photo looks South from plot 018.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #2 and Settling Basin/Plot: 018/Plot Name
Overview photo looks South from 018.jpeg

Figure 34M. Zone 6. Upper Spoil #2 Plot 018 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 016/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.18.21 PM.jpg

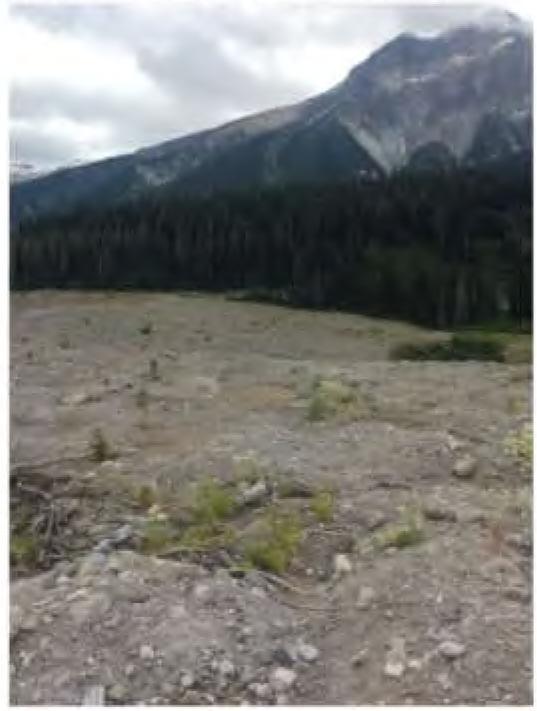
Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 016/Comments
Overview photo looks South from plot 016.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #2 and Settling Basin/Plot: 016/Plot Name
Overview photo looks South from plot 016.jpeg

Figure 35N. Zone 6. Upper Spoil #2 Plot 016 Photos from 2018, 2020 and 2023

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 015/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.03.11 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 015/Comments
Overview photo looks South from plot 015.jpg



Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 016/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.18.21 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 016/Comments
Overview photo looks South from plot 016.jpg

Figure 36O. Zone 6. Upper Spoil #2 & Settling Basin Plot 016 Photos from 2018, 2020 and 2023

Table 6. Zone 6- Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Amabalis fir			Douglas Fir			Lodgepole Pine			Mountain Hemlock		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Diversion Channel and Slopes	2.5	3	267	2,133	2,933	0	133	267	0	0	0	0	67	133
Keyhole Laydown	0.1	1	200	1,400	600	0	0	0	0	0	0	0	0	0
Upper Intake and Laydown	2.4	4	300	2,100	2,650	100	300	400	0	50	50	0	0	0
Upper Spoil #1	2.4	3	0	533	733	0	200	133	0	0	0	0	0	67
Upper Spoil #2 and Settling Basin	2.8	4	0	650	933	0	600	600	0	0	0	0	0	0

Coniferous Diversity From Plot Data (SPH) continued

Site	Area (Ha)	# Plots	Spruce			Western Hemlock			Western Red Cedar			Subalpine Fir		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Diversion Channel and Slopes	2.5	3	0	333	333	0	0	0	0	0	67	0	0	467
Keyhole Laydown	0.1	1	0	0	0	0	0	0	0	0	0	0	0	0
Upper Intake and Laydown	2.4	4	0	350	300	50	50	50	150	250	250	0	0	50
Upper Spoil #1	2.4	3	0	1,000	1,067	0	0	0	0	133	133	0	0	0
Upper Spoil #2 and Settling Basin	2.8	4	0	300	33	0	0	67	0	0	67	0	0	0

Coniferous Diversity From Plot Data (SPH) continued

Site	Area (Ha)	# Plots	Western White Pine			Target SPH	**Total SPH Conifers**		
			2018	2020	2023		**2018**	**2020**	**2023**
Diversion Channel and Slopes	2.5	3	0	0	67	1000	**267**	**2,666**	**4,267**
Keyhole Laydown	0.1	1	0	0	0	1000	**200**	**1,400**	**600**
Upper Intake and Laydown	2.4	4	0	0	50	1000	**600**	**3,100**	**3,800**
Upper Spoil #1	2.4	3	0	0	0	1000	**0**	**1,866**	**2,133**
Upper Spoil #2 and Settling Basin	2.8	4	0	0	0	1000	**0**	**1,550**	**1,700**

Decidious Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood			Red Alder			Trembling Aspen			**Total SPH Deciduous**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Diversion Channel and Slopes	2.5	3	133	1,933	3,267	0	400	0	0	0	0	**133**	**2,333**	**3,267**
Keyhole Laydown	0.1	1	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Upper Intake and Laydown	2.4	4	1,700	16,400	15,500	0	200	0	0	0	0	**1,700**	**16,600**	**15,500**
Upper Spoil #1	2.4	3	533	5,467	8,400	0	67	0	0	67	67	**533**	**5,601**	**8,467**
Upper Spoil #2 and Settling Basin	2.8	4	50	5,050	5,533	0	250	0	0	0	0	**50**	**5,300**	**5,533**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Ceanothus			Black Gooseberry			Bitter Cherry			Hardhack Spirea		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Diversion Channel and Slopes	2.5	3	0	0	67	0	0	67	0	0	0	0	0	0
Keyhole Laydown	0.1	1	0	0	0	0	0	600	0	0	0	0	0	0
Upper Intake and Laydown	2.4	4	0	0	0	0	0	0	0	0	0	0	0	0
Upper Spoil #1	2.4	3	0	0	0	0	0	0	0	0	0	0	0	0
Upper Spoil #2 and Settling Basin	2.8	4	0	0	0	0	0	0	0	0	67	50	0	0

Shrub Diversity From Plot Data (SPH) continued

Site	Area (Ha)	# Plots	Highbrush Cranberry			Kinnikinnick			Oregon Grape			Red Elderberry			Red Osier Dogwood		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Diversion Channel and Slopes	2.5	3	67	67	0	0	0	0	0	0	0	133	67	0	0	67	67
Keyhole Laydown	0.1	1	800	600	0	0	0	0	0	0	0	600	800	200	0	0	0
Upper Intake and Laydown	2.4	4	0	0	0	50	0	50	50	50	50	50	40	0	0	0	0
Upper Spoil #1	2.4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Spoil #2 and Settling Basin	2.8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Shrub Diversity From Plot Data (SPH) continued

Site	Area (Ha)	# Plots	Red Raspberry			Rose Species			Salal			Salmonberry			Sitka Alder		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Diversion Channel and Slopes	2.5	3	0	133	0	0	0	0	133	133	0	67	133	333	267	1000	2,533
Keyhole Laydown	0.1	1	14,800	46,400	46,000	0	0	0	0	0	0	0	0	0	0	0	0
Upper Intake and Laydown	2.4	4	0	0	0	100	100	100	0	0	0	0	0	0	200	50	1,150
Upper Spoil #1	2.4	3	0	0	0	0	0	0	67	0	67	0	0	0	800	2,667	2,267
Upper Spoil #2 and Settling Basin	2.8	4	250	350	0	0	0	0	50	50	67	0	0	0	100	0	400

Shrub Diversity From Plot Data (SPH) continued

Site	Area (Ha)	# Plots	Sitka Mountain-Ash			Thimbleberry			Vaccinium Species			Willow			**Total SPH Shrubs**		
			2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Diversion Channel and Slopes	2.5	3	0	133	0	67	67	67	200	267	333	0	933	600	**934**	**3,000**	**4,067**
Keyhole Laydown	0.1	1	0	0	0	0	0	0	7,200	4,800	4,400	400	400	400	**23,800**	**53,000**	**51,600**
Upper Intake and Laydown	2.4	4	0	0	0	50	0	0	0	0	0	300	1,050	750	**800**	**1,290**	**2,100**
Upper Spoil #1	2.4	3	0	0	0	67	133	133	0	0	0	0	3,600	1,267	**934**	**6,400**	**3,734**
Upper Spoil #2 and Settling Basin	2.8	4	0	0	0	50	50	0	0	0	0	0	250	133	**500**	**700**	**667**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Diversion Channel and Slopes	1	4	7	1	2	1	7	11	7	**9**	**17**	**16**
Keyhole Laydown	1	1	1	0	0	0	5	5	5	**6**	**6**	**6**
Upper Intake and Laydown	4	6	8	1	2	1	7	5	5	**12**	**13**	**14**
Upper Spoil #1	0	4	4	1	3	2	3	3	4	**4**	**10**	**10**
Upper Spoil #2 and Settling Basin	0	3	5	1	2	1	5	4	4	**6**	**9**	**10**

6.2. Results for Civil Work Sites Plots Established in 2019

Within the civil works areas, 26 permanent plots were established on 6 sites in 2019 and 2020. For these sites there is only one year of monitoring data available. These sites include the 38 Km Laydown, Camp, Boulder Spoil #4, Boulder Spoil #7, Upper Spoil #5 and Upper Spoil #7. These civil works sites are not within riparian areas, Ungulate Winter Ranges or Wildlife Habitat Areas and were not planted until the fall of 2018. All sites were planted with a mix of site appropriate conifers. Shrubs and deciduous species have infilled naturally since the sites were reclaimed. A target of 1000 stems per hectare (sph) of conifers has been set for successful reforestation of the sites.

The 38 km laydown site is the largest site in this program. The area has coarse gravel soils that were mixed with topsoil and fluffed up. Coarse woody debris were also scattered across the site. The planted conifers are growing well onsite and the number of sph has remained stable since 2020. There are 1399 sph of conifers on site exceeding the target of 1000 sph. The conifers range from 20 to 120 cm in height. Black cottonwood is the only deciduous species on site. Black cottonwood numbers continue to increase and add biomass to the soils and species diversity. This site was not planted with shrubs, so all shrub species have filled in naturally. The number of shrub plants has doubled from 2020 to 2023 from 2134 to 4239. Most of the shrub counts stayed relatively close to the 2020 counts. There were significant increases in red raspberry and falsebox. This vegetation cover has increased significantly since this site was planted and meets the revegetation targets.

The camp site has coarse gravel soils, this site was decompacted through mounding, topsoil and large woody debris were added to increase nutrient cycling in the soil. This site was planted with 1800 sph of conifers as moderate to high mortality was anticipated due to the structure of the soil. The conifers on this site had excellent survival rates and more conifers continue to infill naturally. There are 2900 sph of conifers and Western red cedar and Western white pine have seeded in naturally since 2020. The planted Douglas fir and lodgepole pine range from 140 to 210 cm in height. Black cottonwood is also scattered throughout the site with 1667 sph in 2023 down from 1900 sph in 2020. The shrub layer is not as robust on this site but is still present. In 2020 there were 1199 sph of shrubs in 2023 this had increased to 1599 sph. No new species were gained between 2020 and 2023. This site continues to exceed the revegetation requirements and no further treatments are required for this site.

Boulder spoil #4 has gravelly, sandy soils and was prepared for planting by mounding the site. Coarse woody debris was placed around the site. Conifer survival on this site was very good with the total number of sph decreasing slightly between 2020 and 2023 from 2000 sph down to 1800 sph. The conifers are of good form and vigor and seem to be well established on site. Black cottonwoods have also infilled and although the total number of sph has decreased slightly there are still 1000 sph. The decrease of 200 sph may be due to some of the smaller plants dying off in the heat dome in 2021. Red raspberry and thimbleberry are the only shrubs on site. Both species had significant increases in the number of plants. The number of shrub sph increased from 6600 in 2020 up to 25,600 in 2023. This site meets the revegetation targets, and no further treatments are required.

Bould spoil #7 is a rocky site with compact, rapidly draining soils. This site was not decompacted and did not have any large diameter woody debris or topsoil added to the site. For these reasons this site was expected to be one of the most difficult to reforest. Despite these site limiting factors, the number of conifers per ha has remained stable at 800 sph. The Douglas fir are in fair to good form and vigor with an average height of 50 cm. Black cottonwood continue to infill on the site and are adding biomass to the site with annual leaf drop. There are no shrubs in the plot but there are scattered shrubs growing on the site. This site falls short of the 1000 sph of conifers but considering the difficult growing conditions and the continuing natural ingress of cottonwoods on the site no further planting treatments are recommended.

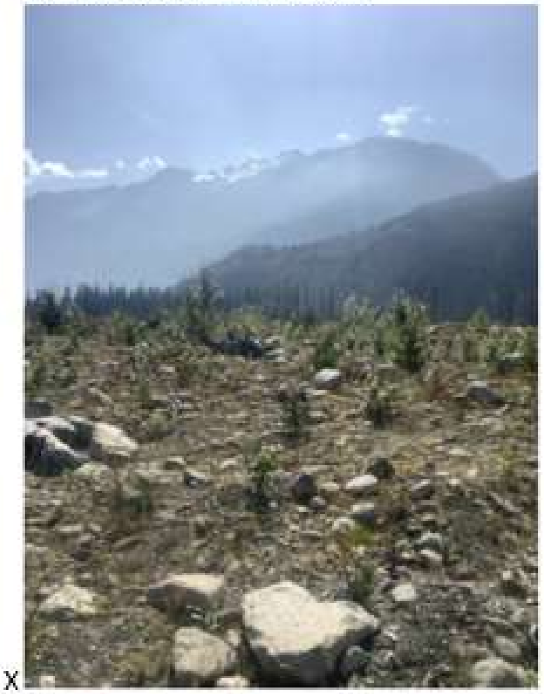
Upper Spoil #5 has moderately steep side slopes and is mostly flat on top, soils are gravelly and well drained. The site was fluffed up a bit to decrease compaction and increase plantability. This site is recovering well, high mortality of the planted trees was noted in 2020, but lots of conifer germinates were infilling. This site had 1000 sph of conifers in 2020, there are currently 1800 sph of conifers. Douglas fir makes up the majority of the sph with spruce and amabalis fir making up minor components. The conifers range from 10 cm to 80 cm in heights and are of good form and vigour. Black cottonwood continues to seed in and is also growing well. There are 1400 sph of black cottonwood up from 800 sph in 2020. Species diversity for shrubs is low on this site and has decreased from 23800 in 2020 to 20,800 in 2023. no species diversity was lost indicating the shrubs onsite are healthy. This site is dominated by fireweed, this species is a common pioneer species on disturbed sites and is adding biomass to the site annually helping to build soils and add nutrients. No erosion or siltation was noted on this site. This site is meeting the revegetation requirements, and no further treatments are required.

Upper Spoil #7 has gravel soils with organic matter mixed in and large woody debris is scattered across the site. The planted and natural conifers are growing well, and numbers continue to increase. In 2020 there were in 2000 sph, in 2023 that number increased to 2200 sph. The conifers are of good form and vigour but are growing a bit slower due to the presence of black cottonwood that is growing vigorously on this site. The number of black cottonwoods has decreased slightly since 2020 but still makes up most of the total stem count with 28,000 sph. The black cottonwood is up 450 cm in height resulting in shading of the conifer and shrub layers. Shrub density and species diversity has decreased on this site since 2020. The number of sph of shrubs was 8200 in 2020 this number has decreased to 3400 sph in 2023. All shrub species have reduced in number and thimbleberry was not found in the plot this year. Despite the loss in shrub sph and diversity this site is recovering nicely, and the black cottonwood and conifers are expected to continue to grow well. No erosion or siltation was noted on this site and moss cover continues to increase. No further planting treatments are required for this opening.

Figures 7 to 11 depicts the pictures taken at each Civil Work Site established in 2019 and Table 7 depicts the change in plant densities and diversity between 2020, and 2023.

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W1/Comments
Overview photo looks South from plot W1.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W1/Plot Name
Overview photo looks S from W1.jpeg



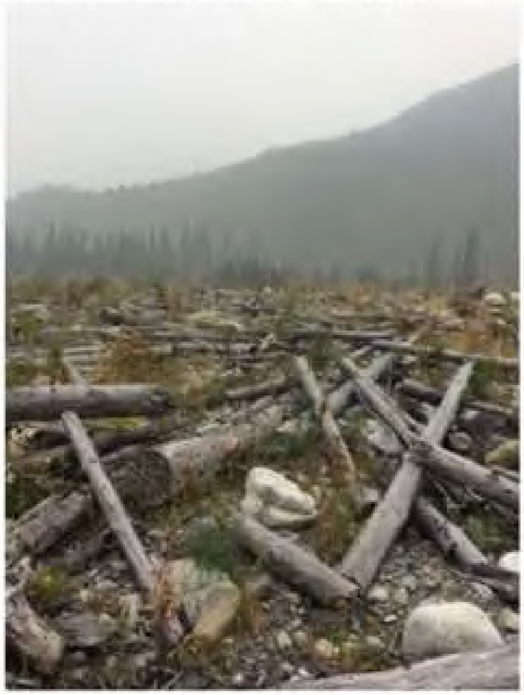
X

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W2/Comments
Overview photo looks South from plot W2.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W2/Plot Name
Overview looks South from plot W2.jpeg

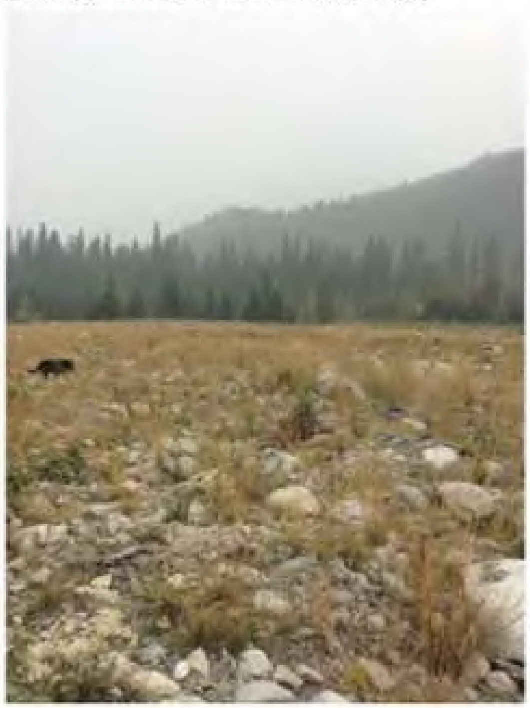
Figure 37A. 38 km Laydown Plot W1/W2 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W3/Plot Name
Overview photo looks South from plot W3.jpg



Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W3/Plot Name
Overview photo looks South from plot W3.jpeg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W4/Comments
Overview photo looks South from plot W4.jpg



Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W4/Plot Name
Overview photo looks South from plot SD1.jpeg

Figure 38B. 38 km Laydown Plot W3/W4 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W5/Comments
Overview photo looks South from W5.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W5/Plot Name
Overview photo looks South from plot W4.jpeg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W6/Comments
Overview photo looks South from plot W6.jpg

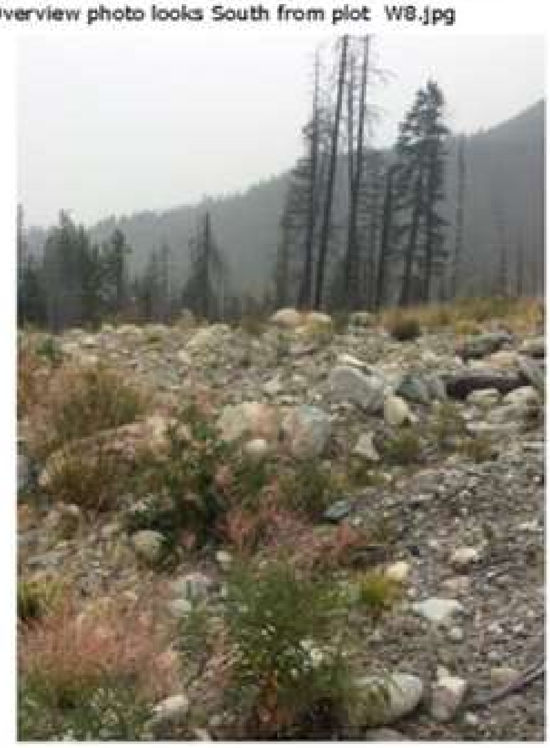
Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W6/Plot Name
Overview photo looks South from W6.jpeg

Figure 39C. 38 km Laydown Plot W5/W6 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W7/Comments
Overview photo looks South from plot W7.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W7/Plot Name
Overview photo looks South from plot W7.jpeg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W8/Comments
Overview photo looks South from plot W8.jpg



Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W8/Plot Name
Overview looks South from W8.jpeg

Figure 40D. 38 km Laydown Plot W7/W8 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W9/Comments
Overview photo looks South from plot W9.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W9/Plot Name
Overview photo looks South from plot W9.jpeg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W10/Comments
Overview photo looks South from plot W10.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W10/Plot Name
Overview photo looks South from W10.jpeg

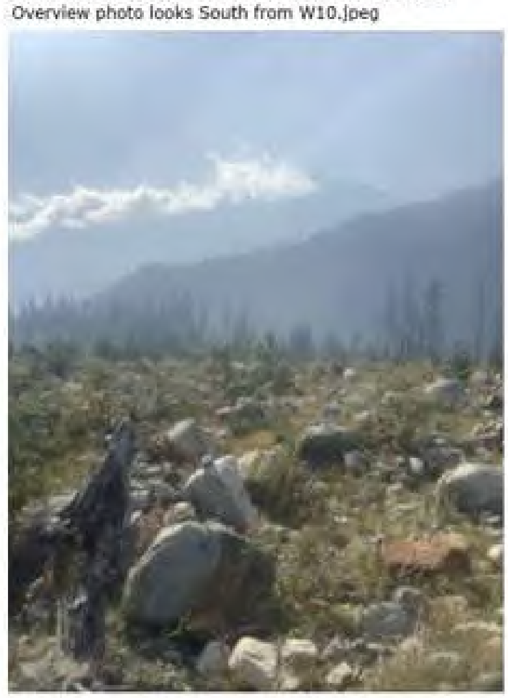


Figure 41E. 38 km Laydown Plot W9/W10 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W11/Comments
Overview photo looks South from plot W11.jpg

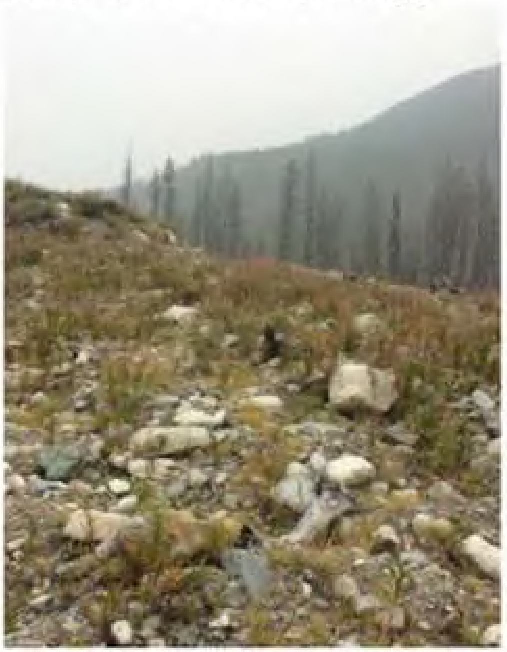
Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W11/Plot Name
Overview photo looks South from plot W11.jpeg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W12/Comments
Overview photo looks South from plot W12.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W12/Plot Name
Overview photo looks South from W12.jpeg

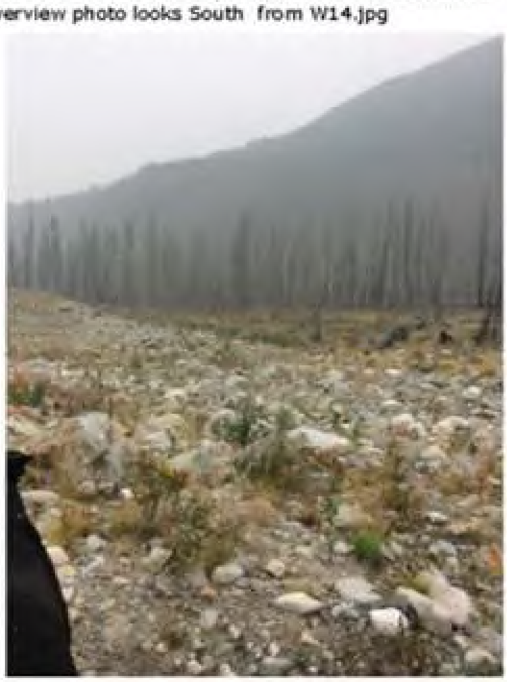
Figure 42F. 38 km Laydown Plot W11/W12 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W13/Comments
Overview photo looks South from plot W13.jpg



Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W13/Plot Name
Overview photo looks South from plot W13.jpeg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W14/Comments
Overview photo looks South from W14.jpg



Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W14/Plot Name
Overview photo looks South from W14.jpeg

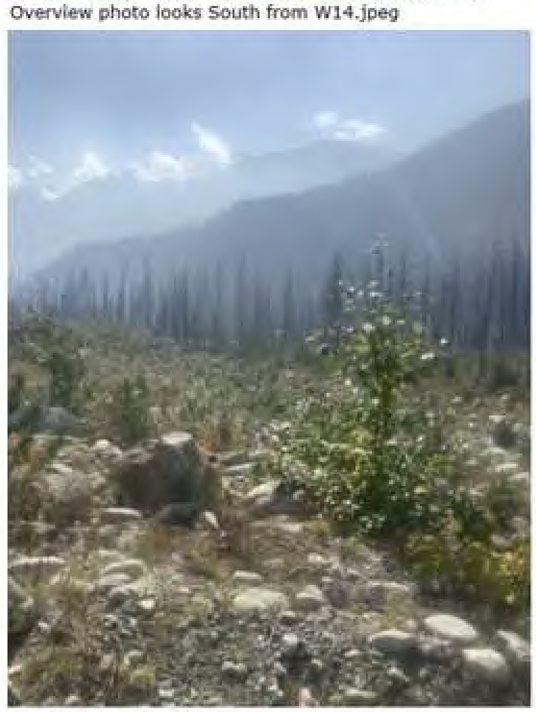


Figure 43G. 38 km Laydown Plot W13/W14 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W15/Comments
Overview photo looks South from plot W15.jpg

Card: Civil Works Sites
Stratum: 2023 38km Laydown/Plot: W15/Plot Name
Overview photo looks South from plot W15.jpeg

Figure 44H. 38 km Laydown Plot W15 photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 Camp/Plot: B1/Comments
Overview photo looks South from plot B1.jpg

Card: Civil Works Sites
Stratum: 2023 Camp/Plot: B1/Plot Name
Overview photo looks South from plot B1.jpeg

Card: Civil Works
Stratum: 2020 Camp/Plot: V/Comments
Overview photo looks South from plot V.jpg

Card: Civil Works Sites
Stratum: 2023 Camp/Plot: V/Plot Name
Overview looks South from plot V.jpeg

Figure 45A. Camp plot B1 and V photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 Camp/Plot: W/Comments
Overview photo looks South from plot W.jpg

Card: Civil Works Sites
Stratum: 2023 Camp/Plot: W/Plot Name
Overview photo looks South from plot W.jpeg

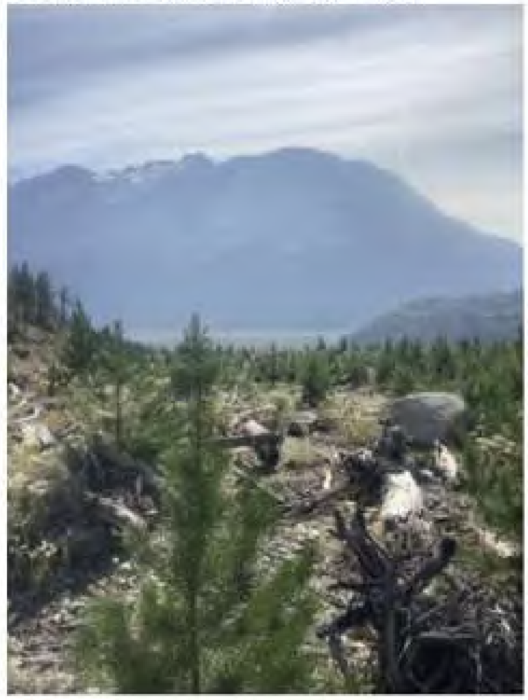
Card: Civil Works
Stratum: 2020 Camp/Plot: X/Comments
Overview photo looks South from plot X.jpg

Card: Civil Works Sites
Stratum: 2023 Camp/Plot: X/Plot Name
Overview photo looks South from X.jpeg

Figure 46B. Camp plot W/X photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 Camp/Plot: Y/Plot Name
Overview photo looks South from plot Y.jpg

Card: Civil Works Sites
Stratum: 2023 Camp/Plot: Y/Plot Name
Overview photo looks South from plot Y1.jpeg



Card: Civil Works
Stratum: 2020 Camp/Plot: Z/Comments
Overview photo looks South from plot Z.jpg

Card: Civil Works Sites
Stratum: 2023 Camp/Plot: Z/Plot Name
Overview photo looks South from Z1.jpeg

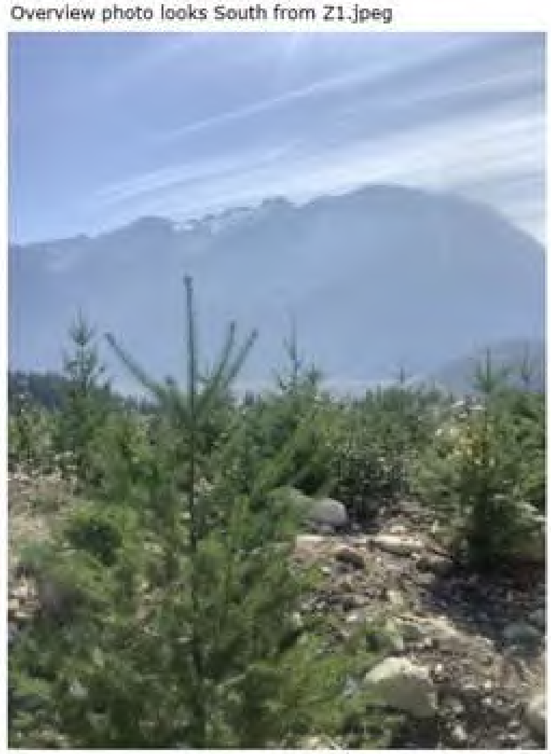
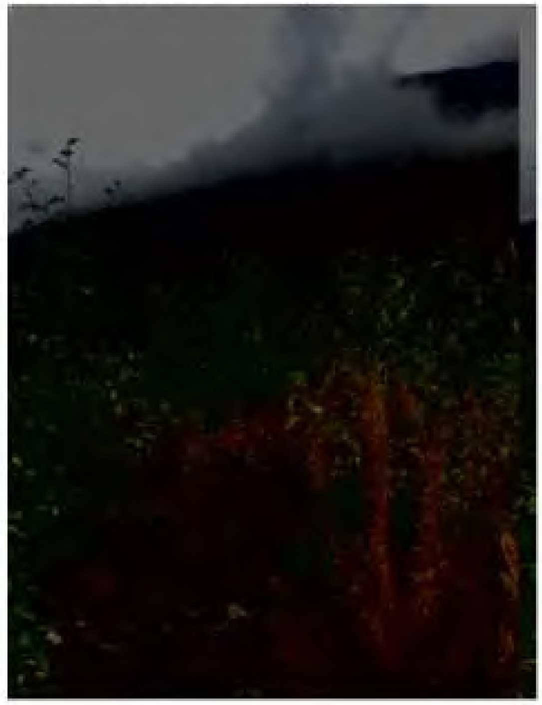


Figure 47C. Camp plot Y/Z photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 Boulder Spoil #4/Plot: D1/Comments
Overview photo looks South from plot D1.jpg

Card: Civil Works Sites
Stratum: 2023 Boulder Spoil #4/Plot: D1/Plot Name
Overview photo looks S from D1.jpeg



Card: Civil Works
Stratum: 2020 Boulder Spoil #7/Plot: E1/Comments
Overview photo looks South from plot E1.jpg

Card: Civil Works Sites
Stratum: 2023 Boulder Spoil #7/Plot: E1/Plot Name
Overview photo looks South from plot E1.jpeg

Figure 48A. Boulder Spoil #4 and #7 Plot D1/E1 Photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 Upper Spoil #7/Plot: T/Comments
Overview photo looks South from plot T.jpg

Card: Civil Works Sites
Stratum: 2023 Upper Spoil #7/Plot: T/Plot Name
Overview photo looks South from plot T.jpeg

Figure 49A. Upper Spoil #7 plot T photos from 2020 and 2023

Card: Civil Works
Stratum: 2020 Upper Spoil #5/Plot: F1/Comments
Overview photo looks South from plot F1.jpg

Figure 50. Upper Spoil #5 Plot F1 Photos from 2020

Table 7. Civil works sites 2019- Vegetation Density and Species Diversity from 2020 to 2023

Coniferous Diversity From Plot Data (SPH)

Site			Amabalis Fir		Douglas Fir		Lodgepole Pine		Ponderosa Pine		Spruce		Western Red Cedar		Western White Pine		**Total SPH Conifers**	
	Area (Ha)	# Plots	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	**2020**	**2023**
38 KM Laydown	15.2	15	27	13	653	707	347	333	67	0	200	160	80	93	0	93	**1,374**	**1,399**
Camp	6.5	6	0	0	1,567	2,000	767	767	0	0	0	0	0	100	0	33	**2,334**	**2,900**
Boulder Spoil #4	0.4	1	0	0	1,200	1,200	0	0	0	0	800	600	0	0	0	0	**2,000**	**1,800**
Boulder Spoil #7	1.1	1	0	0	800	800	0	0	0	0	0	0	0	0	0	0	**800**	**800**
Upper Spoil #5	1.1	1	200	200	200	1,200	0	0	0	0	600	400	0	0	0	0	**1,000**	**1,800**
Upper Spoil #7	0.6	1	800	800	1,200	1,400	0	0	0	0	0	0	0	0	0	0	**2,000**	**2,200**

Deciduous Diversity from Plot Data (SPH)

Site			Black Cottonwood		Red Alder		**Total SPH Deciduous**	
	Area (Ha)	# Plots	2020	2023	2020	2023	**2020**	**2023**
38 KM Laydown	15.2	15	1,573	1,893	40	0	**1,613**	**1,893**
Camp	6.5	6	1,900	1,667	0	0	**1,900**	**1,667**
Boulder Spoil #4	0.4	1	1,200	1,000	0	0	**1,200**	**1,000**
Boulder Spoil #7	1.1	1	15,200	12,200	0	0	**15,200**	**12,200**
Upper Spoil #5	1.1	1	800	1,400	0	0	**800**	**1,400**
Upper Spoil #7	0.6	1	28,800	28,000	0	0	**28,800**	**28,000**

Shrub Diversity From Plot Data (SPH)

Site			Birch Leaf Spirea		Blackcap Raspberry		Ceanothus		Falsebox		Kinnikinnick		Mountain Ash		Red Osier Dogwood	
	Area (Ha)	# Plots	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023
38 KM Laydown	15.2	15	0	0	53	0	27	27	667	867	67	40	0	13	27	13
Camp	6.5	6	33	0	0	0	0	33	867	800	0	0	0	0	0	0
Boulder Spoil #4	0.4	1	0	0	0	0	0	0	200	0	0	0	0	0	0	0
Boulder Spoil #7	1.1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Spoil #5	1.1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Spoil #7	0.6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Shrub Diversity From Plot Data (SPH) continued

Site			Red Raspberry		Saskatoon		Sitka Alder		Thimbleberry		Vaccinium species		Willow		**Total SPH Shrubs**	
	Area (Ha)	# Plots	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	**2020**	**2023**
38 KM Laydown	15.2	15	1,160	3,080	13	40	0	13	80	93	0	13	40	40	**2,134**	**4,239**
Camp	6.5	6	233	733	33	33	0	0	33	0	0	0	0	0	**1,199**	**1,599**
Boulder Spoil #4	0.4	1	5,800	24,000	0	0	0	0	600	1600	0	0	0	0	**6,600**	**25,600**
Boulder Spoil #7	1.1	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
Upper Spoil #5	1.1	1	23,600	20,600	0	0	200	200	0	0	0	0	0	0	**23,800**	**20,800**
Upper Spoil #7	0.6	1	6,400	2,800	0	0	200	200	200	0	0	0	1,400	400	**8,200**	**3,400**

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2020	2023	2020	2023	2020	2023	**2020**	**2023**
38 KM Laydown	6	6	2	1	9	10	**17**	**17**
Camp	2	4	1	1	5	4	**8**	**9**
Boulder Spoil #4	2	2	1	1	3	2	**6**	**5**
Boulder Spoil #7	1	1	1	1	0	0	**2**	**2**
Upper Spoil #5	3	3	1	1	2	2	**6**	**6**
Upper Spoil #7	2	2	2	1	4	3	**8**	**6**

6.3. Results for Transmission Line Sites

The transmission line plot data collected in Year 5 (2023) has been summarized by site comparing the plant communities present in 2018 (Year 1), 2020 (Year 3) and 2023 (Year 5). No new plots were established in 2023 within the transmission line portion of the ULHP revegetation project. Plot data could not be collected on three of the transmission sites. Site 239.1 is located on a drivable road and the rebar marking plot center has been removed. Sites 247.1/249.1 and 250.1 are located under the transmission line and were manually brushed a few weeks prior to the field work being conducted. The rebar plot centers could not be found on the brushed sites and was likely removed by the brushers as a hazard.

The transmission line road sites continue to successfully regenerate. All sites show an increase in species diversity and density. Some sites did have decreases in the number of sph for one or two species but always had an increase in diversity. The decrease in sph is not a sign of the site being unable to regenerate, but it is an example of site succession on a small scale. In general, all species of plants were of good form and vigour and free from any forest health pests. The only plants that were looking spindly or weak were being shaded out by more aggressive species. Each surveyed road site is summarized below.

6.3. Transmission Line Road Site 53.1/56.1 Summary

Transmission line road 53.1/56.1 is deactivated and is not drivable. Soils are rapidly draining and coarse with lots of surface rock. This site was grass seeded with a fall rye blend. No conifers were recorded at this site. Black cottonwood numbers have decreased significantly from 2020 to 2023. This is possibly due to the small black cottonwood being out competed by the more established brush species. All the shrub species have increased in the number of sph since 2023 except red raspberry. Shrub species diversity has also increased from five species in 2020 to 9 species in 2023. The new species on site since 2020 are blackcap raspberry, ceanothus, false box and Douglas maple. No soil erosion or siltation issues were noted, and no further revegetation treatments are required. This site continues to successfully regenerate, and no further actions are required.

Figure 12 depicts the pictures taken at this site and Table 8 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 53.1/56.1/Plot: 31/Comments
Sep 18, 2018 01.29.59 PM.jpg

Card: Transmission Line
Stratum: 2020 53.1/56.1/Plot: 31/Comments
Overview photo looks South from plot 31.jpg

Card: Transmission Line Surveys
Stratum: 2023 53.1/56.1 Road/Plot: 31/Plot Name
Overview photo looks South from plot 31.jpeg

Figure 51. 53.1/56.1 Plot 31 Photos from 2018, 2020 and 2023

Table 8. 53.1/56.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Total SPH Conifers		
	2018	**2020**	**2023**
53.1/56.1	**0**	**0**	**0**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			Total SPH Deciduous		
	2018	2020	2023	**2018**	**2020**	**2023**
53.1/56.1	1,800	3,000	800	**1,800**	**3,000**	**800**

Shrub Diversity From Plot Data (SPH)

Site	Ceanothus			Blackcap Raspberry			Douglas Maple			Faslebox			Red Osier Dogwood		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
53.1/56.1	0	0	200	0	0	200	0	0	200	0	0	200	0	200	400

Shrub Diversity From Plot Data (SPH) continued

Site	Red Raspberry			Thimbleberry			Willow			Total SPH Shrubs		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
53.1/56.1	400	800	0	800	2200	5,000	0	200	200	**1,200**	**3,400**	**6,400**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			Total Number of Species		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
53.1/56.1	0	0	0	1	1	1	2	4	7	**3**	**5**	**9**

6.3.1 Transmission Line Road 73.1 Summary

Transmission line road 73.1 is deactivated and is not drivable. The soils are coarse but not too rocky. Coarse woody debris were added to the road after it was decompacted. This site is dominated by thimbleberry with the number of sph reaching 46,000. Western red cedar is establishing under the cover of the thimbleberry and range from 3 to 50 cm in height. Douglas fir is also present, and they are seeding in between the shrubs where there is exposed mineral soil. Shrub diversity continues to grow, both saskatoon and red osier dogwood are now present onsite at low levels. The deciduous component of the site has decreased significantly from 5800 in 2020 to 1400 in 2023. This is possibly due to the increase in cover of the thimbleberry. No soil erosion or siltation issues were noted at the time of the survey. This site continues to successfully regenerate, and no further actions are required.

Figure 13 depicts the pictures taken at this site and Table 9 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 73.1/Plot: 30/Comments
Sep 18, 2018 12.50.06 PM.jpg

Card: Transmission Line
Stratum: 2020 73.1/Plot: 30/Comments
Overview photo looks South from plot 73.1.jpg

Card: Transmission Line Surveys
Stratum: 2023 73.1 Road/Plot: 30/Plot Name
South from plot. 30.jpeg

Figure 52. 73.1 Plot 30 Photos from 2018, 2020 and 2023

Table 9. 73.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Western Red Ceder			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
73.1	0	400	800	0	0	15,800	**0**	**400**	**16,600**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			**Total SPH Deciduous**		
	2018	2020	2023	**2018**	**2020**	**2023**
73.1	0	5,800	1,400	**0**	**5,800**	**1,400**

Shrub Diversity From Plot Data (SPH)

Site	Falsebox			Red Osier Dogwood			Red Raspberry			Saskatoon			Thimbleberry			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
73.1	0	1,200	2,800	0	0	400	1,600	10,000	5,600	0	0	200	17,800	16,800	46,000	**19,400**	**28,400**	**55,000**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
73.1	0	1	1	0	1	1	2	4	5	**2**	**6**	**8**

6.3.2 Transmission Line Road 129.1 Summary

Transmission line road 129.1 is deactivated and is not drivable. Soils are rapidly draining and coarse with lots of surface rock. This site was grass seeded with a fall rye blend. Lodgepole pine sph have decreased minimally from 1600 in 2020 down to 1400 in 2023. The lodgepole pine are of good form and vigour with heights ranging from 30 to 100 cm in height. Black cottonwood numbers have remained consistent between survey years. This site has decreased in the number of shrubs since 2018. This is likely due to high temperatures in the summer and a lack of soil moisture. False box numbers have decreased by half from 2018 to 2020 and was found not found onsite in 2023. Ceanothus numbers have also decreased from 400 sph in 2018 to 200 sph in 2020 and down to zero in 2023. Both species are typically drought tolerant but may be more susceptible to drought conditions when they are smaller, and their root system is not developed enough to survive season long drought conditions. Blackcap raspberry is new to the site since 2020.The grass seeding treatment could also have created more competition between plants for water. No soil erosion or siltation issues were noted, and no further revegetation treatments are required. The number of conifer and deciduous species on site has remained stable and no further treatments are required.

Figure 14 depicts the pictures taken at this site and Table 10 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 129.1/Plot: 29/Comments
Sep 18, 2018 11.34.17 AM.jpg

Card: Transmission Line
Stratum: 2020 129.1/Plot: 29/Comments
Overview photo looks South from plot 29.jpg

Card: Transmission Line Surveys
Stratum: 2023 129.1 Road/Plot: 29/Plot Name
Overview photo looks South from plot 29.jpeg

Figure 53A. 129.1 Plot 29 Photos from 2018, 2020 and 2023

Table 10. 129.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Lodgepole Pine			**Total SPH Conifers**		
	2018	2020	2023	**2018**	**2020**	**2023**
129.1	1,200	1,600	1,400	**1,200**	**1,600**	**1,400**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			**Total SPH Deciduous**		
	2018	2020	2023	**2018**	**2020**	**2023**
129.1	0	400	400	**0**	**400**	**400**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry			Ceanothus			Falsebox			Kinnikinnick			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
129.1	0	0	200	400	200	0	2,000	1,000	0	0	800	800	**2,400**	**2,000**	**1,000**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
129.1	1	1	1	0	1	1	2	3	2	**3**	**5**	**4**

6.3.3 Transmission Line Road 130.1 Summary

Transmission line road 130.1 is deactivated and is not drivable. Soils are rapidly draining and coarse with lots of surface rock. This site was grass seeded with a fall rye blend. Lodgepole pine, Douglas fir and black cottonwood numbers have remained static from 2020 to 2023. The conifers and deciduous trees are growing vigorously on site with heights ranging from 40 to 150 cm in height. The shrub complex has reduced in species diversity and sph since 2020.The number of falsebox and blackcap raspberry sph has decreased to zero since 2020. The number of kinnikinnick sph has also decreased but the plants are larger and have grown into each other making it difficult to identify individual plants. Vaccinium is now present in the plot, it was not present in 2020. No soil erosion or siltation issues were noted, and no further revegetation treatments are required. Despite the decrease in shrub species since 2020 this site is still performing well with conifers and deciduous stems and no further treatments are required.

Figure 15 depicts the pictures taken at this site and Table 11 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 130.1/Plot: 28/Comments
Sep 18, 2018 11.05.09 AM.jpg

Card: Transmission Line
Stratum: 2020 130.1/Plot: 28/Comments
Overview photo looks South from plot 28.jpg

Card: Transmission Line Surveys
Stratum: 2023 130.1 Road/Plot: 28/Plot Name
Overview photo looks south from 28.jpeg

Figure 54. 130.1 Plot 28 Photos from 2018, 2020 and 2023

Table 11. 130.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Lodgepole Pine			Spruce			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
130.1	200	600	200	3,000	3,200	3,600	400	0	0	**3,600**	**3,800**	**3,800**

Deciduous Diversity from Plot Data (SPH)

Site	Bigleaf Maple			Black Cottonwood			**Total SPH Deciduous**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
130.1	0	0	0	400	400	400	**400**	**400**	**400**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry			Falsebox			Kinnikinnick			Trailing Blackberry			Willow		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
130.1	0	200	0	6,600	1,400	0	0	2,000	400	200	0	0	0	400	200

Shrub Diversity From Plot Data (SPH) continued

Site	Vaccinium species			**Total SPH Shrubs**		
	2018	2020	2023	**2018**	**2020**	**2023**
130.1	0	0	400	**6,800**	**4,000**	**800**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
130.1	3	2	2	1	1	1	2	4	3	**6**	**7**	**6**

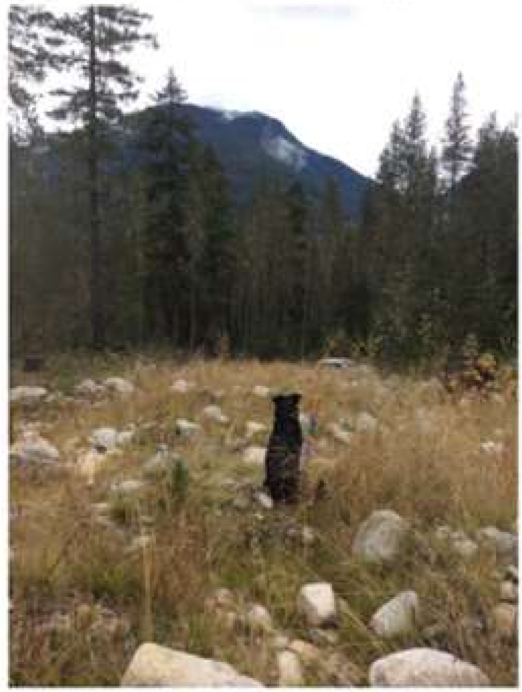
6.3.4 Transmission Line Road 133.1 Summary

Transmission line road 133.1 is deactivated and is not drivable. The soils are coarse and there is lots of surface rock present on the site. This site was grass seeded with a fall rye blend. Lodgepole pine and black cottonwood numbers have remained the same since 2020. Both species are growing vigorously onsite with heights ranging from 100 to 200 cm in height. Douglas fir naturals continue to infill with sph increasing from 400 in 2020 to 2000 in 2023. Western red cedar is also present on site. The Douglas fir and Western red cedar range from 15 to 40 cm in height. The number of black cottonwoods sph has remained stable at 200 sph. Shrub diversity has decreased with falsebox, bitter cherry, trailing blackberry, and red raspberry no longer present onsite. No soil erosion or siltation issues were noted, and no further revegetation treatments are required.

Figure 16 depicts the pictures taken at this site and Table 12 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 133.1/Plot: Plot 27/Comments
Sep 18, 2018 10.34.16 AM.jpg

Card: Transmission Line
Stratum: 2020 133.1/Plot: 27/Comments
Overview photo looks South from plot 27.jpg



Card: Transmission Line Surveys
Stratum: 2023 133.1/Plot: 27/Plot Name
Overview photo looks South from plot 27.jpeg

Figure 55A. 133.1 Plot 27 Photos from 2018, 2020 and 2023

Table 12. 133.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Lodgepole Pline			Western Red Cedar			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
133.1	0	400	2,000	0	800	800	0	0	200	**0**	**1,200**	**2,800**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			**Total SPH Deciduous**		
	2018	2020	2023	**2018**	**2020**	**2023**
133.1	0	200	200	**0**	**200**	**200**

Shrub Diversity From Plot Data (SPH)

Site	Bitter Cherry			Blackcap Raspberry			Falsebox			Red Raspberry			Saskatoon		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
133.1	0	200	0	0	0	200	0	200	0	0	400	0	0	0	600

Shrub Diversity From Plot Data (SPH) continued

Site	Trailing Blackberry			**Total SPH Shrubs**		
	2018	2020	2023	**2018**	**2020**	**2023**
133.1	200	0	0	**200**	**800**	**800**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
133.1	0	2	3	0	1	1	1	3	2	**1**	**6**	**6**

6.3.5 Transmission Line Road 140.1 Summary

Transmission line road 140.1 is deactivated and is not drivable. Scattered coarse woody debris was added to the road after soils were decompacted. This site has been recolonized heavily by red alders suckering up from the stand that previously occupied the site. The number of red alder sph have decreased by almost half since 2020 this is due to stem exclusion that occurs as the site reaches full occupancy. The red alder continues to grow vigorously with heights over 300 cm. Due to low light levels in the stand many of the shade intolerant species have reduced numbers or have disappeared altogether from the plot. The shrubs growing under the canopy of red alder are spindly and are growing slowly. This site is expected to become less diverse over time. The Western red cedar is growing ok under the canopy as it is tolerant of low light levels. Moss cover is increasing slowly. No soil erosion or siltation issues were noted, and no further revegetation treatments are required.

This site falls within the WHA 2-399 and is required to have road and access trails deactivated and non-drivable by ATV or 4x4 vehicles. In 2023 when the access points at this site and inspection site 141.1 were reassessed, they remained non-drivable. The second requirement is that at least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs. This requirement is not required for the road access points due to their proximity to the Lillooet South FSR. The upland areas have a good mix of berry producing shrubs such as thimbleberry, raspberry, and red osier dogwood.

Figure 17 depicts the pictures taken at this site and Table 13 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 140.1/Plot: Plot 35/Comments
Oct 03, 2018 11.08.39 AM.jpg

Card: Transmission Line
Stratum: 2020 140.1/Plot: 35/Comments
Overview photo looks South from plot 35.jpg

Card: Transmission Line Surveys
Stratum: 2023 140.1 Road/Plot: 35/Plot Name
Overview photo looks South from plot 35.jpeg

Figure 56. 140.1 Plot 35 Photos from 2018, 2020 and 2023

Table 13. 140.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Western Red Ceder			**Total SPH Conifers**		
	2018	2020	2023	**2018**	**2020**	**2023**
140.1	0	2,000	1,200	**0**	**2,000**	**1,200**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			Paper Birch			Red Alder			**Total SPH Deciduous**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
140.1	12,000	6,200	400	0	400	0	26,400	27,800	16,600	**38,400**	**34,400**	**17,000**

Shrub Diversity From Plot Data (SPH)

Site	Red Osier Dogwood			Red Raspberry			Saskatoon			Thimbleberry			Willow			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
140.1	0	200	200	0	200	0	0	0	400	3,000	1,600	2,800	0	200	0	**3,000**	**2,200**	**3,400**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
140.1	0	1	1	2	3	2	1	4	3	**3**	**8**	**6**

6.3.6 Transmission Line Road 163.1 Summary

Transmission line road 163.1 is not deactivated. The plot was established in the middle road in 2018. When the plot was revisited in 2020 the rebar was found on the side of the road and the original plot center could not accurately be relocated. The plot was re-established off the side of the road. Due to different plot locations and the spur road not being deactivated this site should be dropped from revegetation monitoring program. If the road is no longer required to access the transmission line, it should be deactivated. This could be completed by decompacting the road and adding coarse woody debris or something less permanent such as putting boulders at the junction of the spur road and the South Lillooet FSR to block access. Plot data was not collected for this site in 2023. Despite not being deactivated this road continues to infill with shrubs and deciduous species.

Figure 18 depicts the pictures taken at this site. A vegetation density and species diversity table were not included for this site as no new data was collected for 2023.

Card: Transmission Line
Stratum: 2018 163.1/Plot: 35/Comments
Sep 25, 2018 02.02.25 PM.jpg

Card: Transmission Line
Stratum: 2020 163.1/Plot: 35A/Comments
Overview photo looks up road from FSR.jpg

Card: Transmission Line Surveys
Stratum: 2023 163.1 Road/Plot: 35A/Plot Name
Overview photo looks South from plot 35A.jpeg

Figure 57. 163.1 Plot 35A Photos from 2018, 2020 and 2023

6.3.7 Transmission Line Road 237.1 Summary

The plot for transmission line road 237.1 is located within the transmission line right of way, this area was cleared to avoid creating a fringe of standing timber between the transmission line and the Ryan River FSR. The road is deactivated and is not drivable. Coarse woody debris was placed on the road and soils were decompacted. The site was partially brushed this summer when the brushing crew accessed the transmission line, however there were still some shrubs and hardwoods remaining. Because of this the plot data was included, but the species count in the plots no longer accurately depict the recovery of the site. This site continues to be dominated by thimbleberry and Douglas fir naturals. The number of sph of thimbleberry has not increased very much but the height and width of the plants has increased significantly covering most of the area. Red alder and bigleaf maple are no longer present in the stem count but will sucker from the cut stumps. Moss cover is increasing slowly. No soil erosion or siltation issues were noted, and no further revegetation treatments are required.

Figure 19 depicts the pictures taken at this site and Table 14 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 237.1/Plot: 34/Comments
Sep 25, 2018 11.25.07 AM.jpg

Card: Transmission Line
Stratum: 2020 237.1/Plot: 34/Comments
Overview photo looks South from plot 34.jpg

Card: Transmission Line Surveys
Stratum: 2023 237.1/Plot: 34/Plot Name
Overview photo looks S from 34 .jpeg

Figure 58. 237.1 Plot 34 Photos from 2018, 2020 and 2023

Table 14. - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Western Red Cedar			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
237.1	0	8,800	3,800	0	0	200	**0**	**8,800**	**3,800**

Deciduous Diversity from Plot Data (SPH)

Site	Bigleaf Maple			Black Cottonwood			Red Alder			**Total SPH Deciduous**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
237.1	200	200	0	200	10,800	600	0	400	0	**400**	**11,400**	**600**

Shrub Diversity From Plot Data (SPH)

Site	Faslebox			Highbrush Cranberry			Rose Species			Thimbleberry			Willow			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
237.1	0	600	0	0	400	800	600	0	800	11,000	14,000	14,600	0	1,600	0	**11,600**	**16,600**	**16,200**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
237.1	0	1	2	2	3	1	2	4	4	**4**	**8**	**7**

6.3.8 Transmission Line Road 238.1 Summary

Transmission line road 238.1 is deactivated and is not drivable. Coarse woody debris were placed on the deactivated road and soils were decompacted. This site has moderately rocky soils. Douglas fir germinates have seeded in densely throughout this site with 14,000 sph of germinates and seedlings in 2020, the number of Douglas fir have decreased to 10,600 in 2023. Western red cedar is also starting to infill at a density of200 sph. Dieback of Douglas fir seedlings was expected due to competition for light and nutrients as the shrub species get larger and outcompete the young plants for nutrients and soil moisture. Black cottonwood is no longer present in this plot. The shrub complex has increased in density from 13,200 sph in 2020 to 16,000 sph in 2023 and the crown closure of the shrubs has increased significantly. Bitter cherry is the only new species on site. Douglas spirea and trailing blackberry were not found in the plot in 2023. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil No soil erosion or siltation issues were noted, and no further revegetation treatments are required.

Figure 20 depicts the pictures taken at this site and Table 15 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 238.1/Plot: Plot 33/Latitude
Sep 25, 2018 10.53.46 AM.jpg

Card: Transmission Line
Stratum: 2020 238.1/Plot: 33/Plot Name
Overview photo looks South from plot 33.jpg

Card: Transmission Line Surveys
Stratum: 2023 238.1/Plot: 33/Plot Name
Overview photo looks South from plot 33.jpeg

Figure 59. 238.1 Plot 33 Photos from 2018, 2020 and 2023

Table 15. 238.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Western Red Cedar			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
238.1	0	14,000	10,400	0	0	200	**0**	**14,000**	**10,600**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			**Total SPH Deciduous**		
	2018	2020	2023	**2018**	**2020**	**2023**
238.1	0	200	0	**0**	**200**	**0**

Shrub Diversity From Plot Data (SPH)

Site	Bitter Cherry			Blackcap Raspberry			Ceanothus			Douglas Spirea			Falsebox		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
238.1	0	0	200	0	800	1,200	1,200	2,000	2,000	0	400	0	0	5,200	5,600

Shrub Diversity From Plot Data (SPH) continued

Site	Thimbleberry			Trailing Blackberry			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
238.1	3,200	4,800	7,000	800	0	0	**5,200**	**13,200**	**16,000**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
238.1	0	1	2	0	1	1	3	5	5	**3**	**7**	**8**

6.3.9 Transmission Line Road 239.1 Summary

Transmission line road 239.1 takes off from an existing forestry road. The portion of the road built to access pole 239 is deactivated and looks similar to the other roads in the area regarding natural ingress of trees and shrubs. The plot was established on the active portion of the road, this location was likely chosen due to its location being outside of the transmission line ROW. Plot data was collected in 2020 but it is recommended that the site be dropped from the monitoring program as the original plot location is not part of the road that Innergex was required to deactivate and is actively being used by industry and recreationalists. There was no increase in species diversity and the total sph for the site has decreased from 2000 sph in 2018 to 800 sph in 2020. No plot data was collected for this site in 2023 as the road is still being actively used.

Figure 21 depicts the pictures taken at this site and Table 16 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 239.1/Plot: 32/Comments
Sep 25, 2018 10.27.43 AM.jpg

Card: Transmission Line
Stratum: 2020 239.1/Plot: 32/Comments
Overview photo looks South from plot 32.jpg

Figure 60. 239.1 Plot 32 Photos from 2018 and 2020

Table 16. 239.1 - Vegetation Density and Species Diversity from 2018 to 2020

* Indicates data was not recorded in 2023

Coniferous Diversity From Plot Data (SPH)			
Site	**Total SPH Conifers**		
	2018	**2020**	**2023**
239.1	**0**	**0**	**0**

Deciduous Diversity from Plot Data (SPH)						
Site	Black Cottonwood			**Total SPH Deciduous**		
	2018	2020	2023	**2018**	**2020**	**2023**
239.1	800	400	*	**800**	**400**	*****

Shrub Diversity From Plot Data (SPH)						
Site	Thimbleberry			**Total SPH Shrubs**		
	2018	2020	2023	**2018**	**2020**	**2023**
239.1	1,200	400	*	**1,200**	**400**	*****

Number of Species by Site												
Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
239.1	0	0	*	1	1	*	1	1	*	**2**	**2**	*****

6.3.11 Transmission Line Road 245.1 Summary

Transmission line road 245.1 is located on a moderately steep slope and is deactivated. Coarse woody debris was placed on the road, soils are rocky and well drained. This site increased significantly in biodiversity between 2018 and 2020. Between 2020 and 2023 species diversity decreased by a third, the site was visually assessed and the vegetation density appears to have increased since 2020.. The remaining plants have increased in size over the last five years and take up more area throughout the site. Some of the larger shrubs have grown together making it difficult to count individual plants. The two species that have increased in density and cover are thimbleberry and ceanothus. The remaining Douglas fir are growing well onsite and have an average height of 50 cm. Black cottonwood is no longer present and paper birch numbers have decreased by half. The remaining paper birch stems are taller than the thimbleberry and ceanothus and are not expected to be outcompeted by the shrubs. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil. No soil erosion or siltation issues were noted, and no further revegetation treatments are required.

Figure 22 depicts the pictures taken at this site and Table 17 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 245.1/Plot: 26/Comments
Sep 12, 2018 01.52.39 PM.jpg

Card: Transmission Line
Stratum: 2020 245.1/Plot: 26/Comments
Overview photo looks South from plot 26.jpg

Card: Transmission Line Surveys
Stratum: 2023 245.1 Road/Plot: 26/Plot Name
Overview photo looks S from 26.jpeg

Figure 61. 245.1 Plot 26 Photos from Photos from 2018, 2020 and 2023

Table 17. 245.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Western Red Cedar			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
245.1	0	8,200	4,000	0	600	0	**0**	**8,800**	**4,000**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			Paper Birch			Red Alder			**Total SPH Deciduous**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
245.1	0	1,000	0	0	400	200	1,000	0	0	**1,000**	**1,400**	**200**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry			Ceanothus			Douglas Spirea			Falsebox			Gooseberry		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
245.1	0	5,800	1,600	0	2,600	3,200	0	400	0	0	1,400	1,000	400	0	0

Shrub Diversity From Plot Data (SPH) continued

Site	Hardhack spirea			Highbrush Cranberry			Red Raspberry			Thimbleberry			Trailing Blackberry			**Total SPH Shru**	
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**
245.1	0	0	1,200	0	600	200	0	600	0	11,000	3,400	5,200	400	1,200	0	**11,800**	**16,000**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
245.1	0	2	1	1	2	1	3	8	6	**4**	**12**	**8**

6.3.12 Transmission Line Road 247.1/249.1 Summary

Spur road 247.1/249.1 is deactivated and is not drivable. The plot was established at the junction of the two roads. Soils are rocky and well drained. In 2018 this site was dominated by herbaceous cover and had minimal woody species diversity with only thimbleberry and ceanothus present in 2018. Conifer and shrub diversity have increased significantly since 2018 with 2000 sph of Douglas fir and 600 sph of bigleaf maple. New shrub species onsite have infilled naturally, and include raspberry species, high brush cranberry and Douglas spirea. The Douglas fir and bigleaf maple will eventually require brushing to maintain transmission line security. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil. No soil erosion or siltation issues were noted.

This site was manually brushed this summer and the rebar plot center could not be located. No new data was collected for the final monitoring year, but it can be assumed that the site continued to recover. No further revegetation treatments are required.

Figure 23 depicts the pictures taken at this site and Table 18 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 247.1 / 249.1/Plot: 25/Comments
Sep 12, 2018 01.30.59 PM.jpg

Card: Transmission Line
Stratum: 2020 247.1/249.1/Plot: 25/Comments
Oct 02, 2020 11.54.59 AM.jpg

Figure 62. 247./249.1 Plot 25 Photos from 2018 and 2020

Card: Transmission Line
Stratum: 2018 247.1 / 249.1/Plot: 25/Comments
Sep 12, 2018 01.30.59 PM.jpg

Card: Transmission Line
Stratum: 2020 247.1/249.1/Plot: 25/Comments
Oct 02, 2020 11.54.59 AM.jpg

Figure 63. 247./249.1 Plot 25 Photos from 2018 and 2020

Table 18. 247./249.1 - Vegetation Density and Species Diversity from 2018 to 2020

* Indicates data was not recorded in 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Total SPH Conifers		
	2018	2020	2023	**2018**	**2020**	**2023**
247.1/249.1	0	2,000	*	**0**	**2,000**	*

Deciduous Diversity from Plot Data (SPH)

Site	Bigleaf Maple			Total SPH Deciduous		
	2018	2020	2023	**2018**	**2020**	**2023**
247.1/249.1	0	600	*	**0**	**600**	*

Shrub Diversity From Plot Data (SPH)

Site	Birchleaf Spirea			Blackcap Raspberry			Ceanothus			Falsebox			Highbrush Cranberry		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
247.1/249.1	0	200	*	0	4,600		1,200	2,000	*	0	10,800	*	0	400	*

Shrub Diversity From Plot Data (SPH) continued

Site	Red Raspberry			Thimbleberry			Total SPH Shrubs		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
247.1/249.1	0	5,600	*	7,600	13,000	*	**8,800**	**36,600**	*

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			Total Number of Species		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
247.1/249.1	0	1	*	0	1	*	2	7	*	**2**	**9**	*

6.3.13 Transmission Line Road 250.1 Summary

Transmission line road 250.1 is deactivated and is not drivable. Large pieces of coarse woody debris were placed across the decompacted road. Soils are rocky and well drained. Douglas fir and Western red cedars have infilled naturally at 16,800 sph and 200 sph respectively. The conifers are still small, and some mortality is expected to occur due to competition from the emerging shrub complex. Thimbleberry sph and cover have increased significantly on this site from 1800 sph in 2018 to 5000 sph in 2020. Other new shrub species onsite include falsebox, ceanothus, black cap raspberry and lesser amounts of high brush cranberry and prince's pine. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil. No soil erosion or siltation issues were noted, and no further revegetation treatments are required.

This site was manually brushed this summer and the rebar plot center could not be located. No new data was collected for the final monitoring year, but it can be assumed that the site continued to recover. No further revegetation treatments are required. The photo below was taken in the general area of plot and looks up the transmission line across the brushed area.

Figure 24 depicts the pictures taken at this site and Table 19 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 250.1/Plot: 24/Comments
Sep 12, 2018 01.00.12 PM.jpg

Card: Transmission Line
Stratum: 2020 250.1/Plot: 24/Comments
Overview photo looks South from plot 24.jpg

Card: Transmission Line Surveys
Stratum: 2023 250.1 Road/Plot: 24/Plot Name
Area was recently manually brushed.jpeg

Figure 64. 250.1 Plot 24 Photos from Photos from 2018, 2020 and 2023

Table 19. 250.1 - Vegetation Density and Species Diversity from 2018 to 2020

* Indicates data was not recorded in 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Western Red Cedar			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
250.1	0	16,800	*	0	200	*	**0**	**18,800**	*****

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			Red Alder			**Total SPH Deciduous**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
250.1	0	3,600	*	200	0	*	**200**	**3,600**	*****

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry			Ceanothus			Falsebox			Gooseberry			Highbrush Cranberry		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
250.1	0	1,000	*	0	1,200	*	0	2,600	*	200	0	*	0	200	*

Shrub Diversity From Plot Data (SPH) contined

Site	Prince's Pine			Thimbleberry			Trailing Blackberry			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
250.1	0	200	*	1,800	5,000	*	200	0	*	**2,200**	**10,200**	*****

Number of Species by Site

Site	Total Number of Coniferous			Total Number of Deciduous			Total Number of Shrub			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
250.1	0	2	*	1	1	*	3	6	*	**4**	**9**	*****

6.3.14 Transmission Line Road 255.1 Summary

Transmission line road 255.1 is deactivated, and wood chipping was completed onsite. This site has increased significantly in biodiversity and stem counts for conifers, deciduous trees, and shrubs. In the 2018 survey there were no conifers. Douglas fir naturals have seeded in heavily since 2018 with 8600 sph in 2020 and is up to 24,200 in 2023. Western red cedar has also infilled at 1200 sph and is currently at a density of 1800 sph. Western hemlock has remained at 200 sph and Western white pine is now present on the site with 200 sph. The Douglas fir have an average height of 50 cm and the rest of the conifers range from 10 to 15 cm. The shrub complex has not increased in species diversity but the number of sph has increased from 24,800 in 2020 to 38,200 in 2023. Due to this road location within the ROW the site will eventually require manual brushing to maintain line security. Moss cover is increasing slowly. No soil erosion or siltation issues were noted. No further revegetation treatments are required for this site.

Figure 25 depicts the pictures taken at this site and Table 20 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 255.1/Plot: 23/Plot Name
Sep 12, 2018 11.51.29 AM.jpg

Card: Transmission Line
Stratum: 2020 255.1/Plot: 23/Comments
Overview photo looks NW from plot 23.jpg

Card: Transmission Line Surveys
Stratum: 2023 255.1 Road/Plot: 23/Plot Name
Overview photo looks South from plot 23.jpeg

Figure 65. 255.1 Plot 23 Photos from 2018 Photos from 2018, 2020 and 2023

Table 20. 255.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			Western Hemlock			Western Red Cedar			Western White Pine			**Total SPH Conifers**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
255.1	0	8,000	24,200	0	200	200	0	1,200	1,800	0	0	200	**0**	**9,400**	**26,400**

Deciduous Diversity from Plot Data (SPH)

Site	Black Cottonwood			Paper Birch			Red Alder			**Total SPH Deciduous**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
255.1	0	800	1,200	0	200	0	200	0	0	**200**	**1,000**	**1,200**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry			Ceanothus			Falsebox			Highbrush Cranberry			Red Raspberry		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
255.1	0	3,000	1,600	0	600	2,000	0	5,400	10,600	0	200	200	200	3,400	5,800

Shrub Diversity From Plot Data (SPH) continued

Site	Salmonberry			Thimbleberry			Trailing Blackberry			Willow			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
255.1	0	600	0	1,000	8,600	18,000	600	2,600	0	0	400	0	**1,800**	**24,800**	**38,200**

Number of Species by Site

Site	Total Number of Coniferous Species			Total Number of Deciduous Species			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
255.1	0	3	4	1	2	1	3	9	6	**4**	**14**	**11**

6.3.15 Transmission Line Road 260.1 Summary

Transmission line road 260.1 is deactivated, soils were decompacted and large boulders have been placed across the road to block access. This site has increased in species diversity and sph since 2020. There are now 600 sph of Douglas fir, with an average height of 30 cm and are of good form and vigour. The bigleaf maple and black cottonwood numbers have increased since 2020 up from 600 sph to 1000 sph in 2023.The shrub complex continues to increase in density and crown closure. As this site is within the transmission line ROW, the hardwoods will eventually need to be brushed to maintain line security. Moss cover is increasing slowly. No soil erosion or siltation issues were noted. No further revegetation treatments are required for this site.

Figure 26 depicts the pictures taken at this site and Table 21 depicts the change in plant densities and diversity between 2018, 2020, and 2023.

Card: Transmission Line
Stratum: 2018 260.1/Plot: 21/Comments
Sep 12, 2018 10.03.55 AM.jpg

Card: Transmission Line
Stratum: 2020 260.1/Plot: 21/Comments
Overview photo looks South from plot 21.jpg

Card: Transmission Line Surveys
Stratum: 2023 260.1 Road/Plot: 21/Plot Name
Overphoto looks south from 21.jpeg

Figure 66. 260.1 Plot 21 Photos from Photos from 2018, 2020 and 2023

Table 21. 260.1 - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Douglas Fir			**Total SPH Conifers**		
	2018	2020	2023	**2018**	**2020**	**2023**
260.1	0	0	600	**0**	**0**	**600**

Deciduous Diversity from Plot Data (SPH)

Site	Bigleaf Maple			Black Cottonwood			**Total SPH Deciduous**		
	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
260.1	200	600	800	200	0	200	**400**	**600**	**1000**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry			Red Raspberry			Saskatoon			Sitka Alder			Thimbleberry			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
260.1	0	1,800	1,200	1,000	0	10,400	200	400	0	0	200	0	7,800	8,400	5,800	**9,000**	**10,800**	**17,400**

Number of Species by Site

Site	Total Number of Coniferous			Total Number of Deciduous			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
260.1	0	0	1	2	1	2	3	4	3	**5**	**5**	**6**

6.3.16 Ryan Crossing Summary

The Ryan Crossing site is located in a narrow corridor with rich organic soils and low light levels. Western red cedar, a low light tolerant species is seeding in naturally from the adjacent stand. The number of seedlings has decreased from 1000 sph in 2020 to 600 sph in 2023. No deciduous stems have infilled on this low light site. Shrub densities have also decreased but the plant size and heights are slowly increasing. Species diversity of the shrubs has increased. Saskatoon, and red elderberry are now present on the site. No erosion or siltation issues were noted. Increases in moss cover are minimal but soil processes are ongoing due to leaf fall from surrounding hardwoods and shrubs. No further revegetation treatments are required for this site.

Figure 27 depicts the pictures taken at this site and Table 22 depicts the change in plant densities and diversity between 2018, 2020, and 2023

Card: Transmission Line
Stratum: 2018 Ryan Crossing/Plot: 22/Comments
Sep 12, 2018 10.55.04 AM.jpg

Card: Transmission Line
Stratum: 2020 Ryan Crossing/Plot: 22/Comments
Overview photo looks South from plot 22.jpg

Card: Transmission Line Surveys
Stratum: 2023 Ryan Crossing/Plot: 22/Plot Name
Overview photo looks South from plot 22.jpeg

Figure 67. Ryan Crossing Photos from 2018, 2020 and 2023

Table 22. Ryan Crossing - Vegetation Density and Species Diversity from 2018 to 2023

Coniferous Diversity From Plot Data (SPH)

Site	Western Red Ceder			**Total SPH Conifers**		
	2018	2020	2023	**2018**	**2020**	**2023**
Ryan Crossing	600	1,000	600	**600**	**1,000**	**600**

Deciduous Diversity from Plot Data (SPH)

Site	**Total SPH Deciduous**		
	2018	**2020**	**2023**
Ryan Crossing	**0**	**0**	**0**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry			Red Osier Dogwood			Thimbleberry			Trailing Blackberry			Salmonberry		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023	2018	2020	2023
Ryan Crossing	0	600	0	0	400	0	4,200	7,400	6,600	600	0	0	0	0	400

Shrub Diversity From Plot Data (SPH) continued

Site	Saskatoon			Pacific Dogwood			Red Elderberry			**Total SPH Shrubs**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Ryan Crossing	0	0	400	0	0	200	0	0	200	**4,800**	**8,400**	**7,800**

Number of Species by Site

Site	Total Number of Coniferous			Total Number of Deciduous			Total Number of Shrub Species			**Total Number of Species**		
	2018	2020	2023	2018	2020	2023	2018	2020	2023	**2018**	**2020**	**2023**
Ryan Crossing	1	1	1	0	0	0	2	3	5	**3**	**4**	**6**

6.3.17 Transmission Line Survey Results Summary

6.4. Quadrat Survey Results

The quadrat data has been summarized separately for the civil works sites and transmission line road sites. The data sets were separated for ease of viewing the tables. The civil works site has been further separated into the sites that had three sets of data collected and the sites that only had two sets of data collected. The Quadrat surveys were completed in 2018 (Year 1) in 2020 (Year 3) and a final time in 2023 (Year 5). The data from the two quadrat plots was collected as outlined in Section 5.2 of this document. For comparison the percent cover data was averaged and then compared to the averaged data collected in 2018 and 2020. The three years of data are displayed in below in Figures 28 to 36.

Some sites had small decreases in percent cover in one of the layers. This was anticipated as some plants were expected to succumb to site limiting factors such as drought, interplant competition or biotic damage. Decreases in one layer led to increases in other layers. This is typical in developing plant communities and is an indication of a recovering site.

6.4.1 Civil Works Sites Quadrat Survey Results

For the civil works sites the results of the quadrat survey continue to be positive. The data indicates that the percent ground cover continues to increase in all layers with the tree layer making the largest increase since 2020. The tree layer had less than 1% cover in 2018, increasing to 4% in 2020 and increasing exponentially to 20% in 2023. The shrub cover layer had moderate increases in percent cover from 2% in 2018 to 6% in 2020 and up to 9% in 2023. The herb layer also increased significantly from 5% in 2018, up to 11% in 2020 and more than doubling in 2023 to 23%. Within the individual sites there were some decreases in the herb cover, this is due to the shrub and tree layers becoming more established and shading out the light dependant herb species. The incremental increases in vegetation cover demonstrate that the planted and natural species are continuing to grow in size as well as number, and continue to occupy more of these reclaimed sites.

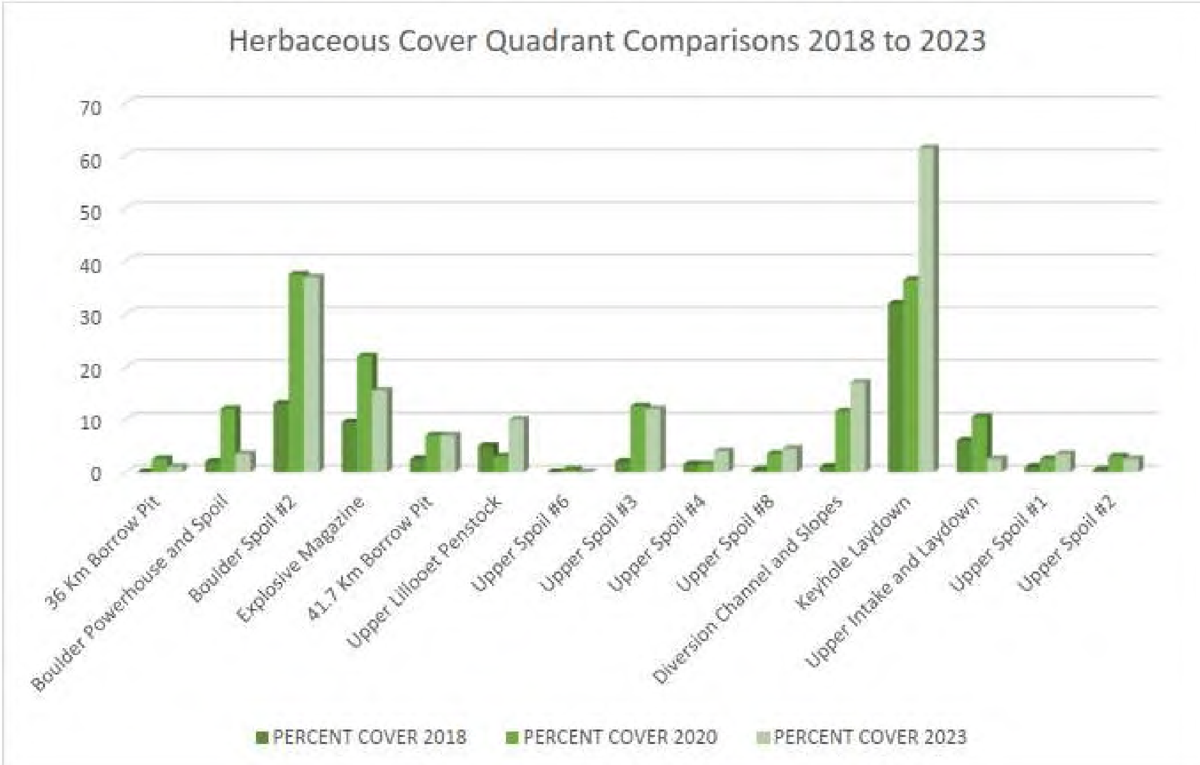


Figure 68. Civil Works Sites - Percent Cover of Herbaceous Layer from Quadrat Plot Data

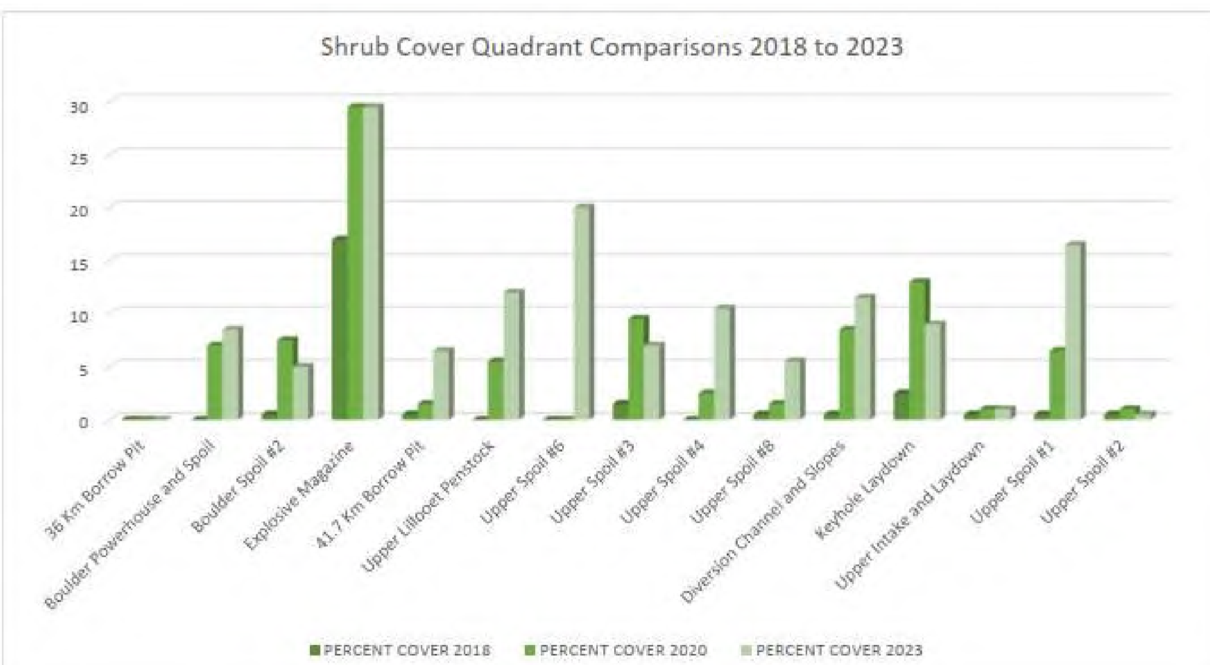


Figure 69. Civil Works Sites - Percent Cover of Shrub Layer from Quadrat Plot Data

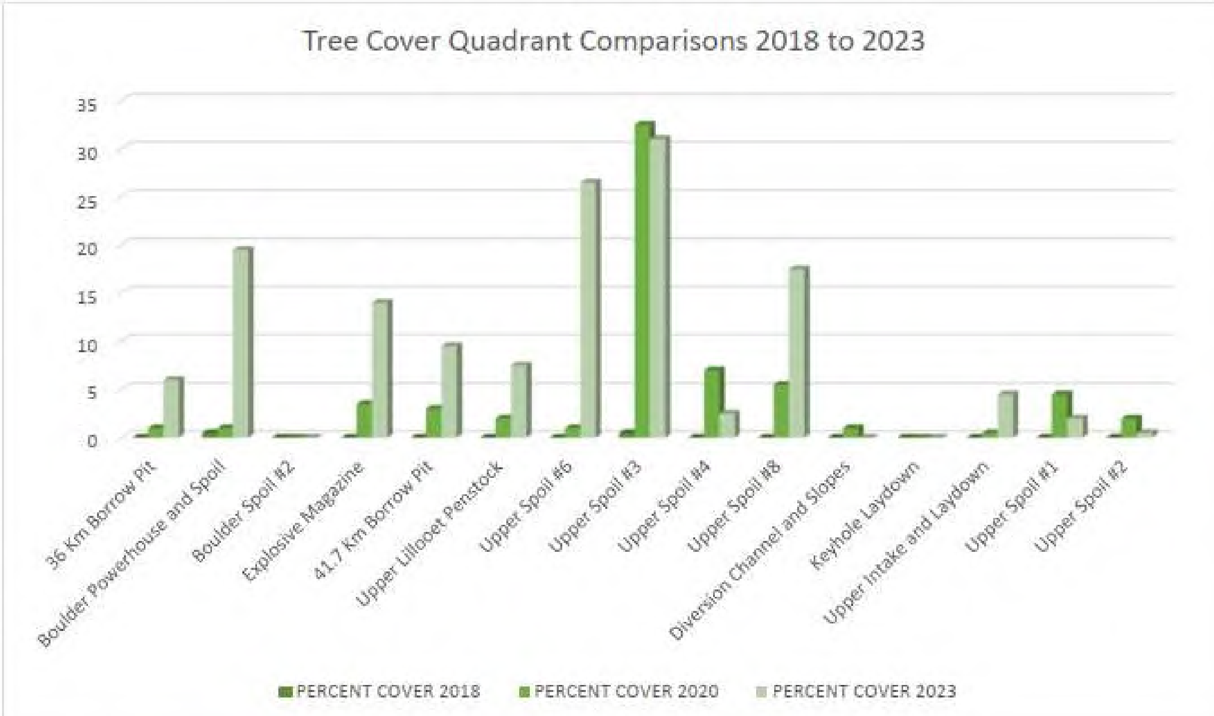


Figure 70. Civil Works Sites - Percent Cover of Tree Layer from Quadrat Plot Data

6.4.2 Civil Works Sites from 2020 to 2023 Quadrat Survey Results

The civil works sites that were planted in 2019 were separated out as they only had data collected on them in 2020 one year after planting and a second time in 2023. These sites were planted with a variety of conifers the shrubs and herbs were left to come back naturally. Like the other sites within the civil works area all three layers continue to increase. In 2020 the tree layer had 4% cover; this has increased rapidly to 20% in 2023. The Shrub layer is increasing a bit slower, from 4% in 2020 to 9% in 2023. Some of the sites surveyed in this group are cold higher elevation sites where shrub ingress is often slower. The herb layer continues to fill in with 12% cover in 2020 up to 18% in 2023. All three layers are anticipated to continue to rise until the sites reach full occupancy and the herb and shrub layers are shaded out by the tree layers. The quadrat data indicates these sites are continuing to recover as the planted and natural species grow and fill in the sites.

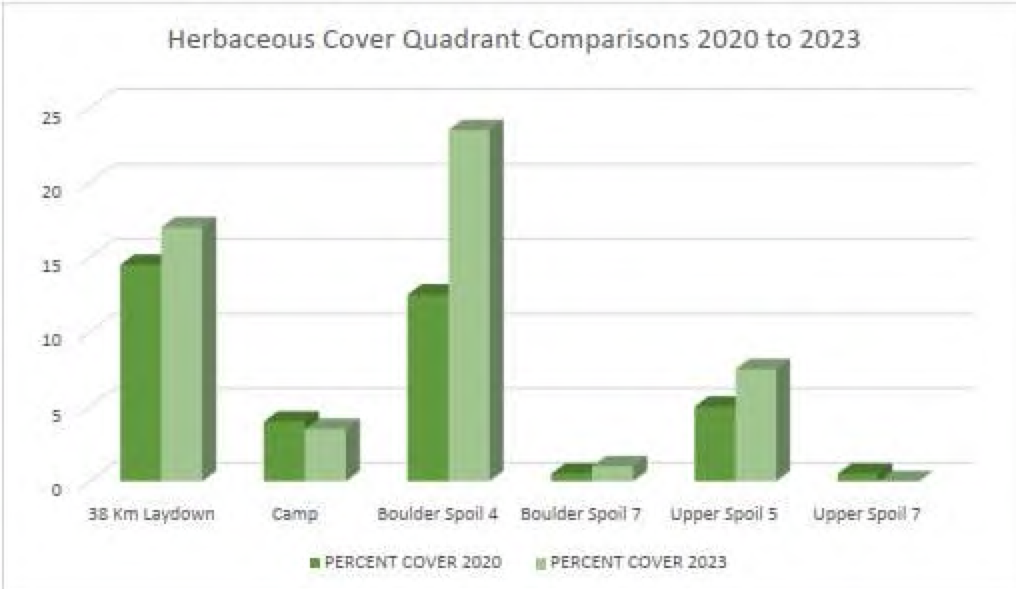


Figure 71. Civil Works Sites 2020 to 2023 - Percent Cover of Herbaceous Layer from Quadrat Plot Data

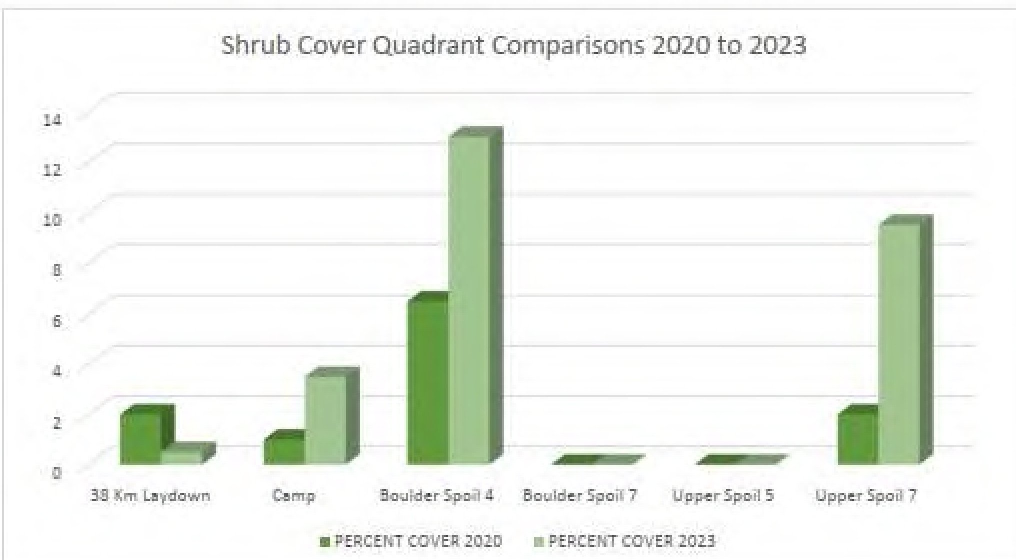


Figure 72. Civil Works Sites 2020 to 2023 - Percent Cover of Shrub Layer from Quadrat Plot Data

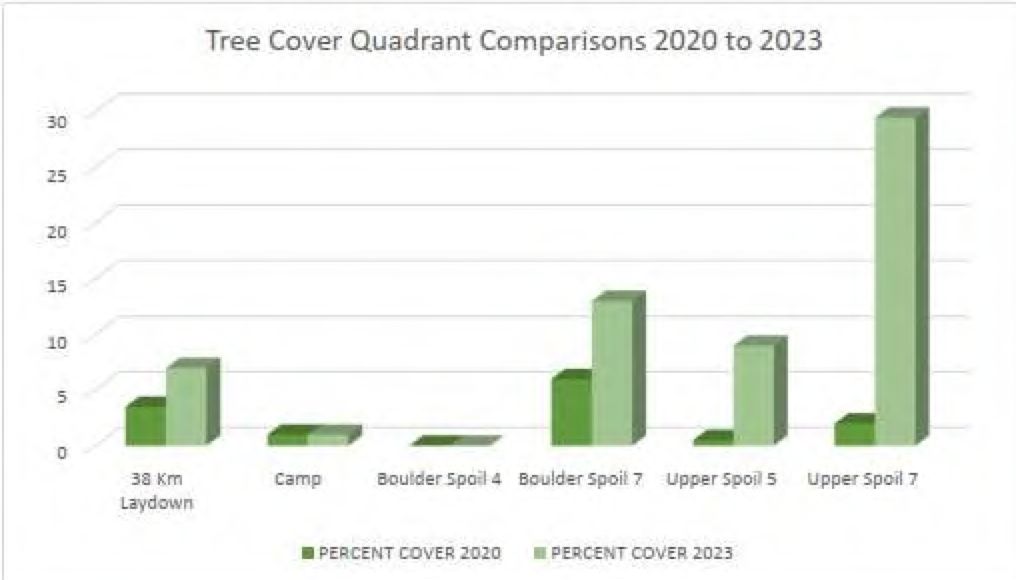


Figure 73. Civil Works Sites 2020 to 2023 - Percent Cover of Tree Layer from Quadrat Plot Data

6.4.3 Transmission Line Quadrat Survey Results

For the transmission line road sites, the results of the quadrat survey are also positive. The shrub and tree layers had the largest gains in percent cover in 2023. The tree layer is developing quickly now that the trees in the quadrat are established and starting to increase in size. In 2018 the tree layer had an average cover of 1%, this increased to 4% in 2020 and increased significantly to 17% in 2023. The shrub layer also continues to increase on almost all sites where shrub cover was measurable. Site 237.1 had a decrease in cover due to brushing activities. Gains in percent cover for the shrub layer went from 4% in 2018 to 13% in 2020 and up to 46% in 2023. The shrub layer is anticipated to continue to cover until the tree layer is tall enough to begin shading out the shrub layer. The herb layer had a moderate decrease in percent cover between 2020 and 2023. There are two possible reasons for the decrease, the first reason is the tree and shrub layers are taking up more space and therefore decreasing the available light to the mostly shade intolerant herbs. The second reason is the extended drought conditions of 2022 and 2023 reduced the vigour of the herbaceous species. At the time of the data collection many of the herbs were dying off. In 2018 the herbaceous layer had an average cover of 10%, increasing to 44% in 2020 and then dropping to 30% in 2023. The herb layer is anticipated to decrease over the next few years as the tree and shrub layers continue to grow. The quadrat surveys have shown that the combined percent cover of all layers continues to increase demonstrating that the sites are recovering from the disturbance.

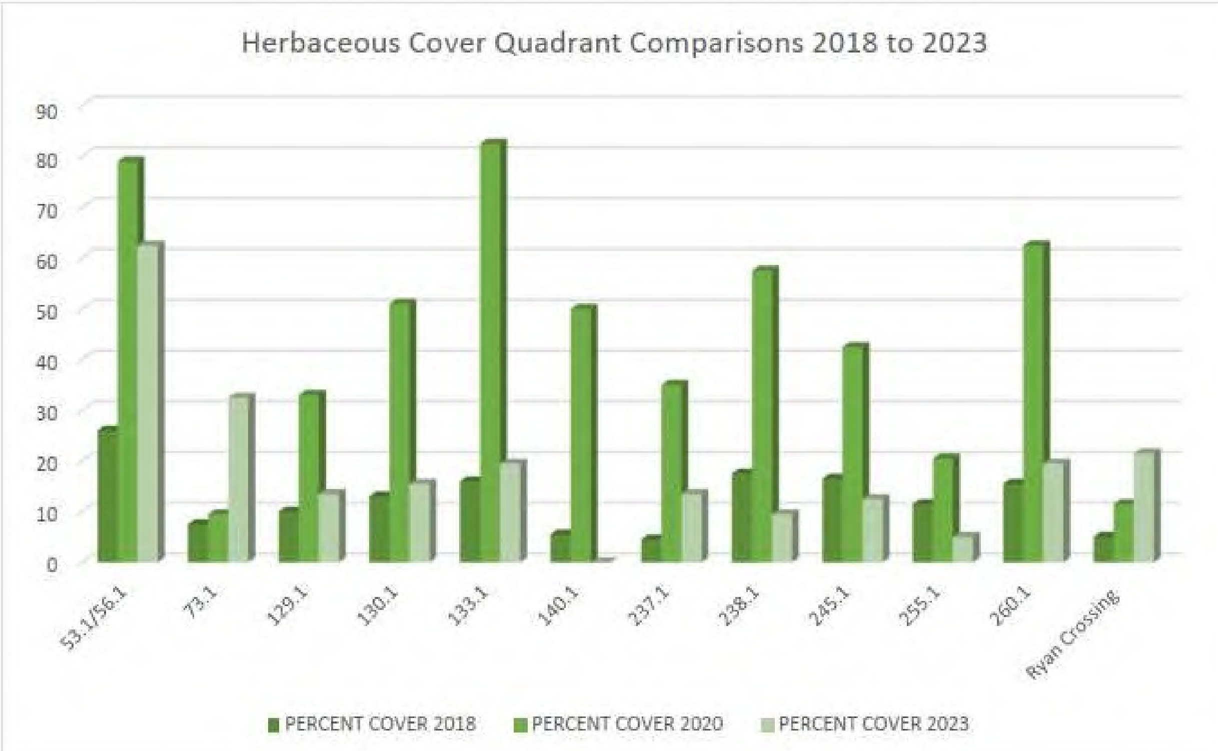


Figure 74. Transmission Line Sites - Percent Cover of Herbaceous Layer from Quadrat Plot Data

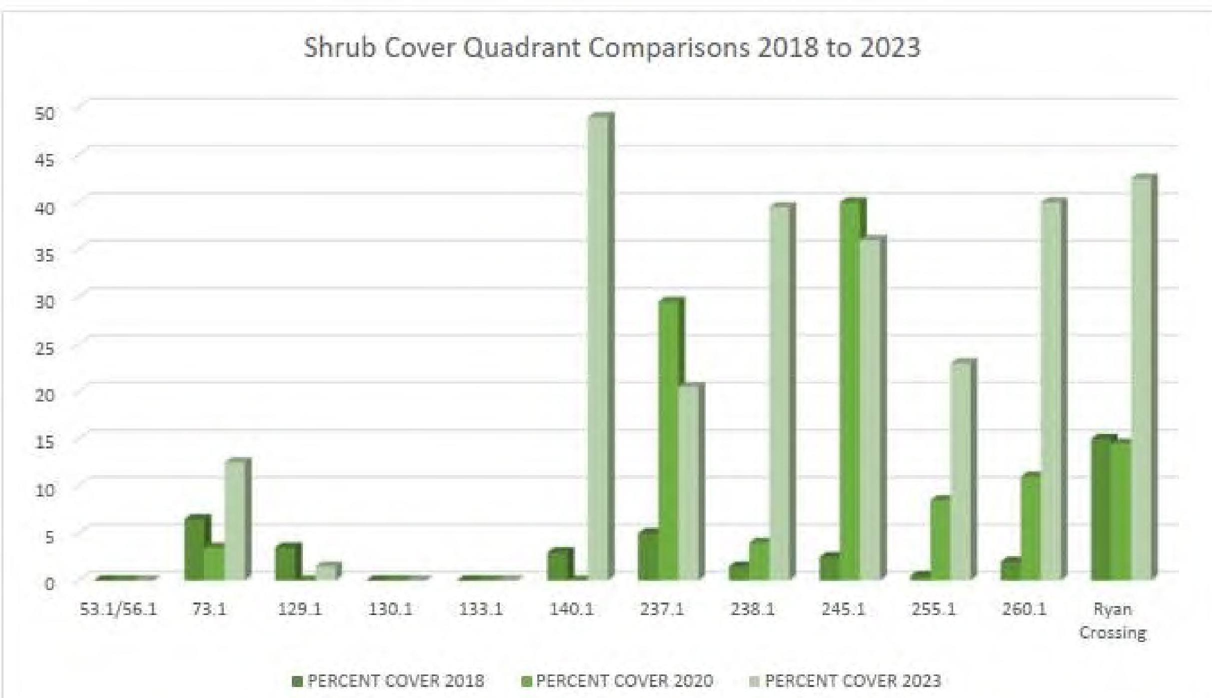


Figure 75. Transmission Line Sites - Percent Cover of Shrub Layer from Quadrat Plot Data

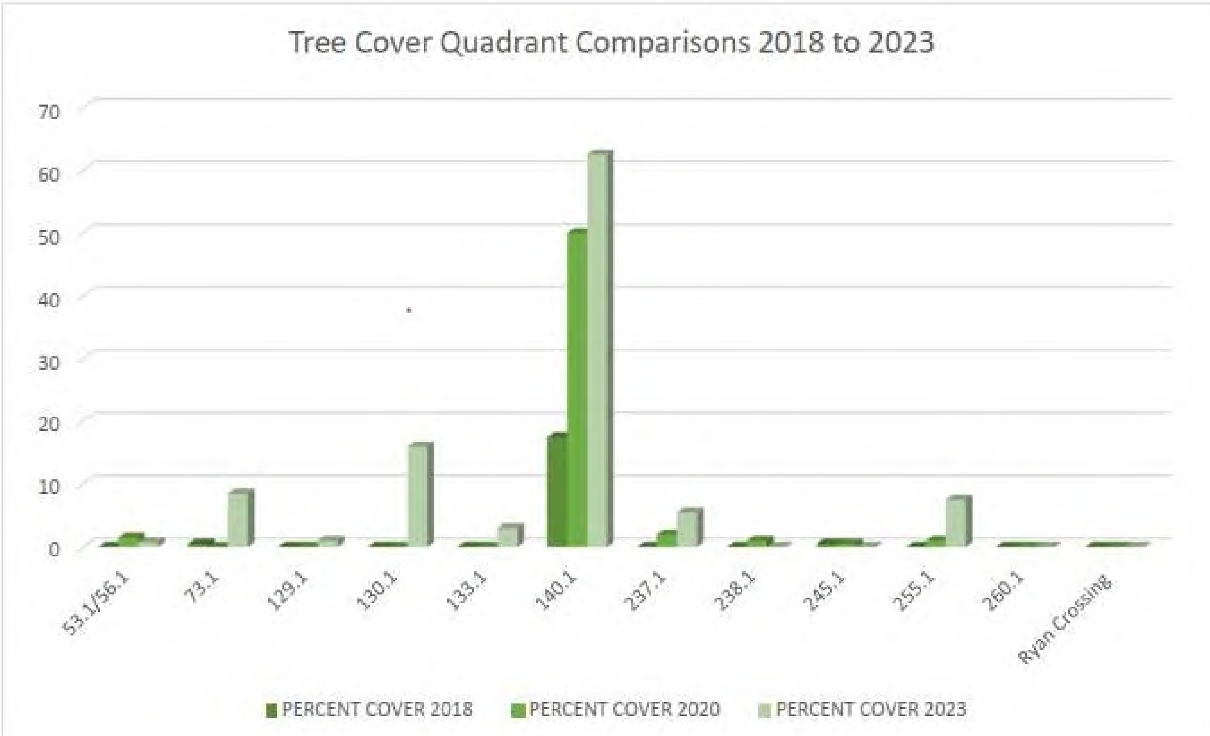


Figure 76. Transmission Line Sites - Percent Cover of Tree Layer from Quadrat Plot Data

6.5. Invasive Plants Monitoring Results

Invasive species are often found on disturbed sites where other native vegetation have not yet colonized the area. Depending on the species and number of plants found on the site these plants may out compete native vegetation for light, water and nutrients and can be unpalatable to wildlife species. When left untreated invasive species may decrease the productivity of a site.

In 2018 small numbers of invasive species were noted while assessing the transmission line and civil work sites. These plants were hand pulled and removed from site by the surveyors. During the 2020 field data collection phase three invasive species were identified on thirteen out of the thirty sites that were visited (see Table 28 for a list of sites and number of plants per site). The invasive plants were not pulled during the 2020 field work due to increased numbers. Population densities are still moderately low but have increased since 2018. Invasive plant species found in 2020 are orange hawkweed (*Hieracium aurantiacum*), bull thistle (*Cirsium vulgare*) and St. Johns-wort (*Hypericum perforatum*). Hawk weed, bull thistle and St. Johns-wort are shade intolerant species and do not typically grow well on sites that have moved past the pioneer phase of reestablishment and into seral stages. With the low number of occurrences, increased plant diversity and native plants continuing to occupy more space, the number of invasive plant occurrences is expected to stabilize and eventually decrease.

These three invasive species are not listed in the I*nvasive Weed Control Act* and *Regulation Schedule A* among the 21 noxious species that require treatment. Industrial users are required to annually report to the Invasive Alien Plant Program (IAPP) any newly discovered invasive plant centers as per Section 3.3.2. of the OEMP. Innergex is not required to treat the invasive plants identified in 2020 as they are not among the 21 noxious species. Reporting the invasive species identified within the project area to IAPP is required.

In 2023 no previously unidentified invasive species population centers were found, thus no additional information was recorded. Because the previously identified invasive species are not shade tolerant the site will become increasingly unsuitable for these species as the shrubs and trees increase in size. Numbers are not expected to increase and further invasion by invasive species is not a current concern.

Table 23. Invasive Species Occurrences by Site

Number of Invasive Plant Occurances by Site			
Site	Orange Hawkweed	St. Johns Wart	Bull Thistle
36 Km Borrow Pit	5		
38 Km Laydown	13	5	
Boulder Powerhouse and Spoil	10		
Camp	15		
Diversion Channel and Slopes	9		
Keyhole Laydown	10		
Upper Lillooet Penstock	1		
163.1			
238.1		5	4
239.1		3	
249.1			3
255.1	5		5
260.1			75

6.6. Species Diversity Results

A complete list of tree and shrub species growing in the ULHP civil work and transmission line sites has been compiled in Table 23 and includes common and Latin names for clarity. In 2018 there were 23 different tree and shrub species observed across all project sites. This number increased to 39 in 2020 and remained at 39 species in 2023. The number of coniferous species increased from 5 in 2018 to 8 in 2020 and increased 9 in 2023. Subalpine fir and yellow cedar were not present in 2020 but were found in the 2023 data collection. Ponderosa pine was found in 2020 but was not identified in 2023. Deciduous species diversity has remained stable with trembling aspen being present in 2020 but not in 2023. Ponderosa pine and trembling aspen are not commonly found in the Upper Lillooet River valley. New shrub species identified in 2023 are false azalea and Western trumpet honeysuckle. Shrub species not found in the final year of surveys are birch leaf spirea, prince's pine and trailing black berry. There is good species diversity across the survey areas and the short-term re-vegetation goal of increasing species diversity has been met.

Table 24. **List of Tree and Shrub Species Observed in the Revegetation Monitoring Plots**

Identified Tree and Shrub Species		Present in	Present in	Present in
Common Name	Latin Name	2018	2020	2023
Amabalis Fir	Abies amabalis	√	√	√
Bigleaf Maple	Acer macrophyllum	√	√	√
Birch Leaf Spirea	Spirea betulifolia		√	
Bitter Cherry	Prunus emarginata		√	√
Black Cottonwood	Populus balsamifera	√	√	√
Blackcap Raspberry	Rubus occidentalis		√	√
Ceanothus	Ceanothus velutinus	√	√	√

Douglas Fir	Pseudotsuga menziesii	√	√	√
Douglas Maple	Acer glabrum		√	√
False Azalea	Menziesia ferruginea			√
Falsebox	Paxistima myrsinites	√	√	√
Black Gooseberry	Ribes lacustre		√	√
Hardhack Spirea	Spirea douglassi		√	√
High Brush Cranberry	Viburnum trilobum	√	√	√
Kinnickinnick	Arctostaphylos uva-ursi	√	√	√
Lodgepole Pine	Pinus contorta	√	√	√
Mountain Hemlock	Tsuga mertensiana		√	√
Oregon Grape	Mahonia aquifolium	√	√	√
Pacific Dogwood	Cornus nuttallii		√	√
Paper Birch	Betula papyrifera		√	√
Ponderosa Pine	Pinus ponderosa		√	
Princes Pine	Chimaphila umbellata		√	
Red Alder	Alnus rubra	√	√	√
Red Elderberry	Sambucus racemosa	√	√	√
Red Osier Dogwood	Cornus stolonifera	√	√	√
Red Raspberry	Rubus idaeus	√	√	√
Rose	Rosa species	√	√	√
Salal	Gaultheria shallon	√	√	√
Salmonberry	Rubus spectabilis		√	√
Saskatoon	Amelanchier alnifolia		√	√
Sitka Alder	Alnus crispa		√	√
Sitka Mountain Ash	Sorbus sitchensis		√	√
Spruce	Picea species	√	√	√
Subalpine Fir	Abies lasiocarpa			√
Thimbleberry	Rubus parviflorus	√	√	√
Trailing Blackberry	Rubus ursinus	√	√	
Trembling Aspen	Populus tremuloides		√	
Vaccinium	Vaccinium species	√	√	√
Western Hemlock	Tsuga heterophylla	√	√	√
Western Trumpet Honeysuckle	Lonicera ciliosa			√
Western Red Cedar	Thuja plicata	√	√	√
Western White Pine	Pinus monticola		√	√
Willow	Salix spp	√	√	√
Yellow Cedar	Chamaecyparis nootkatensis			√

7. Conclusions

All long-term revegetation monitoring areas in the ULHP project area that were assessed in 2018 (Year 1) and 2020 (Year 3) and 2023 (Year 5) are showing continual development of revegetation processes. On all sites there has been some fluctuation in density and species diversity of conifers, deciduous trees, and shrubs but overall, the sites are increasing in cover and number of stems. Biodiversity on almost all sites have continued to increase or stayed the same (see Table 29). Within all sites sampled, pioneering species such as thimbleberry, alders, cottonwood, and other early colonizers remain present, and numbers are continuing to increase. Percent ground cover has also increased on all sites (see Figures 22 to 27). The plants that were present on most sites are vigorous and healthy and no major disease infestations or damaged areas were observed. No major erosion issues were noted. Slope shaping, soil decompaction and/or other soil treatments were helped to revegetate the sites and no further actions are required. In conclusion, all sites assessed in 2023 have met project requirements as per Section 5.1 to 5.4 of this document.

Conifer numbers have increased significantly from 2018 (Year 1) to 2023 (Year 6). On some sites there are less conifers and deciduous trees. This is due to counting germinates (trees < 10 cm in height) as trees and not all germinates surviving due to small root systems and increased susceptibility to high temperatures, drought conditions and long winters under snowpack. Very few trees over 15 cm in height were found dead. If a small to moderate amount of conifer mortality occurs in the future most sites will still be above the target of 1000 sph. Almost all sites that were planted with conifers in 2017 and 2018 are not reliant on germinates to meet target stocking levels. There are two sites within the Civil work sites that were found to be stocked with less than 1000 sph of conifers. Boulder Spoil #2 and Boulder Spoil #7 are located on the Boulder Intake Road. The sites have warm Western aspects and rapidly draining rocky compact soils. Reforestation of these sites was expected to be difficult and take longer to revegetate than other sites within the project. Boulder spoil #2 has 0 sph of conifers. The vegetation that is currently present is well established and will continue to provide additional organic matter to the soil, in addition to other soil development contributions, that will allow for the slow introduction of later successional species. The adjacent stand will provide a viable seed source, of Douglas Fir and Western Red Ceder, once the soil has been further developed by early successional species. Boulder spoil #7 has 800 sph of conifers, in addition to a continuous ingress of Black Cottonwood stems. The 800 sph of remaining conifers are now well established and most trees are in good condition. Extensive reductions in conifer densities throughout this site is not to be expected. Additionally, Black Cottonwood will continue to add biomass to the soil as it drops its leaves each year, this will further develop the soil and create more favorable conditions for later successional species. Both sites have demonstrated no soil erosion issues. Both sites make up a small portion of the overall restoration effort and when assessing the shrub and tree cover throughout the entire management area it is clear that most of the area has meet the restorative standards set in the OEMP. Although both Boulder spoil #2 and #7 have failed to meet the requirements of 1000 conifer sph, the sites are demonstrating restorative progress as a rate that is to be expected given the site limiting conditions. As such, no restorative efforts are currently recommended, and further monitoring is not required.

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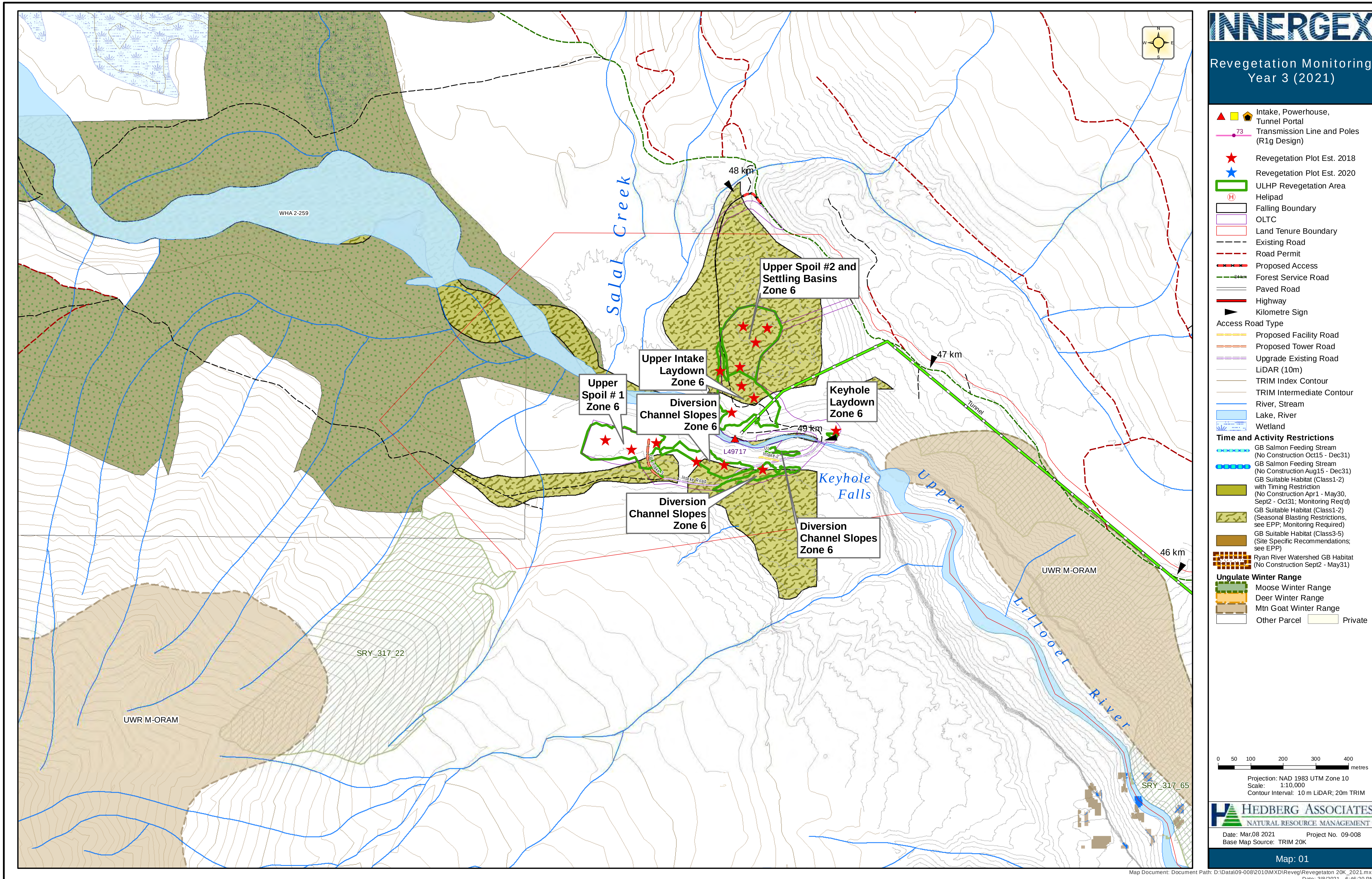
Appendices

Appendix A: Maps of Project Monitoring Program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Intake, Powerhouse, Tunnel Portal
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Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign
Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland
Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)
Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
0 50 100 200 300 400 metres
Projection: NAD 1983 UTM Zone 10
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NATURAL RESOURCE MANAGEMENT
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Project No. 09-008
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Upper Intake Laydown Zone 6
Upper Spoil # 1 Zone 6
Diversion Channel Slopes Zone 6
Diversion Channel Slopes Zone 6
Diversion Channel Slopes Zone 6
Keyhole Laydown Zone 6
Salal Creek
Keyhole Falls
Upper Lillooet River
WHA 2-259
48 km
47 km
49 km
46 km
L49717
Tunnel
Intake Road
UWR M-ORAM
UWR M-ORAM
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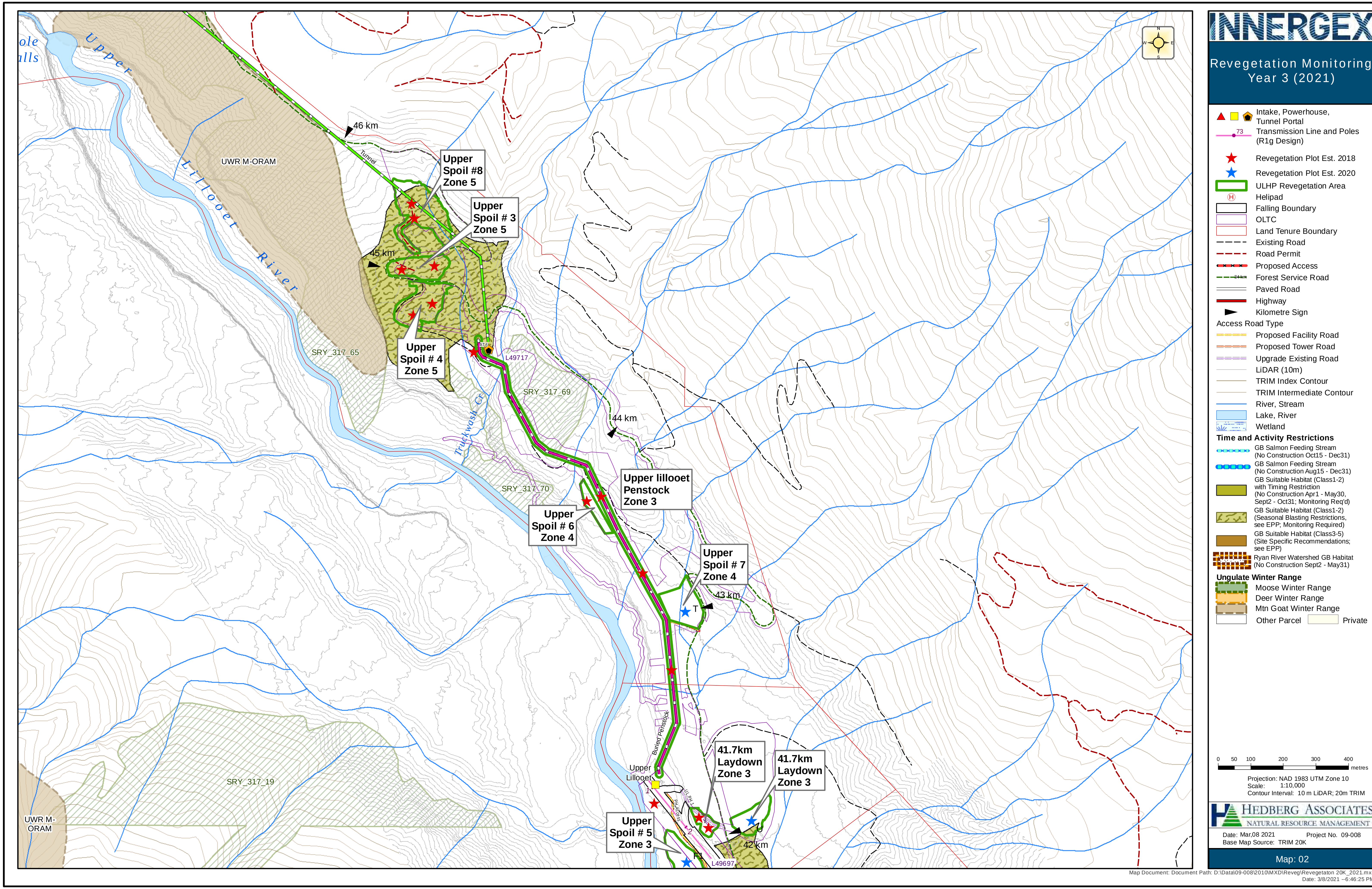
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Helipad
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OLTC
Land Tenure Boundary
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Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign
Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
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TRIM Intermediate Contour
River, Stream
Lake, River
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Time and Activity Restrictions
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Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
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Project No. 09-008
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Tunnel
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Upper Spoil # 3 Zone 5
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Upper Spoil # 4 Zone 5
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SRY_317_69
Truckwash Cr.
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Upper lillooet Penstock Zone 3
SRY_317_70
Upper Spoil # 6 Zone 4
Upper Spoil # 7 Zone 4
43 km
Buried Penstock
41.7km Laydown Zone 3
41.7km Laydown Zone 3
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Upper Spoil # 5 Zone 3
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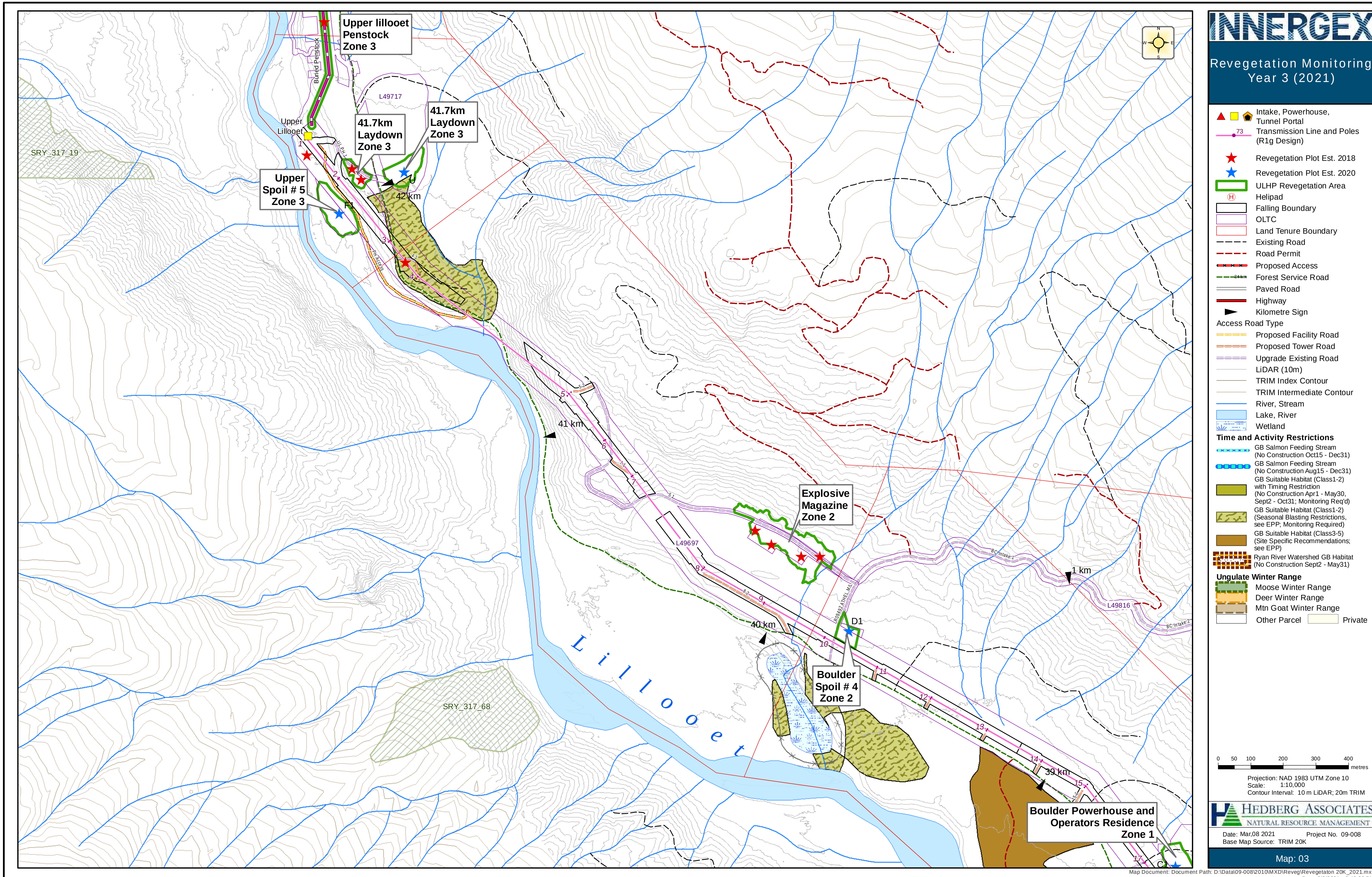

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Mtn Goat Winter Range
Other Parcel
Private
0 50 100 200 300 400 metres
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Buried Penstock
Upper Lillooet
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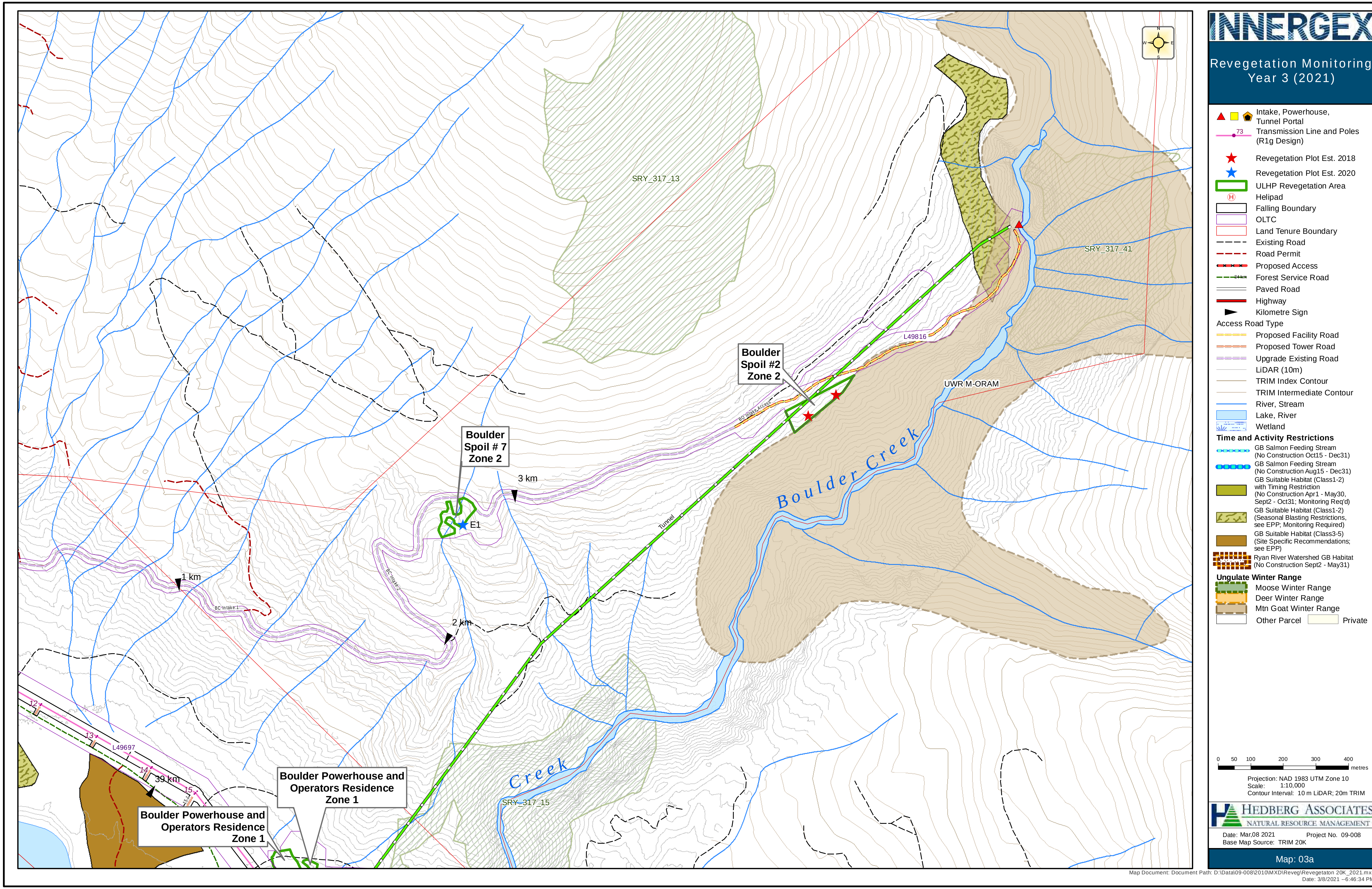
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Revegetation Plot Est. 2020
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Helipad
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OLTC
Land Tenure Boundary
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Proposed Access
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Paved Road
Highway
Kilometre Sign
Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
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TRIM Intermediate Contour
River, Stream
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Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
0 50 100 200 300 400 metres
Projection: NAD 1983 UTM Zone 10
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L49816
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Boulder Creek
Creek
Tunnel
Boulder Spoil #2 Zone 2
Boulder Spoil # 7 Zone 2
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2 km
3 km
39 km
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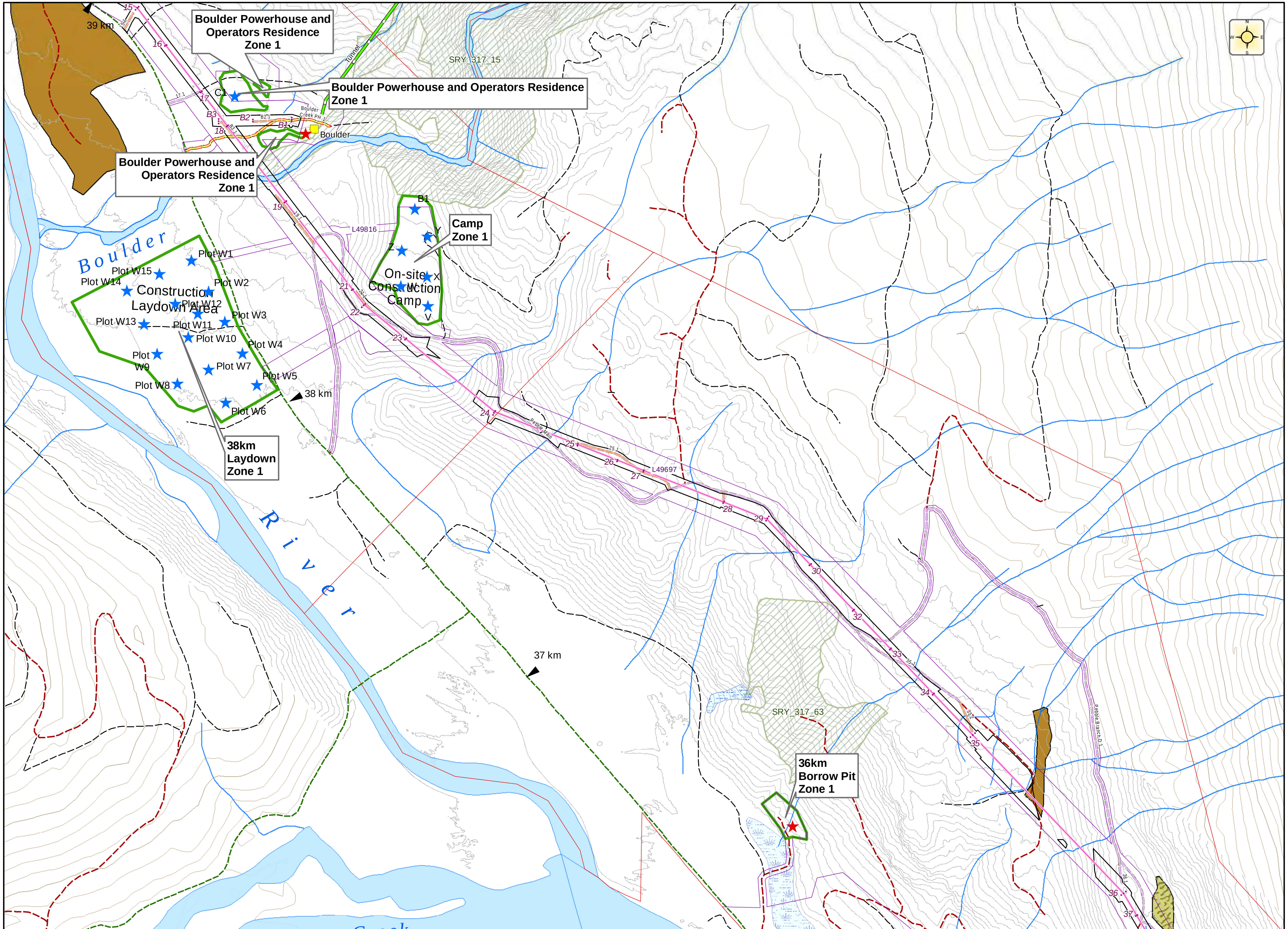

INNERGEX

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Revegetation Plot Est. 2020
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OLTC
Land Tenure Boundary
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Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign

Access Road Type

Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
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TRIM Intermediate Contour
River, Stream
Lake, River
Wetland

Time and Activity Restrictions

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Ungulate Winter Range

Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private

0 50 100 200 300 400 metres

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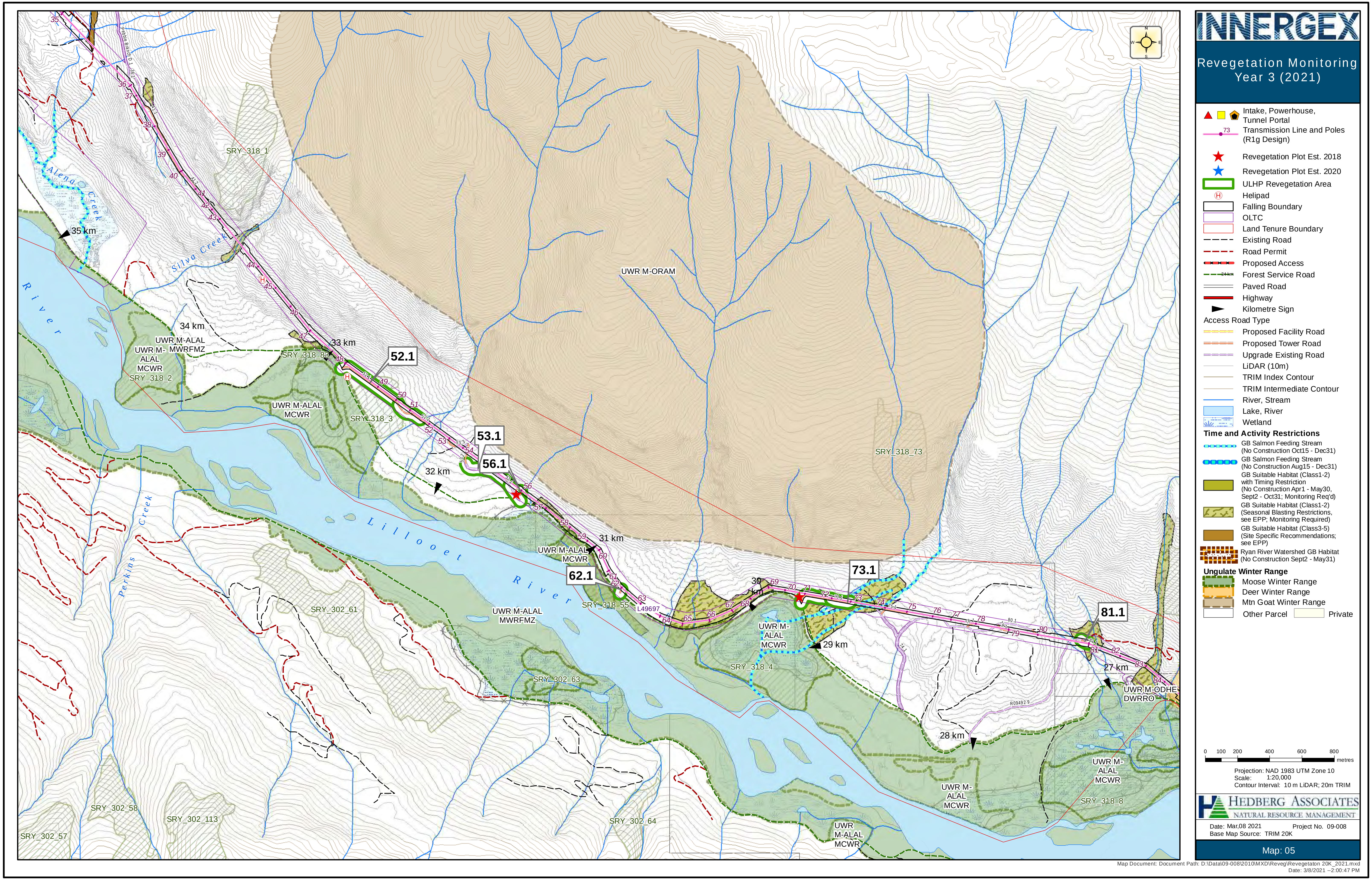
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Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland
Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
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GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)
Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
0 100 200 400 600 800 metres
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT
Date: Mar.08 2021
Project No. 09-008
Base Map Source: TRIM 20K
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52.1
53.1
56.1
62.1
73.1
81.1
35 km
34 km
33 km
32 km
31 km
30 km
29 km
28 km
27 km
Lillooet River
Alena Creek
Silva Creek
Perkins Creek
UWR M-ORAM
UWR M-ALAL MWRFMZ
UWR M-ALAL MCWR
UWR M-ODHE DWRRO
SRY_318_1
SRY_318_2
SRY_318_3
SRY_318_4
SRY_318_8
SRY_318_55
SRY_318_73
SRY_318_83
SRY_302_57
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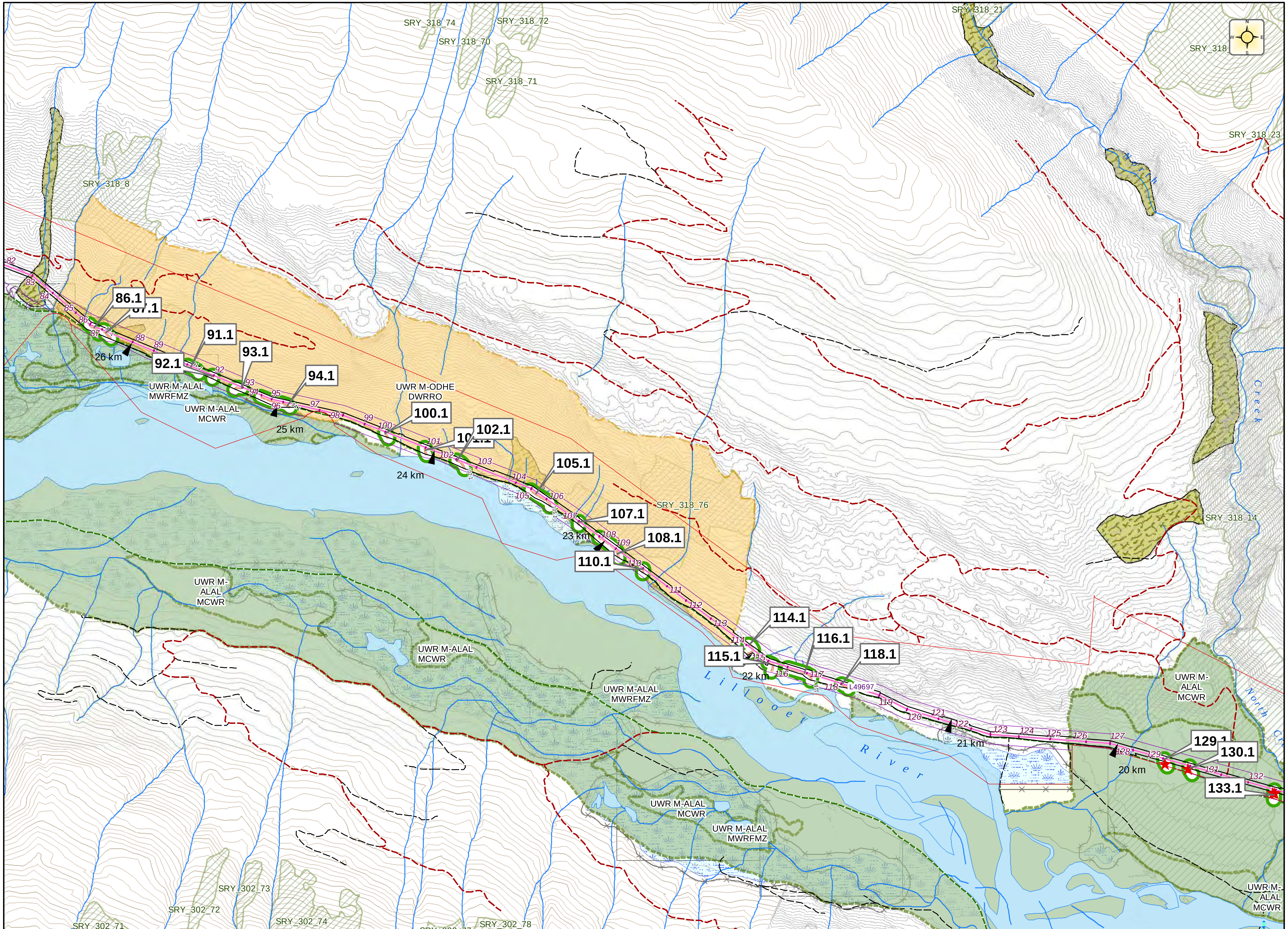

INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type

- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions

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Ungulate Winter Range

- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 100 200 400 600 800 metres

Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 06

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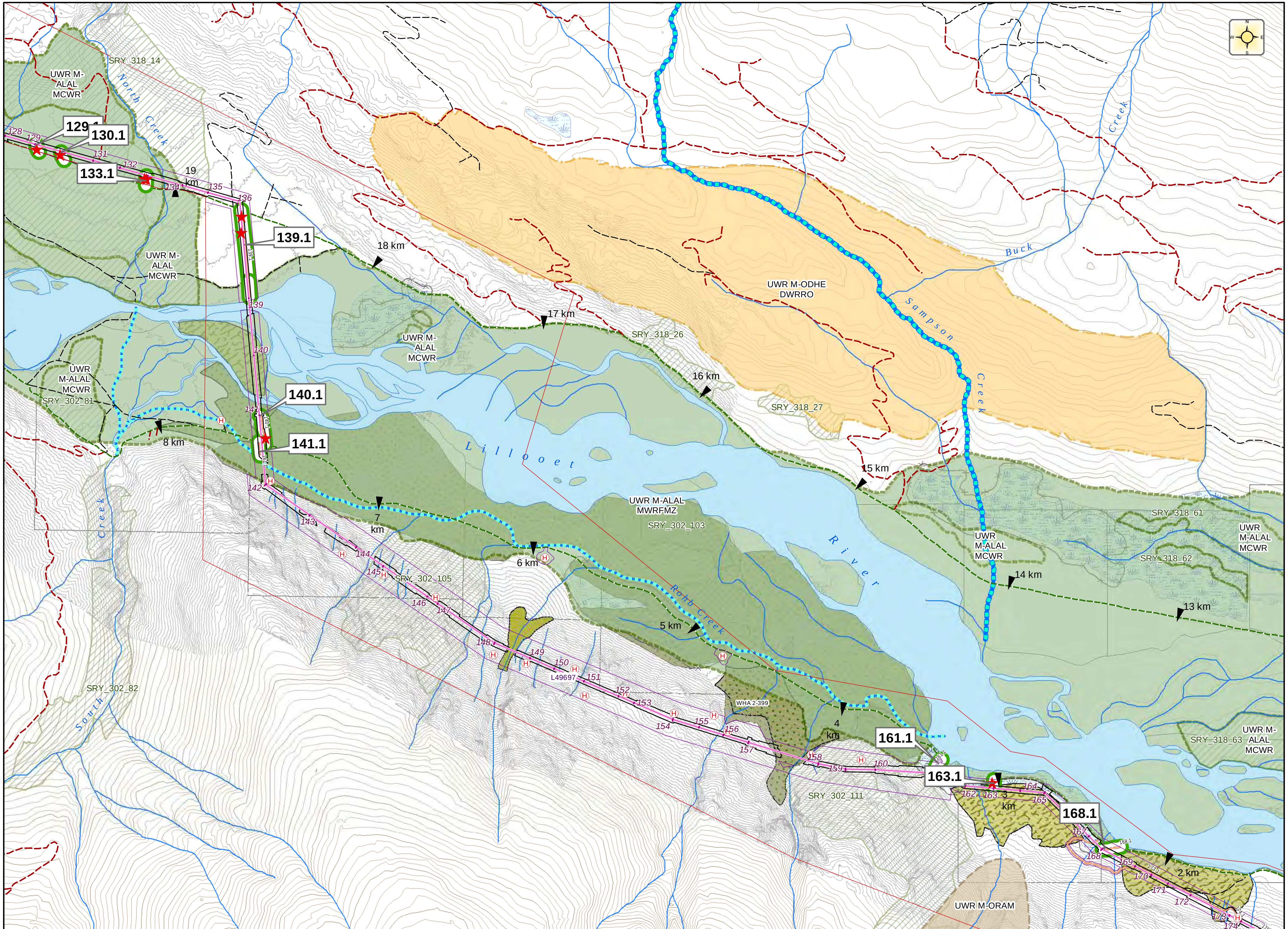

INNERGEX

Revegetation Monitoring Year 3 (2021)

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- Transmission Line and Poles (R1g Design)
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Access Road Type

- Proposed Facility Road
- Proposed Tower Road
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- TRIM Index Contour
- TRIM Intermediate Contour
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- Lake, River
- Wetland

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0 100 200 400 600 800 metres

Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K

Map: 07

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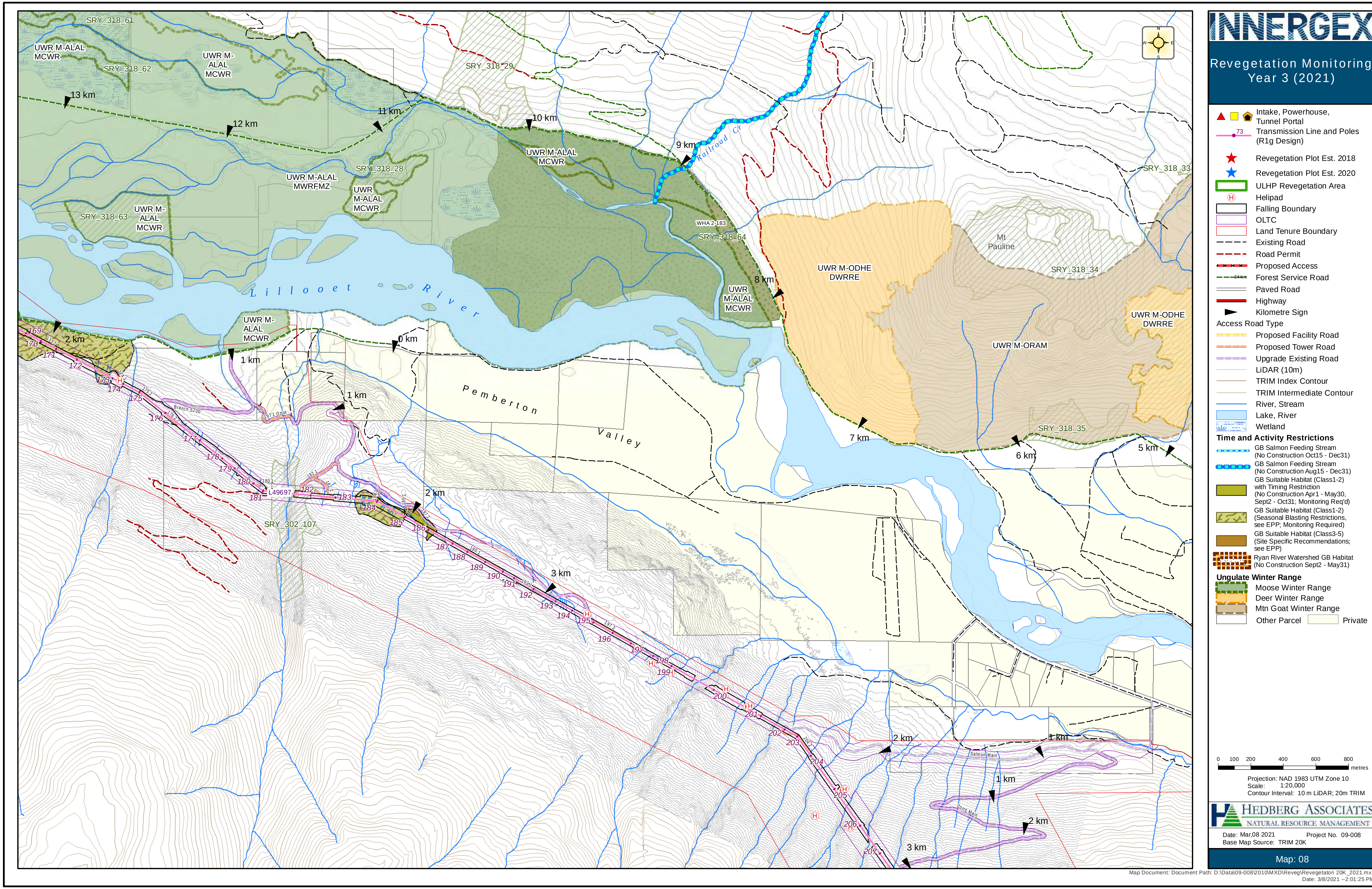
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Revegetation Monitoring Year 3 (2021)
Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
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Highway
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Access Road Type
Proposed Facility Road
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Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
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Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
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Other Parcel
Private
0 100 200 400 600 800 metres
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT
Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K
Map: 08
Lillooet River
Pemberton Valley
Railroad Cr
Mt Pauline
UWR M-ALAL MCWR
UWR M-ALAL MWRFMZ
UWR M-ODHE DWRRE
UWR M-ORAM
WHA 2-183
SRY_318_61
SRY_318_62
SRY_318_63
SRY_318_28
SRY_318_29
SRY_318_64
SRY_318_33
SRY_318_34
SRY_318_35
SRY_302_107
L49697
Branch S200
Salmon Main
13 km
12 km
11 km
10 km
9 km
8 km
7 km
6 km
5 km
0 km
1 km
2 km
3 km
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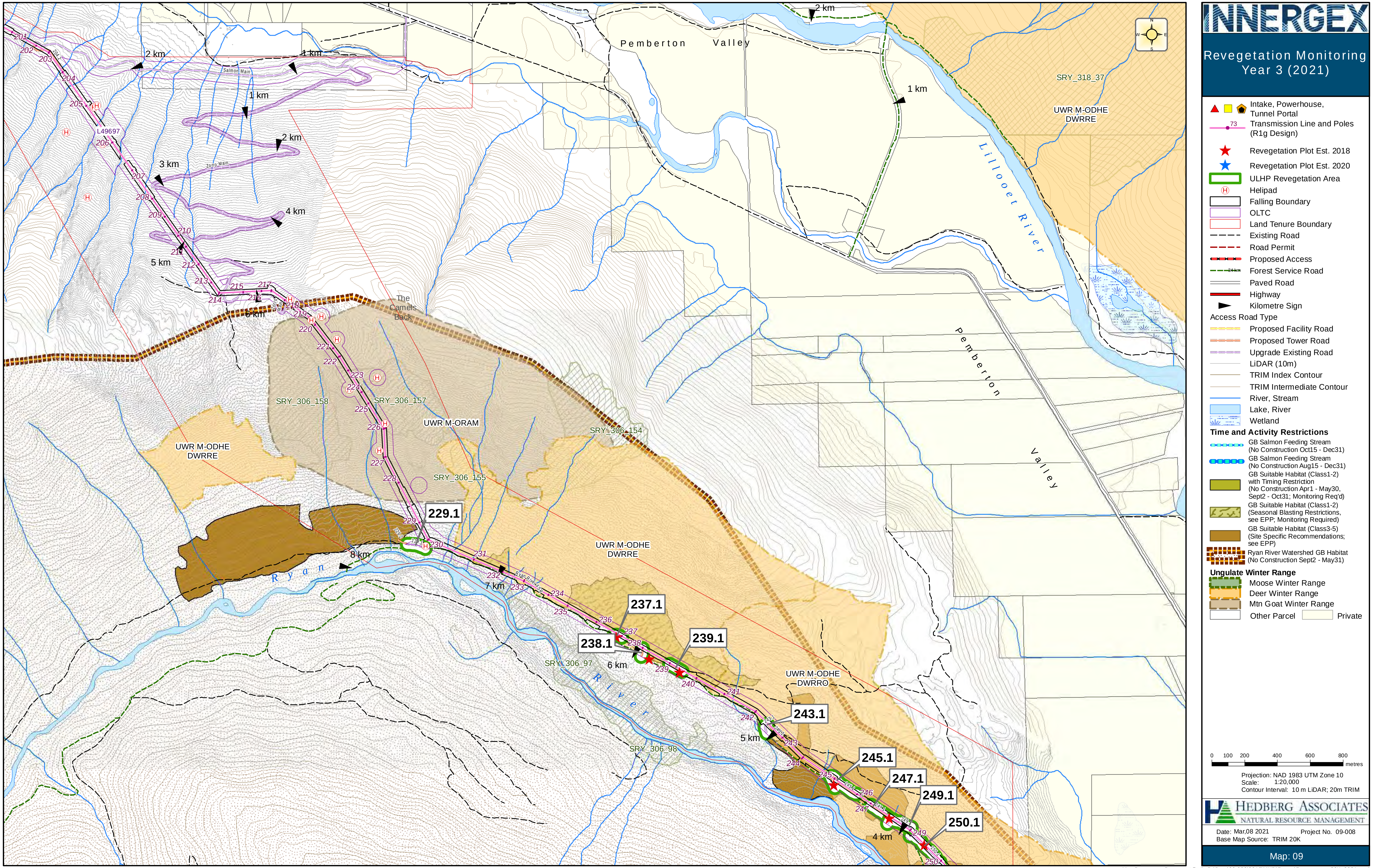

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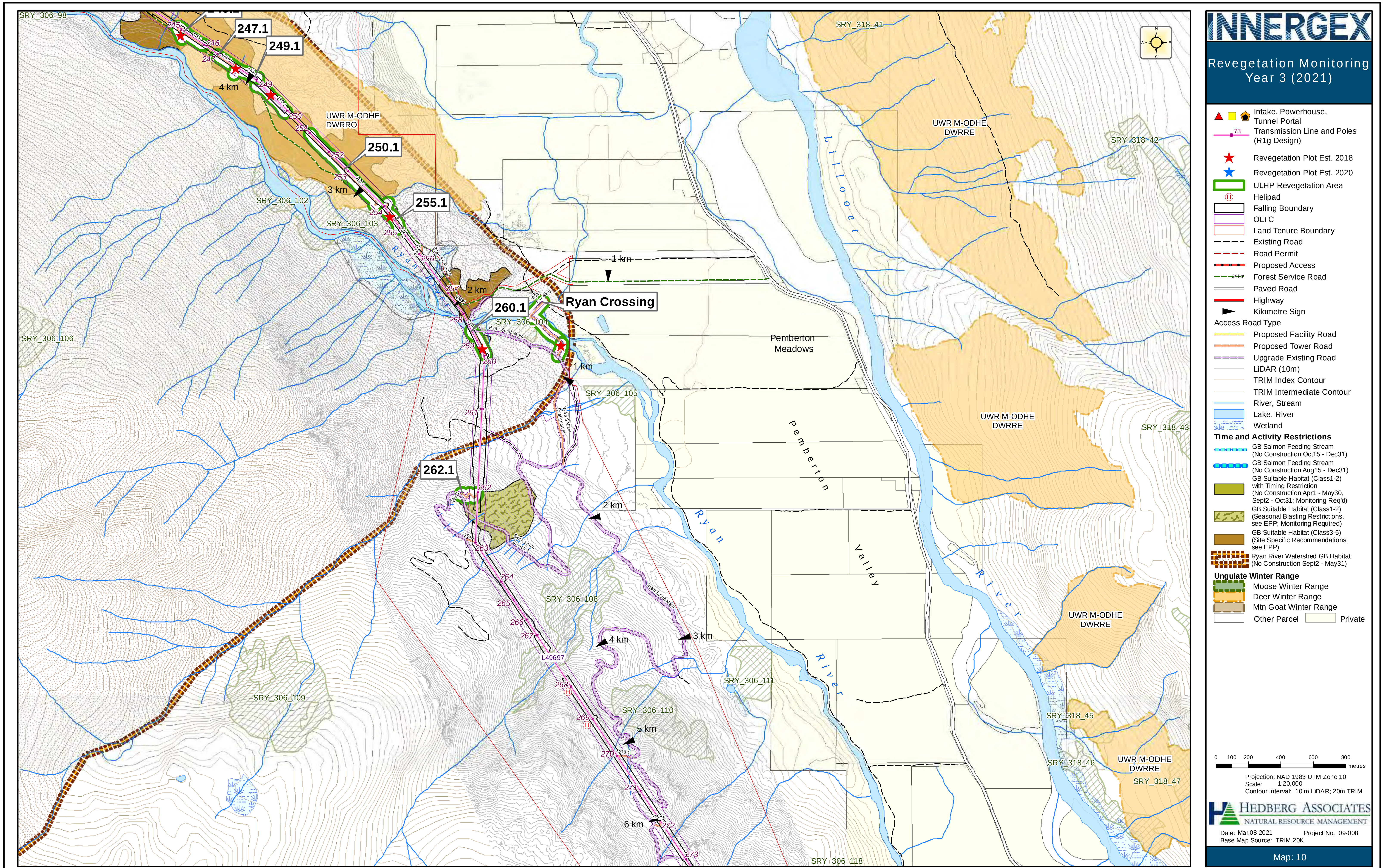

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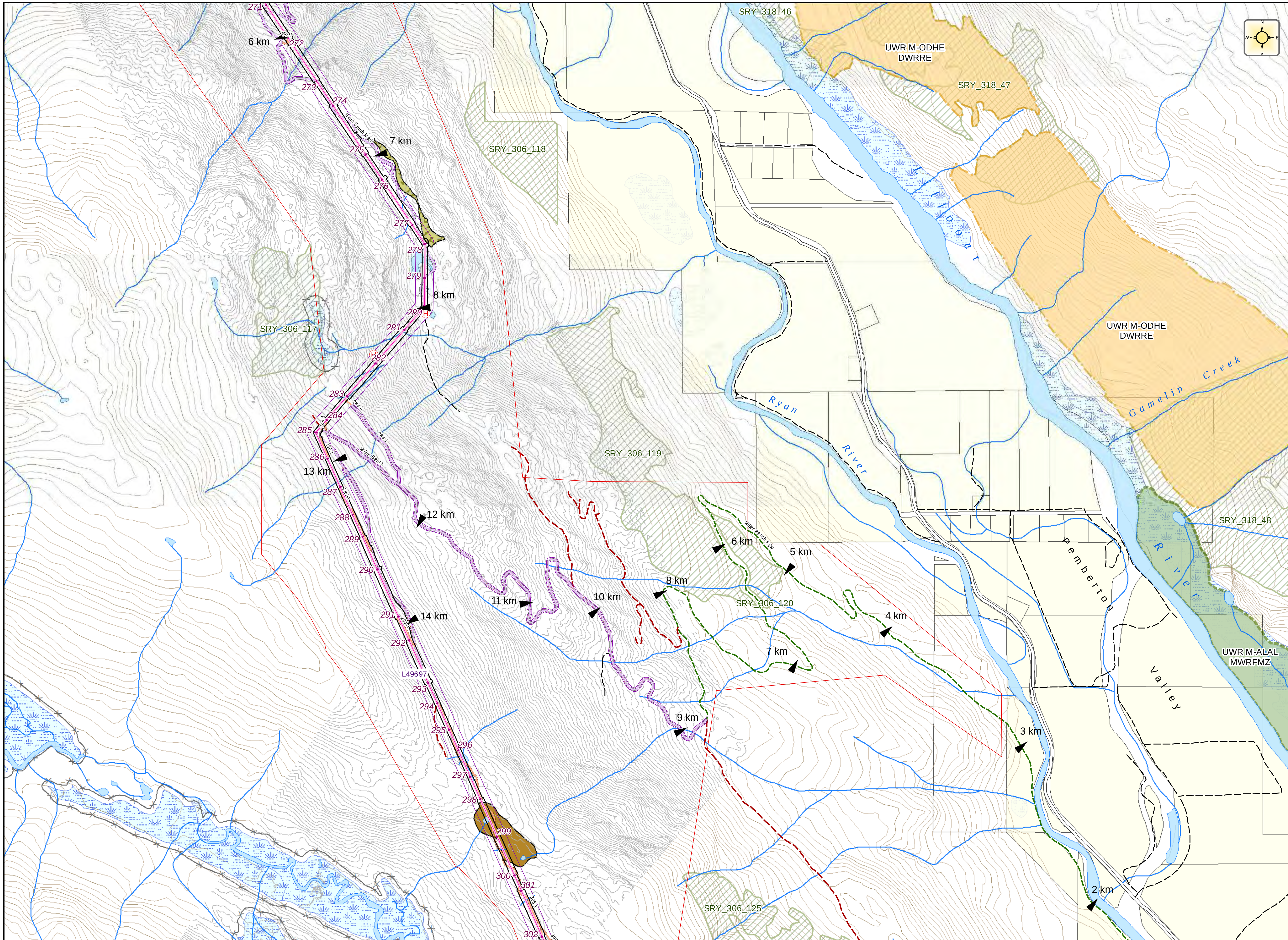

INNERGEX

Revegetation Monitoring Year 3 (2021)

Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
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Falling Boundary
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Access Road Type
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Ungulate Winter Range
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Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private

0 100 200 400 600 800 metres

Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K

Map: 11

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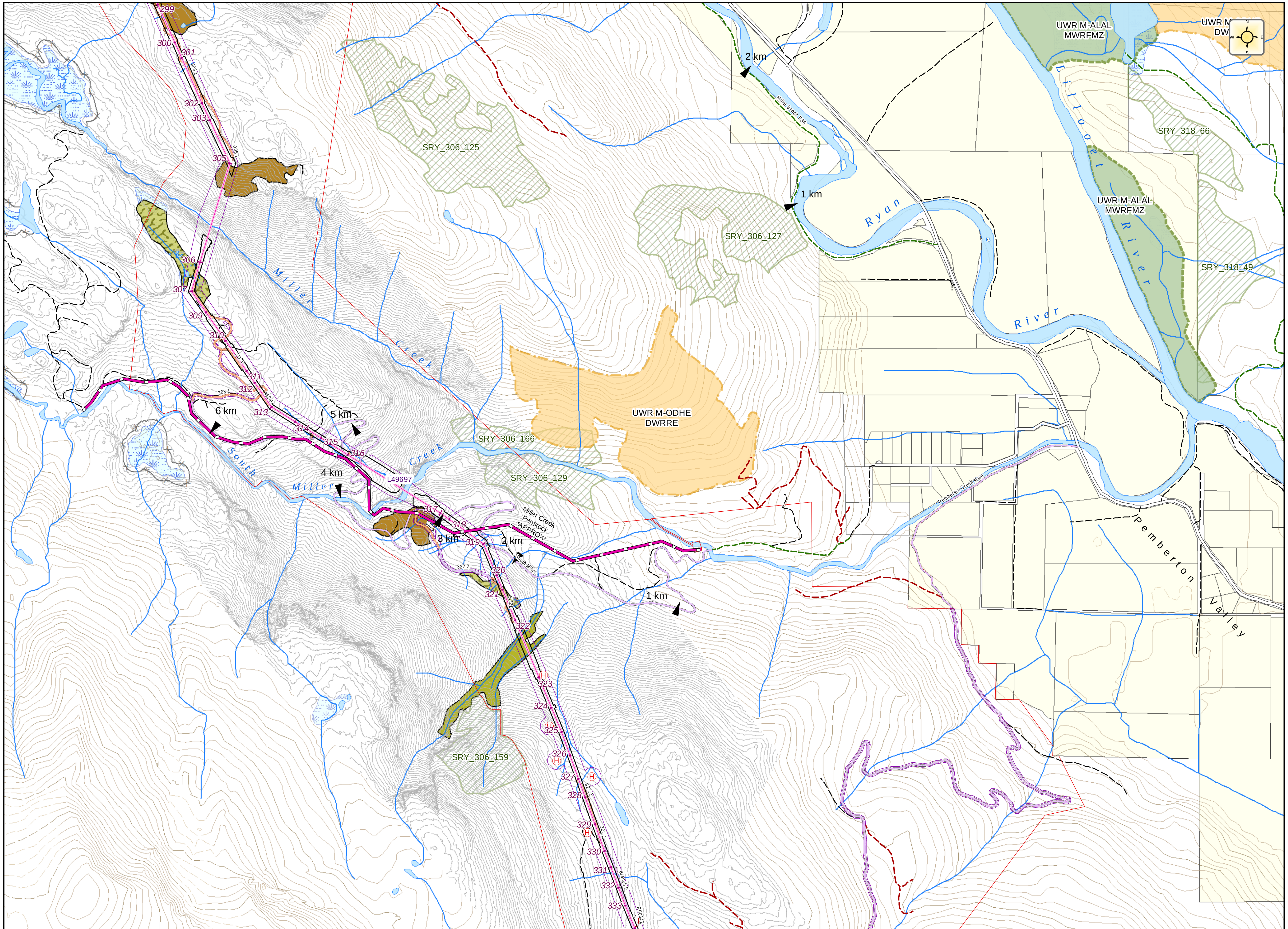

INNERGEX

Revegetation Monitoring Year 3 (2021)

Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
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Private

0 100 200 400 600 800 metres

Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K

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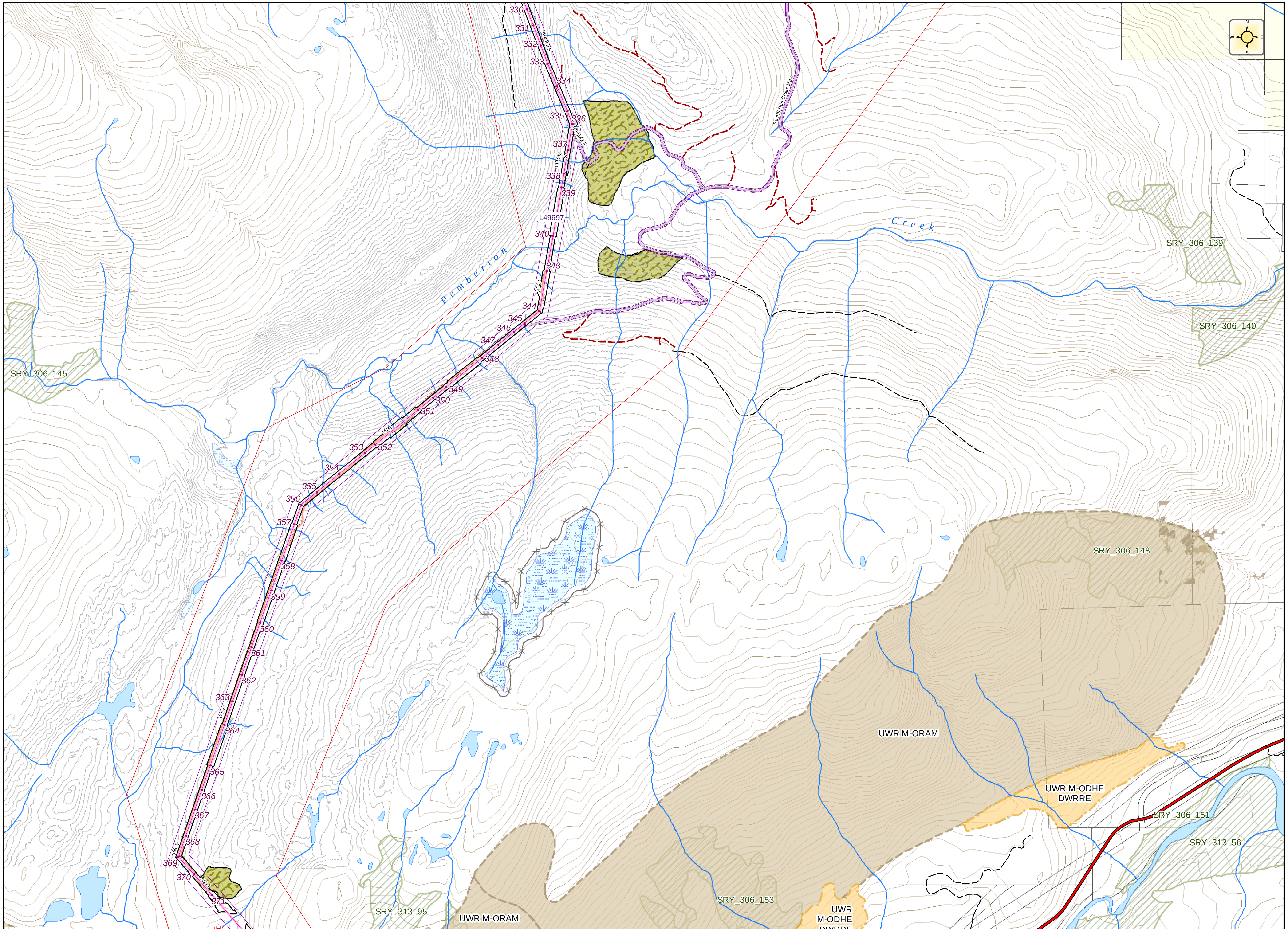

INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
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- Revegetation Plot Est. 2018
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0 100 200 400 600 800 metres

Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 13

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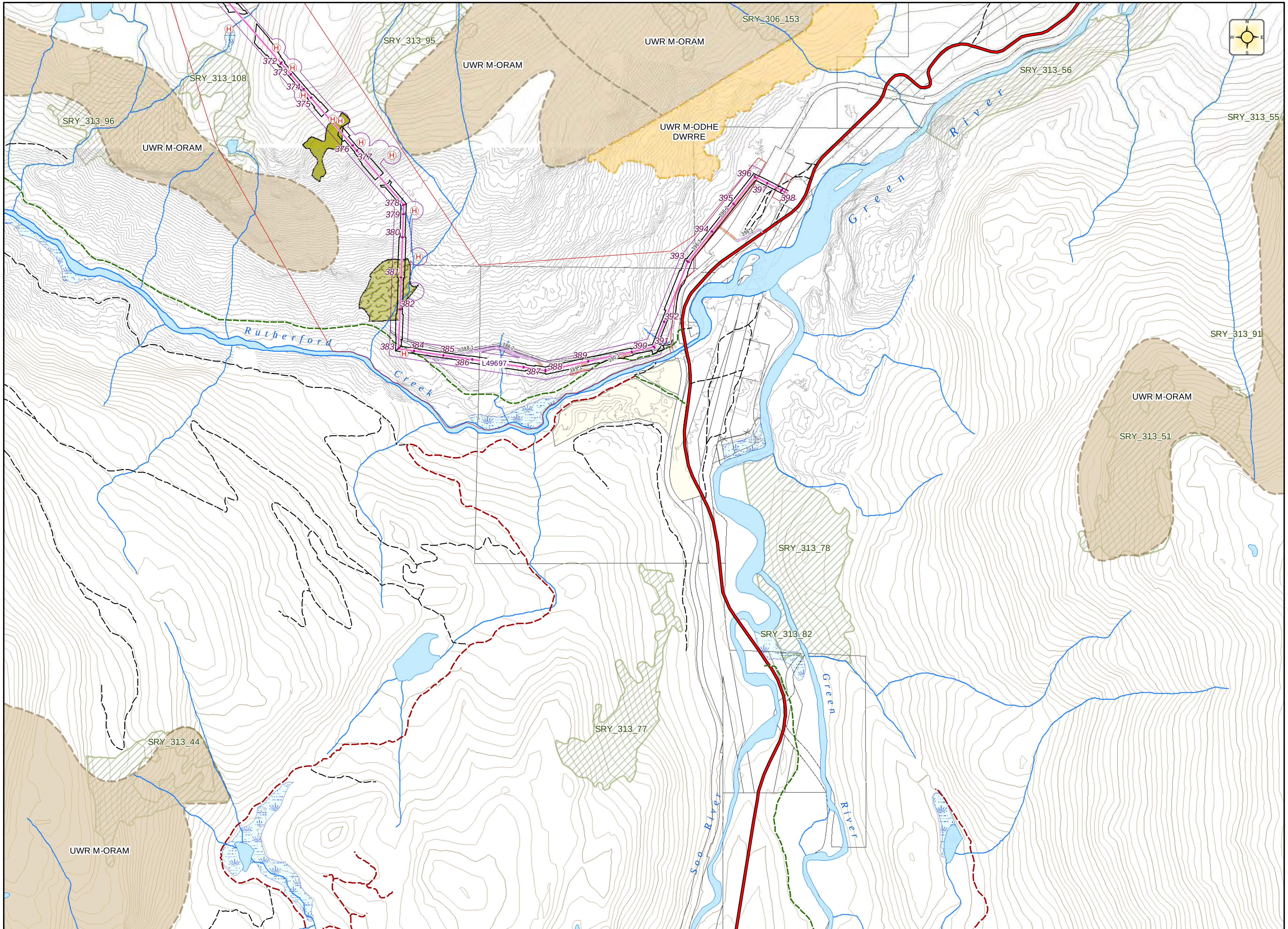

INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
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Ungulate Winter Range

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- Other Parcel
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0 100 200 400 600 800 metres

Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 14

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
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Appendix B: Civil Works Sites Permanent Monitoring Plot Data Established 2018.

Civil Works Sites

36 Km Borrow Pit

Project Information

Project:	Longterm Revegetation Monitoring	**Contractor:**	CRGL
Site:	36 Km Borrow Pit	**Surveyor(s):**	C. Johnston, B. Van Loon
Location:	Upper Lillooet Hydro Project	**Field Start:**	12-Sep-23
Mapsheet:	36 Km Brw	**Field Finish**	03-Oct-23
Net Area:	0.5 Ha	**# of plots:**	1

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	9,600	84
Douglas Fir	1,000	9
Red Alder	400	4
Falsebox	200	2
Salix	200	2
Summary:	***11,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	1	14
Herb 2	-	0
Shrub 1	-	0
Shrub 2	-	0
Tree 1	9	68
Tree 2	3	45

Qualified Forest Professional's Statement	
Declaration	
Forest Professional	**Date**

Civil Works Sites
38 Km Laydown

Project Information

Project: Longterm Revegetation Monitoring
Site: 38 Km Laydown
Location: Upper Lillooet Hydro Project
Mapsheet: Map 4
Net Area: 15.2 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 15

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	3,080	41
Black Cottonwood	1,893	25
Falsebox	867	12
Douglas Fir	707	9
Lodgepole Pine	333	4
Spruce	160	2
Thimbleberry	93	1
Western Red Cedar	93	1
Western White Pine	93	1
Kinnickinick	40	1
Salix	40	1
Saskatoon	40	1
Ceanothus	27	0
Amabalis fir	13	0
Mountain Ash	13	0
Red Osier Dogwood	13	0
Sitka Alder	13	0
Vaccinium spp	13	0
Summary:	***7,533***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	16	34
Herb 2	18	40
Shrub 1	1	13
Shrub 2	-	8
Tree 1	5	31
Tree 2	9	39

Pest / Disease	*Host Species*	*Dead Trees (SPH)*	*Live Trees (SPH)*	*% Total Affected*	*% Conifers Affected*	*% Host Trees Affected*
ND Drought	FDC,SX,BA	13	53	1	500	-
NY Snow or Ice (includes snow press	FDC,SX	-	27	0		-

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works Sites
41.7 Km Borrow Pit

Project Information

Project: Longterm Revegetation Monitoring
Site: 41.7 Km Borrow Pit
Location: Upper Lillooet Hydro Project
Mapsheet: BO-1
Net Area: 1.1 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, B. Van Loon
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 2

Inventory Information

Species	TS (SPH)	TS %
Black Cottonwood	3,300	35
Red Raspberry	3,250	34
Douglas Fir	1,350	14
Thimbleberry	850	9
Salix spp	250	3
Spruce	150	2
Sitka Alder	100	1
Oregon grape	50	1
Western Hemlock	50	1
Western Red Cedar	50	1
Yellow Cedar	50	1
Summary:	***9,450***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	7	26
Herb 2	7	23
Shrub 1	5	50
Shrub 2	8	18
Tree 1	4	26
Tree 2	15	61

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Civil Works Sites

Boulder Powerhouse and Spoil

Project Information

Project:	Longterm Revegetation Monitoring	**Contractor:**	CRGL
Site:	Boulder Powerhouse and Spoil	**Surveyor(s):**	C. Johnston, S. Dayton
Location:	Upper Lillooet Hydro Project	**Field Start:**	12-Sep-23
Mapsheet:	BO-1	**Field Finish**	03-Oct-23
Net Area:	1.4 Ha	**# of plots:**	2

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	10,400	38
Red Raspberry	7,400	27
Douglas Fir	4,100	15
Thimbleberry	2,600	9
Lodgepole Pine	1,000	4
Falsebox	700	3
Western Hemlock	500	2
Blackcap Raspberry	200	1
Western Red Cedar	200	1
Western white pine	200	1
False Azalea	100	0
Red Osier Dogwood	100	0
Summary:	***27,500***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	4	17
Herb 2	3	22
Shrub 1	12	90
Shrub 2	5	18
Tree 1	23	88
Tree 2	16	111

Qualified Forest Professional's Statement		*Affix Professional Seal Here*
Declaration		
Forest Professional	**Date**	

Civil Works Sites
Boulder Spoil #2

Project Information

Project:	Longterm Revegetation Monitoring	**Contractor:**	CRGL
Site:	Boulder Spoil #2	**Surveyor(s):**	C. Johnston, S. Dayton
Location:	Upper Lillooet Hydro Project	**Field Start:**	12-Sep-23
Mapsheet:	BO-2	**Field Finish**	03-Oct-23
Net Area:	1.3 Ha	**# of plots:**	2

Inventory Information

Species	***TS (SPH)***	***TS %***
Thimbleberry	1,100	52
Falsebox	700	33
Vaccinium spp	200	10
Rose	100	5
Summary:	***2,100***	***100***

Veg / Brush	***% Cover***	***Avg Ht. (cm)***
Herb 1	46	26
Herb 2	28	19
Shrub 1	-	
Shrub 2	10	50
Tree 1	-	
Tree 2	-	

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works Sites

Boulder Spoil #4

Project Information

Project: Longterm Revegetation Monitoring
Site: Boulder Spoil #4
Location: Upper Lillooet Hydro Project
Mapsheet: Map 3
Net Area: 0.4 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	24,000	85
Thimbleberry	1,600	6
Douglas Fir	1,200	4
Black Cottonwood	1,000	4
Spruce	600	2
Summary:	***28,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	29	115
Herb 2	18	20
Shrub 1	7	72
Shrub 2	19	35
Tree 1	-	
Tree 2	-	

Qualified Forest Professional's Statement

Declaration

Forest Professional	Date

Affix Professional Seal Here

Civil Works Sites
Boulder Spoil #7

Project Information

Project:	Longterm Revegetation Monitoring	**Contractor:**	CRGL
Site:	Boulder Spoil #7	**Surveyor(s):**	C. Johnston, S. Dayton
Location:	Upper Lillooet Hydro Project	**Field Start:**	12-Sep-23
Mapsheet:	BO-3a	**Field Finish**	03-Oct-23
Net Area:	1.1 Ha	**# of plots:**	1

Inventory Information

Species	*TS (SPH)*	*TS %*	*Ocular SPH*	*Ocular %*	*Inv Ht (m)*	*Inv Age*
Black Cottonwood	12,200	94				
Douglas Fir	800	6				
Summary:	***13,000***	***100***	***-***	***-***	***0.00***	***-***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	1	209
Herb 2	1	7
Shrub 1	-	
Shrub 2	-	
Tree 1	6	23
Tree 2	20	66

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works Sites

Camp

Project Information

Project: Longterm Revegetation Monitoring
Site: Camp
Location: Upper Lillooet Hydro Project
Mapsheet: Map 4
Net Area: 6.5 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 6

Inventory Information

Species	*TS (SPH)*	*TS %*
Douglas Fir	2,000	32
Black Cottonwood	1,667	27
Falsebox	800	13
Lodgepole Pine	767	12
Red Raspberry	733	12
Western Red Cedar	100	2
Ceanothus	33	1
Saskatoon	33	1
Western White Pine	33	1
Summary:	***6,167***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	2	16
Herb 2	5	16
Shrub 1	6	110
Shrub 2	1	16
Tree 1	2	40
Tree 2	-	29

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Declaration		
Forest Professional	Date	

Civil Works Sites

Diversion Channel and Slopes

Project Information

Project: Longterm Revegetation Monitoring
Site: Diversion Channel and Slopes
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 2.5 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, B. Van Loon
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 3

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	3,267	28
Amabalis fir	2,933	25
Sitka Alder	2,533	22
Salix spp	600	5
Subalpine Fir	467	4
Salmonberry	333	3
Spruce	333	3
Vaccinium spp	333	3
Douglas Fir	267	2
Mountain Hemlock	133	1
Ceanothus	67	1
Red Osier Dogwood	67	1
Ribes	67	1
Thimbleberry	67	1
Western Red Cedar	67	1
Western white pine	67	1
Summary:	***11,600***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	8	20
Herb 2	26	18
Shrub 1	8	59
Shrub 2	15	61
Tree 1	-	15
Tree 2	-	

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Declaration		
Forest Professional	**Date**	

Civil Works Sites
Explosive Magazine

Project Information

Project: Longterm Revegetation Monitoring
Site: Explosive Magazine
Location: Upper Lillooet Hydro Project
Mapsheet: Map 3
Net Area: 2.5 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 4

Inventory Information

Species	TS (SPH)	TS %
Red Raspberry	14,550	56
Salix spp	4,350	17
Thimbleberry	4,100	16
Douglas Fir	1,650	6
Black Cottonwood	900	3
Ceanothus	200	1
Western Red Cedar	150	1
Lodgepole Pine	100	0
Mountain Ash	100	0
Bigleaf Maple	50	0
Sitka Alder	50	0
Summary:	***26,200***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	18	41
Herb 2	13	42
Shrub 1	30	33
Shrub 2	29	24
Tree 1	7	74
Tree 2	21	219

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Declaration		
Forest Professional	**Date**	

Civil Works Sites

Keyhole Laydown

Project Information

Project: Longterm Revegetation Monitoring
Site: Keyhole Laydown
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 0.1 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Red Raspberry	46,800	88
Vaccinium spp	4,400	8
Amabalis fir	600	1
Ribes	600	1
Salix spp	400	1
Red elderberry	200	0
Summary:	***53,000***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	83	29
Herb 2	40	103
Shrub 1	4	31
Shrub 2	14	55
Tree 1	-	
Tree 2	-	

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Forest Professional	**Date**	

Civil Works Sites
Upper Intake and Laydown

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Intake and Laydown
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 2.4 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 4

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	15,500	72
Amabalis fir	2,650	12
Sitka Alder	1,150	5
Salix spp	750	4
Douglas Fir	400	2
Spruce	300	1
Western Red Cedar	250	1
Rose	100	0
Kinnickinick	50	0
Lodgepole Pine	50	0
Oregon grape	50	0
Subalpine Fir	50	0
Western Hemlock	50	0
Western White Pine	50	0
Summary:	***21,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	3	12
Herb 2	2	8
Shrub 1	-	
Shrub 2	2	19
Tree 1	3	29
Tree 2	6	53

Pest / Disease	*Host Species*	*Dead Trees (SPH)*	*Live Trees (SPH)*	*% Total Affected*	*% Conifers Affected*	*% Host Trees Affected*
ND Drought	CW	-	100	0		-

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Declaration		
Forest Professional	Date	

Civil Works Sites

Upper Lillooet Penstock

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Lillooet Penstock
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 4.6 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, B. Van Loon
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 2

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	21,400	73
Black Cottonwood	3,500	12
Douglas Fir	2,600	9
Thimbleberry	1,200	4
Yellow Cedar	200	1
Ceanothus	100	0
Falsebox	100	0
Red Osier Dogwood	100	0
Salix spp	100	0
Western Red Cedar	100	0
Summary:	***29,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	10	20
Herb 2	10	15
Shrub 1	20	38
Shrub 2	4	50
Tree 1	5	45
Tree 2	10	100

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Declaration		
Forest Professional	Date	

Civil Works Sites
Upper Spoil #1

Project Information

Project:	Longterm Revegetation Monitoring	**Contractor:**	CRGL
Site:	Upper Spoil #1	**Surveyor(s):**	C. Johnston, S. Dayton
Location:	Upper Lillooet Hydro Project	**Field Start:**	12-Sep-23
Mapsheet:	Map 1	**Field Finish**	03-Oct-23
Net Area:	2.4 Ha	**# of plots:**	3

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	8,400	59
Sitka Alder	2,267	16
Salix spp	1,267	9
Spruce	1,067	7
Amabalis fir	733	5
Douglas Fir	133	1
Thimbleberry	133	1
Western Red Cedar	133	1
Mountain Hemlock	67	0
Salal	67	0
Summary:	***14,267***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	4	26
Herb 2	3	30
Shrub 1	13	83
Shrub 2	20	57
Tree 1	2	31
Tree 2	2	44

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Forest Professional	**Date**	

Civil Works Sites
Upper Spoil #2 and Settling Basin

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Spoil #2 and Settling Basin
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 2.8 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 3

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	5,533	67
Amabalis fir	933	11
Douglas Fir	600	7
Sitka Alder	400	5
Spruce	333	4
Salix spp	133	2
Bitter Cherry	67	1
Lodgepole Pine	67	1
Salal	67	1
Western Hemlock	67	1
Western Red Cedar	67	1
Summary:	***8,267***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	4	25
Herb 2	1	10
Shrub 1	1	4
Shrub 2	-	0
Tree 1	1	15
Tree 2	-	0

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Forest Professional	**Date**	

Civil Works Sites
Upper Spoil #3

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Spoil #3
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 1.1 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, S. Dayton
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 2

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	15,700	68
Black Cottonwood	3,800	16
Douglas Fir	2,300	10
Thimbleberry	900	4
Amabalis fir	200	1
Spruce	200	1
Salix spp	100	0
Summary:	***23,200***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	15	40
Herb 2	9	18
Shrub 1	4	11
Shrub 2	10	28
Tree 1	27	66
Tree 2	35	85

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Civil Works Sites

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Upper Spoil #4

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Spoil #4
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 1.6 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, B. Van Loon
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 4

Inventory Information

Species	*TS (SPH)*	*TS %*	*Ocular SPH*	*Ocular %*	*Inv Ht (m)*	*Inv Age*
Red Raspberry	4,800	46			0.25	
Douglas Fir	2,750	26			1.18	
Black Cottonwood	1,000	10			2.45	
Thimbleberry	700	7			0.20	
Sitka Alder	550	5			1.60	
Spruce	300	3			0.60	
Salix spp	200	2			1.40	
Amabalis fir	100	1			0.05	
Red Osier Dogwood	50	0			0.40	
Western white pine	50	0				
Summary:	***10,500***	***100***	***-***	***-***	***0.94***	***-***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	4	15
Herb 2	4	19
Shrub 1	7	35
Shrub 2	14	51
Tree 1	4	68
Tree 2	1	18

Pest / Disease	*Host Species*	*Dead Trees (SPH)*	*Live Trees (SPH)*	*% Total Affected*	*% Conifers Affected*	*% Host Trees Affected*
ND Drought	SX	-	150	1		-

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Declaration	
Forest Professional	**Date**

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Civil Works Sites

Upper Spoil #5

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Spoil #5
Location: Upper Lillooet Hydro Project
Mapsheet: Map 3
Net Area: 1.1 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, B. Van Loon
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Red Raspberry	20,600	86
Black Cottonwood	1,400	6
Douglas Fir	1,200	5
Spruce	400	2
Amabalis fir	200	1
Sitka Alder	200	1
Summary:	***24,000***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	5	20
Herb 2	10	100
Shrub 1	-	0
Shrub 2	-	0
Tree 1	18	120
Tree 2	-	0

Pest / Disease	Host Species	Dead Trees (SPH)	Live Trees (SPH)	% Total Affected	% Conifers Affected	% Host Trees Affected
IS - Leader worm	FDC	-	200	1		-

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Civil Works Sites

Upper Spoil #6

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Project Information

Project: Longterm Revegetation Monitoring
Site: Upoper Spoil #6
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 1 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, B. Van Loon
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	3,200	68
Douglas Fir	1,000	21
Sitka Alder	200	4
Spruce	200	4
Western Red Cedar	100	2
Summary:	***4,700***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	-	0
Herb 2	-	0
Shrub 1	-	0
Shrub 2	40	138
Tree 1	11	126
Tree 2	42	150

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Forest Professional	Date	

Civil Works Sites
Upper Spoil #7

Project Information

Project:	Longterm Revegetation Monitoring	**Contractor:**	CRGL
Site:	Upoper Spoil #7	**Surveyor(s):**	C. Johnston, B. Van Loon
Location:	Upper Lillooet Hydro Project	**Field Start:**	12-Sep-23
Mapsheet:	Map 2	**Field Finish**	03-Oct-23
Net Area:	0.6 Ha	**# of plots:**	1

Inventory Information

Species	***TS (SPH)***	***TS %***
Black Cottonwood	20,800	79
Red Raspberry	2,800	11
Douglas Fir	1,400	5
Amabalis fir	800	3
Salix spp	400	2
Sitka Alder	200	1
Summary:	***26,400***	***100***

Veg / Brush	***% Cover***	***Avg Ht. (cm)***
Herb 1	-	0
Herb 2	-	0
Shrub 1	15	52
Shrub 2	4	20
Tree 1	33	141
Tree 2	26	128

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Forest Professional	**Date**	

Civil Works Sites
Upper Spoil #8

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Spoil #8
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 2.2 Ha

Contractor: CRGL
Surveyor(s): C. Johnston, B. Van Loon
Field Start: 12-Sep-23
Field Finish 03-Oct-23
# of plots: 2

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	6,800	39
Black Cottonwood	4,400	25
Douglas Fir	3,600	20
Amabalis fir	1,100	6
Salix spp	400	2
Western Hemlock	400	2
Western Red Cedar	300	2
Red Osier Dogwood	200	1
Western white pine	200	1
Sitka Alder	100	1
Spruce	100	1
Summary:	***17,600***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	5	22
Herb 2	4	17
Shrub 1	9	20
Shrub 2	2	10
Tree 1	5	32
Tree 2	30	76

Pest / Disease	*Host Species*	*Dead Trees (SPH)*	*Live Trees (SPH)*	*% Total Affected*	*% Conifers Affected*	*% Host Trees Affected*
ND Drought	FDC	200	-	1	100	-

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Declaration	
Forest Professional	**Date**

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
36 Km Borrow Pit	S	Sep 28, 2023 13:59	5607381	472677	Black Cottonwood	48	Herb 1	1	14
					Douglas Fir	5	Herb 2	0	0
					Falsebox	1	Shrub 1	0	0
					Red Alder	2	Shrub 2	0	0
					Salix	1	Tree 1	9	68
							Tree 2	3	45
						57			
						57			
38km Laydown	W1	Sep 13, 2023 12:53	5608975	470994	Black Cottonwood	9	Herb 1	31	57
					Douglas Fir	7	Herb 2	17	56
					Falsebox	8	Shrub 1	3	30
					Lodgepole Pine	4	Shrub 2	0	0
					Red Raspberry	5	Tree 1	0	0
					Salix	2	Tree 2	3	9
					Thimbleberry	1			
					White Pine	2			
						38			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	W2	Sep 13, 2023 09:59	5608894	471038	Black Cottonwood	1	Herb 1	26	41
					Douglas Fir	3	Herb 2	22	48
					Falsebox	1	Shrub 1	0	0
					Red Raspberry	75	Shrub 2	0	0
							Tree 1	0	0
							Tree 2	0	0
						80			
	W3	Sep 13, 2023 10:09	5608803	471087	Douglas Fir	7	Herb 1	7	131
					Falsebox	2	Herb 2	4	110
					Lodgepole Pine	9	Shrub 1	3	54
					Red Raspberry	53	Shrub 2	4	55
					Saskatoon	1	Tree 1	1	24
					Spruce	2	Tree 2	0	0
					Western Red Cedar	1			
					White Pine	3			
						78			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	W4	Sep 13, 2023 10:22	5608716	471133	Black Cottonwood	4	Herb 1	28	61
					Douglas Fir	4	Herb 2	25	14
					Falsebox	11	Shrub 1	0	0
					Kinnickinick	2	Shrub 2	0	0
					Lodgepole Pine	1	Tree 1	0	0
					Mountain Ash	1	Tree 2	0	0
					Vaccinium	1			
						24			
	W5	Sep 13, 2023 10:33	5608613	471170	Black Cottonwood	5	Herb 1	4	8
					Douglas Fir	2	Herb 2	45	43
					Falsebox	1	Shrub 1	0	0
					Spruce	2	Shrub 2	0	0
					Western Red Cedar	1	Tree 1	23	71
							Tree 2	0	0
						11			
	W6	Sep 13, 2023 10:41	5608575	471082	Black Cottonwood	36	Herb 1	11	15
					Douglas Fir	4	Herb 2	2	10
					Falsebox	2	Shrub 1	0	0
					Lodgepole Pine	1	Shrub 2	0	0
							Tree 1	40	76
							Tree 2	45	60
						43			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	W7	Sep 13, 2023 11:04	5608669	471042	Black Cottonwood	7	Herb 1	38	11
					Douglas Fir	4	Herb 2	19	10
					Falsebox	7	Shrub 1	0	0
					Lodgepole Pine	3	Shrub 2	0	0
					Red Raspberry	33	Tree 1	0	0
					Spruce	2	Tree 2	0	0
					Thimbleberry	1			
					Western Red Cedar	4			
						61			
	W8	Sep 13, 2023 11:19	5608641	470953	Black Cottonwood	2	Herb 1	18	30
					Ceanothus	1	Herb 2	39	68
					Douglas Fir	6	Shrub 1	0	0
					Falsebox	3	Shrub 2	0	0
					Red Raspberry	2	Tree 1	0	0
					Spruce	3	Tree 2	0	0
					Thimbleberry	3			
						20			
	W9	Sep 13, 2023 11:31	5608710	470890	Black Cottonwood	8	Herb 1	5	10
					Douglas Fir	3	Herb 2	5	23
					Falsebox	1	Shrub 1	0	0
							Shrub 2	0	0
							Tree 1	3	36
							Tree 2	0	0
						12			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	W10	Sep 13, 2023 11:39	5608761	470990	Black Cottonwood	5	Herb 1	17	34
					Douglas Fir	4	Herb 2	18	66
					Falsebox	6	Shrub 1	4	35
					Lodgepole Pine	1	Shrub 2	0	0
					Red Raspberry	23	Tree 1	0	0
					Saskatoon	2	Tree 2	0	0
					Spruce	1			
						42			
	W11	Sep 13, 2023 11:52	5608823	471014	Douglas Fir	3	Herb 1	9	13
					Falsebox	9	Herb 2	19	11
					Kinnickinick	1	Shrub 1	0	0
					Red Raspberry	3	Shrub 2	0	0
							Tree 1	0	0
							Tree 2	0	0
						16			
	W12	Sep 13, 2023 12:00	5608855	470947	Black Cottonwood	22	Herb 1	19	10
					Douglas Fir	2	Herb 2	9	32
					Falsebox	1	Shrub 1	0	0
					Red Raspberry	1	Shrub 2	0	0
					Salix	1	Tree 1	3	12
					White Pine	1	Tree 2	83	271
						28			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	W13	Sep 13, 2023 12:13	5608796	470860	Black Cottonwood	11	Herb 1	16	55
					Ceanothus	1	Herb 2	22	40
					Douglas Fir	2	Shrub 1	0	0
					Falsebox	8	Shrub 2	0	0
					Red Raspberry	33	Tree 1	2	31
					Sitka Alder	1	Tree 2	0	0
					Spruce	2			
					White Pine	1			
						59			
	W14	Sep 13, 2023 12:30	5608886	470812	Black Cottonwood	15	Herb 1	9	26
					Douglas Fir	2	Herb 2	14	32
					Falsebox	4	Shrub 1	0	0
					Lodgepole Pine	3	Shrub 2	0	0
					Thimbleberry	2	Tree 1	6	56
							Tree 2	11	88
						26			

CHARTWELL INNERGEX

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	W15	Sep 13, 2023 12:40	5608922	470903	Amabalis fir	1	Herb 1	4	10
					Black Cottonwood	17	Herb 2	5	35
					Falsebox	1	Shrub 1	0	0
					Lodgepole Pine	3	Shrub 2	0	0
					Red Osier Dogwood	1	Tree 1	0	0
					Red Raspberry	3	Tree 2	0	0
					Western Red Cedar	1			
						27			
						565			
41.7 Km Borrow Pit	M	Sep 28, 2023 12:53	5611548	468611		0		0	0
						0			
	N	Sep 28, 2023 12:45	5611583	468585	Black Cottonwood	19	Herb 1	10	30
					Douglas Fir	21	Herb 2	10	30
					Oregon grape	1	Shrub 1	10	50
					Red Raspberry	44	Shrub 2	15	30
					Salix	2	Tree 1	5	20
					Sitka Alder	1	Tree 2	20	50
					Thimbleberry	7			
					Western Red Cedar	1			
						96			
	R	Sep 28, 2023 13:24	5611629	468437		0		0	0
						0			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	U	Sep 28, 2023 12:59	5611569	468744	Black Cottonwood	47	Herb 1	4	22
					Douglas Fir	6	Herb 2	3	16
					Red Raspberry	21	Shrub 1	0	0
					Salix	3	Shrub 2	1	5
					Sitka Alder	1	Tree 1	3	31
					Spruce	3	Tree 2	10	71
					Thimbleberry	10			
					Western Hemlock	1			
					Yellow Cedar	1			
						93			
						189			
2020 Upper Spoil #8	005	Sep 28, 2023 10:05	5613446	467693	Amabalis fir	3	Herb 1	9	22
					Black Cottonwood	16	Herb 2	6	26
					Douglas Fir	4	Shrub 1	15	20
					Red Osier Dogwood	1	Shrub 2	1	8
					Red Raspberry	68	Tree 1	5	38
					Spruce	1	Tree 2	40	112
					Western Hemlock	1			
					Western Red Cedar	3			
					White Pine	1			
						98			
	006	Sep 28, 2023 10:16	5613503	467674	Amabalis fir	8	Herb 1	0	0
					Black Cottonwood	28	Herb 2	2	8
					Douglas Fir	32	Shrub 1	2	20

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
					Red Osier Dogwood	1	Shrub 2	2	12
					Salix	4	Tree 1	5	25
					Sitka Alder	1	Tree 2	20	40
					Western Hemlock	3			
					White Pine	1			
						78			
						176			
Boulder Powerhouse and Spoil	C1	Sep 26, 2023 10:30	5609472	471155	Black Cottonwood	34	Herb 1	0	0
					Douglas Fir	7	Herb 2	0	0
					Falsebox	5	Shrub 1	0	0
					Lodgepole Pine	2	Shrub 2	7	15
					Thimbleberry	3	Tree 1	45	88
							Tree 2	0	0
						51			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	Q	Sep 26, 2023 10:43	5609323	471318	Black Cottonwood	70	Herb 1	8	17
					Blackcap Raspberry	2	Herb 2	6	22
					Douglas Fir	34	Shrub 1	23	90
					False Azalea	1	Shrub 2	3	20
					Falsebox	2	Tree 1	0	0
					Lodgepole Pine	8	Tree 2	32	111
					Red Osier Dogwood	1			
					Red Raspberry	74			
					Thimbleberry	23			
					Western Hemlock	5			
					Western Red Cedar	2			
					White Pine	2			
						224			
						275			
Boulder Spoil #2	K	Sep 26, 2023 13:28	5610852	472709	Falsebox	3	Herb 1	12	17
					Rose	1	Herb 2	45	22
					Thimbleberry	1	Shrub 1	0	0
							Shrub 2	0	0
							Tree 1	0	0
							Tree 2	0	0
						5			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	L	Sep 26, 2023 13:09	5610955	472789	Falsebox	4	Herb 1	80	35
					Thimbleberry	10	Herb 2	10	15
					Vaccinium	2	Shrub 1	0	0
							Shrub 2	20	50
							Tree 1	0	0
							Tree 2	0	0
						16			
						21			
Boulder Spoil #4	D1	Sep 26, 2023 11:08	5610147	470113	Black Cottonwood	5	Herb 1	29	115
					Douglas Fir	6	Herb 2	18	20
					Red Raspberry	120	Shrub 1	7	72
					Spruce	3	Shrub 2	19	35
					Thimbleberry	8	Tree 1	0	0
							Tree 2	0	0
						142			
						142			
Boulder Spoil #7	E1	Sep 26, 2023 12:51	5610506	471649	Black Cottonwood	61	Herb 1	1	209
					Douglas Fir	4	Herb 2	1	7
							Shrub 1	0	0
							Shrub 2	0	0
							Tree 1	6	23
							Tree 2	20	66
						65			
						65			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
Camp	B1	Sep 13, 2023 13:29	5609124	471620	Black Cottonwood	4	Herb 1	1	30
					Douglas Fir	13	Herb 2	8	12
					Falsebox	7	Shrub 1	35	110
					Red Raspberry	1	Shrub 2	0	0
					Western Red Cedar	3	Tree 1	0	0
							Tree 2	2	29
						28			
	V	Sep 13, 2023 14:19	5608851	471655	Black Cottonwood	15	Herb 1	0	0
					Douglas Fir	1	Herb 2	1	14
					Falsebox	1	Shrub 1	0	0
					Lodgepole Pine	11	Shrub 2	2	5
					Red Raspberry	8	Tree 1	4	15
					White Pine	1	Tree 2	0	0
						37			
	W	Sep 13, 2023 14:11	5608909	471583	Black Cottonwood	1	Herb 1	4	8
					Ceanothus	1	Herb 2	3	19
					Douglas Fir	10	Shrub 1	0	0
					Falsebox	9	Shrub 2	0	0
							Tree 1	0	0
							Tree 2	0	0
						21			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	X	Sep 13, 2023 14:02	5608927	471652	Black Cottonwood	9	Herb 1	2	4
					Douglas Fir	9	Herb 2	0	0
					Falsebox	5	Shrub 1	0	0
					Lodgepole Pine	4	Shrub 2	5	27
							Tree 1	0	0
							Tree 2	0	0
						27			
	Y	Sep 13, 2023 13:52	5609046	471649	Black Cottonwood	7	Herb 1	1	4
					Douglas Fir	16	Herb 2	9	20
					Falsebox	1	Shrub 1	0	0
					Lodgepole Pine	7	Shrub 2	0	0
					Red Raspberry	12	Tree 1	7	65
							Tree 2	0	0
						43			
	Z	Sep 13, 2023 13:40	5609010	471581	Black Cottonwood	14	Herb 1	2	32
					Douglas Fir	11	Herb 2	6	13
					Falsebox	1	Shrub 1	0	0
					Lodgepole Pine	1	Shrub 2	0	0
					Red Raspberry	1	Tree 1	0	0
					Saskatoon	1	Tree 2	0	0
						29			
						185			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
Diversion Channel and Slopes	008	Sep 28, 2023 09:23	5614016	466032	Amabalis fir	17	Herb 1	15	29
					Black Cottonwood	13	Herb 2	70	20
					Douglas Fir	1	Shrub 1	19	66
					Mountain Hemlock	2	Shrub 2	1	15
					Salix	4	Tree 1	0	0
					Salmonberry	2	Tree 2	0	0
					Sitka Alder	7			
					Spruce	3			
					Subalpine Fir	4			
					Thimbleberry	1			
					White Pine	1			
						55			
	009	Sep 28, 2023 09:08	5613989	466109	Amabalis fir	8	Herb 1	0	0
					Black Cottonwood	34	Herb 2	0	0
					Ceanothus	1	Shrub 1	4	52
					Douglas Fir	3	Shrub 2	40	150
					Red Osier Dogwood	1	Tree 1	0	0
					Salix	3	Tree 2	0	0
					Sitka Alder	17			
					Spruce	2			
					Western Red Cedar	1			
						70			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

							Percent Cover of Quadrant Plots		
Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Species	% Cover	Height (cm)
	013	Sep 28, 2023 08:53	5613987	466238	Amabalis fir	19	Herb 1	8	11
					Black Cottonwood	2	Herb 2	7	15
					Ribes	1	Shrub 1	0	0
					Salix	2	Shrub 2	5	17
					Salmonberry	3	Tree 1	1	15
					Sitka Alder	14	Tree 2	0	0
					Subalpine Fir	3			
					Vaccinium	5			
						49			
						174			
Explosive Magazine	001	Sep 26, 2023 12:12	5610461	469828	Black Cottonwood	1	Herb 1	0	0
					Ceanothus	2	Herb 2	0	0
					Douglas Fir	10	Shrub 1	100	8
					Red Raspberry	42	Shrub 2	100	7
					Salix	60	Tree 1	0	0
							Tree 2	0	0
						115			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	002	Sep 26, 2023 11:56	5610436	469886	Black Cottonwood	7	Herb 1	2	17
					Douglas Fir	11	Herb 2	25	70
					Lodgepole Pine	1	Shrub 1	2	30
					Mountain Ash	2	Shrub 2	5	25
					Red Raspberry	44	Tree 1	12	108
					Salix	17	Tree 2	0	0
					Sitka Alder	1			
					Thimbleberry	24			
					Western Red Cedar	3			
						110			
	003	Sep 26, 2023 11:35	5610397	469961	Black Cottonwood	10	Herb 1	50	35
					Douglas Fir	9	Herb 2	10	15
					Lodgepole Pine	1	Shrub 1	10	40
					Red Raspberry	205	Shrub 2	10	40
					Salix	6	Tree 1	7	95
					Thimbleberry	10	Tree 2	85	219
						241			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	4	Sep 26, 2023 11:24	5610395	470023	Bigleaf Maple	1	Herb 1	20	70
					Ceanothus	2	Herb 2	16	42
					Douglas Fir	3	Shrub 1	9	52
					Salix	4	Shrub 2	0	0
					Thimbleberry	48	Tree 1	9	20
							Tree 2	0	0
						58			
						524			
Keyhole Laydown	007	Sep 12, 2023 13:07	5614082	466435	Amabalis fir	3	Herb 1	83	29
					Elderberry	1	Herb 2	40	103
					Red Raspberry	234	Shrub 1	4	31
					Ribes	3	Shrub 2	14	55
					Salix	2	Tree 1	0	0
					Vaccinium	22	Tree 2	0	0
						265			
						265			
Upper Intake and Laydown	014	Sep 12, 2023 11:52	5614291	466096	Amabalis fir	42	Herb 1	6	17
					Black Cottonwood	196	Herb 2	1	6
					Douglas Fir	1	Shrub 1	0	0
					Lodgepole Pine	1	Shrub 2	3	13
					Salix	10	Tree 1	9	49
					Sitka Alder	11	Tree 2	17	53
					Western Red Cedar	2			
						263			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	A	Sep 12, 2023 11:32	5614240	466167	Amabalis fir	10	Herb 1	2	5
					Black Cottonwood	102	Herb 2	2	20
					Douglas Fir	3	Shrub 1	0	0
					Kinnickinick	1	Shrub 2	2	25
					Rosa spp	2	Tree 1	1	9
					Salix	5	Tree 2	0	0
					Sitka Alder	1			
					Western Red Cedar	2			
						126			
	B	Sep 12, 2023 11:32	5614202	466202	Douglas Fir	2	Herb 1	3	5
					Sitka Alder	11	Herb 2	3	5
					Spruce	5	Shrub 1	0	0
					Western Red Cedar	1	Shrub 2	0	0
							Tree 1	0	0
							Tree 2	0	0
						19			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	C	Sep 28, 2023 09:44	5614149	466137	Amabalis fir	1	Herb 1	1	20
					Black Cottonwood	12	Herb 2	0	0
					Douglas Fir	2			
					Oregon grape	1			
					Spruce	1			
					Subalpine Fir	1			
					Western Hemlock	1			
					White Pine	1			
						20			
						428			
Upper Lillooet Penstock	I	Sep 28, 2023 11:38	5612564	468289	Black Cottonwood	20	Herb 1	15	10
					Douglas Fir	17	Herb 2	0	0
					Red Osier Dogwood	1	Shrub 1	20	30
					Red Raspberry	202	Shrub 2	8	50
					Salix	1	Tree 1	10	45
					Thimbleberry	12	Tree 2	20	100
					Western Red Cedar	1			
						254			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
	O	Sep 28, 2023 12:15	5612329	468405	Black Cottonwood	15	Herb 1	5	30
					Ceanothus	1	Herb 2	20	15
					Douglas Fir	9	Shrub 1	20	45
					Falsebox	1	Shrub 2	0	0
					Red Raspberry	12	Tree 1	0	0
					Yellow Cedar	2	Tree 2	0	0
						40			
						294			
Upper Spoil #1	010	Sep 12, 2023 13:33	5614046	465820	Amabalis fir	3	Herb 1	11	40
					Black Cottonwood	29	Herb 2	2	40
					Douglas Fir	1	Shrub 1	0	0
					Mountain Hemlock	1	Shrub 2	11	30
					Salix	3	Tree 1	0	0
					Sitka Alder	2	Tree 2	0	0
					Spruce	6			
					Thimbleberry	2			
					Western Red Cedar	1			
						48			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	011	Sep 12, 2023 13:46	5614051	465832	Amabalis fir	6	Herb 1	1	11
					Black Cottonwood	7	Herb 2	0	0
					Douglas Fir	1	Shrub 1	0	0
					Salal	1	Shrub 2	4	17
					Salix	4	Tree 1	1	8
					Sitka Alder	3	Tree 2	2	9
					Spruce	3			
					Western Red Cedar	1			
						26			
	012	Sep 12, 2023 14:07	5614076	465893	Amabalis fir	2	Herb 1	0	0
					Black Cottonwood	90	Herb 2	7	19
					Salix	12	Shrub 1	40	83
					Sitka Alder	29	Shrub 2	45	125
					Spruce	7	Tree 1	5	54
							Tree 2	3	79
						140			
						214			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
Upper Spoil #2 and Settling Basin	016	Sep 12, 2023 12:13	5614385	466204	Amabalis fir	1	Herb 1	4	22
					Black Cottonwood	23	Herb 2	0	0
					Douglas Fir	1	Shrub 1	0	0
					Sitka Alder	1	Shrub 2	0	0
					Spruce	4	Tree 1	4	44
					Western Hemlock	1	Tree 2	0	0
					Western Red Cedar	1			
						32			
	017	Sep 12, 2023 12:41	5614472	466211	Amabalis fir	10	Herb 1	1	6
					Bitter Cherry	1	Herb 2	1	12
					Black Cottonwood	48	Shrub 1	0	0
					Douglas Fir	5	Shrub 2	0	0
					Salix	2	Tree 1	0	0
					Sitka Alder	5	Tree 2	0	0
						71			
	018	Sep 12, 2023 12:23	5614431	466160	Amabalis fir	3	Herb 1	6	47
					Black Cottonwood	12	Herb 2	3	18
					Douglas Fir	3	Shrub 1	3	13
					Lodgepole Pine	1	Shrub 2	0	0
					Salal	1	Tree 1	0	0
					Spruce	1	Tree 2	0	0
						21			
						124			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
Upper Spoil #3	D	Sep 26, 2023 14:32	5613276	467767	Amabalis fir	1	Herb 1	25	50
					Black Cottonwood	7	Herb 2	18	35
					Douglas Fir	15	Shrub 1	0	0
					Red Raspberry	92	Shrub 2	20	55
					Salix	1	Tree 1	50	100
					Spruce	1	Tree 2	20	50
						117			
	E	Sep 26, 2023 14:18	5613296	467769	Amabalis fir	1	Herb 1	4	30
					Black Cottonwood	31	Herb 2	0	0
					Douglas Fir	8	Shrub 1	8	21
					Red Raspberry	65	Shrub 2	0	0
					Spruce	1	Tree 1	4	32
					Thimbleberry	9	Tree 2	50	120
						115			
						232			
Upper Spoil #4	A1	Sep 28, 2023 10:50	5612994	467931		0		0	0
						0			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	F	Sep 28, 2023 11:15	5613160	467770	Amabalis fir	1	Herb 1	0	0
					Black Cottonwood	7	Herb 2	2	22
					Douglas Fir	12	Shrub 1	0	0
					Red Osier Dogwood	1	Shrub 2	3	15
					Red Raspberry	47	Tree 1	3	142
					Spruce	3	Tree 2	3	40
					Thimbleberry	6			
						77			
	G	Sep 28, 2023 11:06	5613113	467716	Amabalis fir	1	Herb 1	5	20
					Black Cottonwood	3	Herb 2	2	15
					Douglas Fir	5	Shrub 1	8	25
					Red Raspberry	33	Shrub 2	0	0
					Spruce	3	Tree 1	6	30
					White Pine	1	Tree 2	0	0
						46			
	H	Sep 28, 2023 10:39	5613023	467889	Black Cottonwood	10	Herb 1	7	25
					Douglas Fir	38	Herb 2	8	19
					Red Raspberry	16	Shrub 1	14	80
					Salix	4	Shrub 2	38	138
					Sitka Alder	11	Tree 1	4	32
					Thimbleberry	8	Tree 2	1	15
						87			
						210			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots		
							Species	% Cover	Height (cm)
Upper Spoil #5	F1	Sep 28, 2023 13:29	5611450	468549	Amabalis fir	1	Herb 1	5	20
					Black Cottonwood	7	Herb 2	10	100
					Douglas Fir	6	Shrub 1	0	0
					Red Raspberry	103	Shrub 2	0	0
					Sitka Alder	1	Tree 1	18	120
					Spruce	2	Tree 2	0	0
						120			
						120			
Upper Spoil #6	J	Sep 28, 2023 11:50	5612555	468262	Black Cottonwood	32	Herb 1	0	0
					Douglas Fir	10	Herb 2	0	0
					Sitka Alder	2	Shrub 1	0	0
					Spruce	2	Shrub 2	40	138
					Western Red Cedar	1	Tree 1	11	126
							Tree 2	42	150
						47			
	P	Sep 26, 2023 14:09	5612024	468502		0		0	0
						0			
						47			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Civil Work Sites (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
Upper Spoil #7	T	Sep 28, 2023 12:28	5612208	468544	Amabalis fir	4	Herb 1	0	0
					Black Cottonwood	104	Herb 2	0	0
					Douglas Fir	7	Shrub 1	15	52
					Red Raspberry	14	Shrub 2	4	20
					Salix	2	Tree 1	33	141
					Sitka Alder	1	Tree 2	26	128
						132			
						132			
						4439			

Appendix C: Civil Works Sites Permanent Monitoring Plot Data Established 2020.

Transmission Line Surveys

53.1/56.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 53.1/56.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1

Contractor: CRGL
Surveyors: C. Johnston, B. Van Loon
Field Start: 14-Sep-2023
Field Finish: Oct 3, 2023
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %	Inv Ht (m)
Thimbleberry	5,000	50	1.05
Black Cottonwood	2,800	28	3.50
Red Raspberry	800	8	0.70
Red Osier Dogwood	400	4	1.15
Blackcap Raspberry	200	2	1.30
Ceanothus	200	2	1.30
Douglas Maple	200	2	0.25
Falsebox	200	2	0.10
Salix spp	200	2	1.65
Summary:	***10,000***	***100***	***1.22***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	60	8
Herb 2	65	22
Shrub 1	-	0
Shrub 2	8	25
Tree 1	3	68
Tree 2	1	31

Qualified Forest Professional's Statement

Declaration

Forest Professional

Affix Professional Seal Here

Transmission Line Surveys

73.1 Road

Project Information:

Project: Longterm Revegetation Monitoring
Site: 73.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1

Contractor: CRGL
Surveyors: C. Johnston, B. Van Loon
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Thimbleberry	46,000	63
Western Red Cedar	15,800	22
Red Raspberry	5,600	8
Falsebox	2,800	4
Black Cottonwood	1,400	2
Douglas Fir	800	1
Red Osier Dogwood	400	1
Saskatoon	200	0
Summary:	***73,000***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	25	15
Herb 2	40	30
Shrub 1	5	70
Shrub 2	20	20
Tree 1	5	50
Tree 2	12	30

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

129.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 129.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Lodgepole Pine	1,400	50
Kinnickinick	800	29
Black Cottonwood	400	14
Blackcap Raspberry	200	7
Summary:	***2,800***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	21	7
Herb 2	6	11
Shrub 1	-	0
Shrub 2	3	60
Tree 1	-	0
Tree 2	2	60

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

130.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 130.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %	Inv Ht (m)
Lodgepole Pine	3,600	69	
Black Cottonwood	400	8	
Kinnickinick	400	8	0.12
Vaccinium spp	400	8	0.22
Douglas Fir	200	4	
Salix spp	200	4	0.52
Summary:	***5,200***	***100***	***0.29***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	16	65
Herb 2	15	10
Shrub 1	-	0
Shrub 2	-	0
Tree 1	2	22
Tree 2	30	100

Pest / Disease	Host Species	Dead Trees (SPH)	Live Trees (SPH)	% Total Affected	% Conifers Affected	% Host Trees Affected
DSG Western Gall Rust	PLC	400	800	300	300	-

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Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

133.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 133.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet:

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %	Inv Ht (m)
Douglas Fir	2,000	50	0.34
Lodgepole Pine	800	20	2.03
Saskatoon	600	15	0.22
Black Cottonwood	200	5	0.14
Blackcap Raspberry	200	5	0.55
Western Red Cedar	200	5	0.15
Summary:	***4,000***	***100***	***0.57***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	25	6
Herb 2	14	7
Shrub 1	-	0
Shrub 2	-	0
Tree 1	1	12
Tree 2	5	37

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Declaration		
Forest Professional	Date	

Transmission Line Surveys

140.1 Road

Project Information

Project:	Longterm Revegetation Monitoring	**Contractor:**	CRGL
Site:	140.1 Road	**Surveyors:**	C. Johnston
Location:	Upper Lillooet Hydro Project	**Field Start:**	14-Sep-2023
Mapsheet:		**Field Finish:**	3-Oct-2023
		# of plots:	1

Inventory Information

Species	*TS (SPH)*	*TS %*	*Inv Ht (m)*
Red Alder	16,600	77	3.20
Thimbleberry	2,800	13	1.70
Western Red Cedar	1,200	6	0.35
Black Cottonwood	400	2	6.75
Saskatoon	400	2	1.00
Red Osier Dogwood	200	1	1.10
Summary:	***21,600***	***100***	***2.35***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	-	0
Herb 2	-	0
Shrub 1	-	0
Shrub 2	95	165
Tree 1	100	300
Tree 2	25	300

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Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

163.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 163.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: CRGL
Surveyors: C. Johnston
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1-Jan-1900

Inventory Information

Species	*TS (SPH)*	*TS %*	*Inv Ht (m)*
Western Red Cedar	25,000	33	0.13
Red Raspberry	22,800	30	0.77
Salix spp	10,200	14	4.50
Thimbleberry	9,600	13	0.70
Douglas Fir	5,600	7	0.68
Falsebox	800	1	0.70
Black Cottonwood	600	1	4.63
Western Trumpet Honey Suckle	400	1	2.70
High Brush Cranberry	200	0	1.01
Paper Birch	200	0	1.99
Summary:	***75,400***	***100***	***1.78***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	4	30
Herb 2	15	35
Shrub 1	68	110
Shrub 2	22	75
Tree 1	1	15
Tree 2	-	0

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

CHARTWELL

Transmission Line Surveys

237.1 Road

INNERGEX

Project Information

Project: Longterm Revegetation Monitoring
Site: 237.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Thimbleberry	14,600	70
Douglas Fir	3,800	18
High Bush Cranberry	800	4
Rose	800	4
Black Cottonwood	600	3
Western Red Cedar	200	1
Summary:	***20,800***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	2	15
Herb 2	25	10
Shrub 1	11	66
Shrub 2	30	89
Tree 1	8	27
Tree 2	3	15

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

CHARTWELL

Transmission Line Surveys

238.1 Road

INNERGEX

Project Information

Project: Longterm Revegetation Monitoring
Site: 238.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Douglas Fir	10,400	39
Thimbleberry	7,000	26
Falsebox	5,600	21
Ceanothus	2,000	8
Blackcap Raspberry	1,200	5
Bitter Cherry	200	1
Western Red Cedar	200	1
Summary:	***26,600***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	6	38
Herb 2	13	54
Shrub 1	24	115
Shrub 2	55	60
Tree 1	-	0
Tree 2	-	0

Pest / Disease	Host Species	Dead Trees (SPH)	Live Trees (SPH)	% Total Affected	% Conifers Affected	% Host Trees Affected
ND Drought	FDC	800	400	150	150	-

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

245.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 245.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*	*Inv Ht (m)*
Thimbleberry	5,200	31	0.63
Douglas Fir	4,000	24	0.48
Ceanothus	3,200	19	1.80
Blackcap Raspberry	1,600	10	0.63
Hardhack Spirea	1,200	7	0.66
Falsebox	1,000	6	0.27
High Brush Cranberry	200	1	0.63
Paper Birch	200	1	1.82
Summary:	***16,600***	***100***	***0.87***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	10	12
Herb 2	15	53
Shrub 1	2	50
Shrub 2	70	200
Tree 1	-	
Tree 2	-	

Pest / Disease	*Host Species*	*Dead Trees (SPH)*	*Live Trees (SPH)*	*% Total Affected*	*% Conifers Affected*	*% Host Trees Affected*
ND Drought	FDC	400	-	100	100	-

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys
255.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 255.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 6

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*	*Inv Ht (m)*
Douglas Fir	24,200	37	0.50
Thimbleberry	18,000	27	0.77
Falsebox	10,600	16	0.31
Red Raspberry	5,800	9	0.53
Ceanothus	2,000	3	1.16
Western Red Cedar	1,800	3	0.24
Blackcap Raspberry	1,600	2	1.20
Black Cottonwood	1,200	2	0.35
High Bush Cranberry	200	0	0.50
Western Hemlock	200	0	0.16
Western White Pine	200	0	0.14
Summary:	***65,800***	***100***	***0.53***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*
Herb 1	4	6
Herb 2	6	5
Shrub 1	14	50
Shrub 2	32	31
Tree 1	12	32
Tree 2	3	22

Qualified Forest Professional's Statement

Declaration

Forest Professional	**Date**

Affix Professional Seal Here

Transmission Line Surveys

260.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 260.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 6

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %	Inv Ht (m)
Red Raspberry	10,400	55	0.43
Thimbleberry	5,800	31	
Blackcap Raspberry	1,200	6	1.98
Bigleaf Maple	800	4	0.45
Douglas Fir	600	3	0.33
Black Cottonwood	200	1	1.33
Summary:	***19,000***	***100***	***0.90***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	20	52
Herb 2	19	48
Shrub 1	68	137
Shrub 2	12	108
Tree 1	-	0
Tree 2	-	0

Pest / Disease	Host Species	Dead Trees (SPH)	Live Trees (SPH)	% Total Affected	% Conifers Affected	% Host Trees Affected
AD Deer	FDC	-	200			-

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys
Ryan Crossing

Project Information

Project: Longterm Revegetation Monitoring
Site: Ryan Crossing
Location: Upper Lillooet Hydro Project
Mapsheet: Map 6

Contractor: CRGL
Surveyors: C. Johnston, S. Dayton
Field Start: 14-Sep-2023
Field Finish: 3-Oct-2023
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %	Inv Ht (m)
Thimbleberry	6,600	79	1.25
Western Red Cedar	600	7	1.43
Salmonberry	400	5	1.07
Saskatoon	400	5	0.78
Pacific Dogwood	200	2	1.06
Red Elderberry	200	2	0.70
Summary:	***8,400***	***100***	***1.05***

Veg / Brush	% Cover	Avg Ht. (cm)
Herb 1	35	50
Herb 2	8	45
Shrub 1	50	95
Shrub 2	35	105
Tree 1	-	0
Tree 2	-	0

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Transmission Line Surveys (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
53.1/56.1 Road	31	Sep 28, 2023 14:51	5604639	476001	Black Cottonwood	14	Herb 1	60	8
					Blackcap Raspberry	1	Herb 2	65	22
					Ceanothus	1	Shrub 1	0	0
					Douglas Maple	1	Shrub 2	8	25
					Falsebox	1	Tree 1	3	68
					Red Osier Dogwood	2	Tree 2	1	31
					Red Raspberry	4			
					Salix	1			
					Thimbleberry	25			
						50			
						50			
73.1 Road	30	Sep 28, 2023 15:10	5604013	477754	Black Cottonwood	7	Herb 1	25	15
					Douglas Fir	4	Herb 2	40	30
					Falsebox	14	Shrub 1	5	70
					Red Osier Dogwood	2	Shrub 2	20	20
					Red Raspberry	28	Tree 1	5	50
					Saskatoon	1	Tree 2	12	30
					Thimbleberry	230			
					Western Red Cedar	79			
						365			
						365			
129.1 Road	29	Sep 14, 2023 13:14	5600847	486277	Black Cottonwood	2	Herb 1	21	7
					Blackcap Raspberry	1	Herb 2	6	11
					Kinnickinick	4	Shrub 1	0	0
					Lodgepole Pine	7	Shrub 2	3	60
							Tree 1	0	0
							Tree 2	2	60
						14			
						14			

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Project: Longterm Revegetation Monitoring 2023 (Year 5)

Transmission Line Surveys (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
130.1 Road	28	Sep 14, 2023 13:01	5600816	486417	Black Cottonwood	2	Herb 1	16	65
					Douglas Fir	1	Herb 2	15	10
					Kinnickinick	2	Shrub 1	0	0
					Lodgepole Pine	18	Shrub 2	0	0
					Salix	1	Tree 1	2	22
					Vaccinium spp	2	Tree 2	30	100
						26			
						26			
133.1	27	Sep 14, 2023 12:47	5600682	486899	Black Cottonwood	1	Herb 1	25	6
					Blackcap Raspberry	1	Herb 2	14	7
					Douglas Fir	10	Shrub 1	0	0
					Lodgepole Pine	4	Shrub 2	0	0
					Saskatoon	3	Tree 1	1	12
					Western Red Cedar	1	Tree 2	5	37
						20			
						20			
140.1 Road	35	Oct 3, 2023 13:18	5599221	487559	Black Cottonwood	2	Herb 1	0	0
					Red Alder	83	Herb 2	0	0
					Red Osier Dogwood	1	Shrub 1	0	0
					Saskatoon	2	Shrub 2	95	165
					Thimbleberry	14	Tree 1	100	300
					Western Red Cedar	6	Tree 2	25	300
						108			
						108			

CHARTWELL INNERGEX

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Transmission Line Surveys (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
163.1 Road	35A	Oct 3, 2023 13:46	5597295	491658	Black Cottonwood	3	Herb 1	4	30
					Douglas Fir	28	Herb 2	15	35
					Falsebox	4	Shrub 1	68	110
					High Brush Cranberry	1	Shrub 2	22	75
					Paper Birch	1	Tree 1	1	15
					Red Raspberry	114	Tree 2	0	0
					Salix	51			
					Thimbleberry	48			
					Western Red Cedar	125			
					Western Trumpet Honey Suckle	2			
						377			
						377			
237.1	34	Sep 14, 2023 10:36	5590775	500650	Black Cottonwood	3	Herb 1	2	15
					Douglas Fir	19	Herb 2	25	10
					High Brush Cranberry	4	Shrub 1	11	66
					Rose	4	Shrub 2	30	89
					Thimbleberry	73	Tree 1	8	27
					Western Red Cedar	1	Tree 2	3	15
						104			
						104			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Transmission Line Surveys (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
238.1	33	Sep 14, 2023 10:55	5590638	500861	Bitter Cherry	1	Herb 1	6	38
					Blackcap Raspberry	6	Herb 2	13	54
					Ceanothus	10	Shrub 1	24	115
					Douglas Fir	52	Shrub 2	55	60
					Falsebox	28	Tree 1	0	0
					Thimbleberry	35	Tree 2	0	0
					Western Red Cedar	1			
						133			
						133			
239.1 Road	32	Sep 14, 2023 11:10	5590558	501033		0		0	0
						0			
						0			
245.1 Road	26	Sep 14, 2023 11:22	5589883	501978	Blackcap Raspberry	8	Herb 1	10	12
					Ceanothus	16	Herb 2	15	53
					Douglas Fir	20	Shrub 1	2	50
					Falsebox	5	Shrub 2	70	200
					Hardhack Spirea	6	Tree 1	0	0
					High Brush Cranberry	1	Tree 2	0	0
					Paper Birch	1			
					Thimbleberry	26			
						83			
						83			
247.1/249.1 Road	25								
						0			
						0			
250.1 Road	24								
						0			
						0			

Project: Longterm Revegetation Monitoring 2023 (Year 5)

Transmission Line Surveys (Plots established in 2023)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
255.1 Road	23	Sep 14, 2023 09:58	5588763	503263	Black Cottonwood	6	Herb 1	4	6
					Blackcap Raspberry	8	Herb 2	6	5
					Ceanothus	10	Shrub 1	14	50
					Douglas Fir	121	Shrub 2	32	31
					Falsebox	53	Tree 1	12	32
					High Brush Cranberry	1	Tree 2	3	22
					Red Raspberry	29			
					Thimbleberry	90			
					Western Hemlock	1			
					Western Red Cedar	9			
					Western White Pine	1			
						329			
						329			
260.1 Road	21	Sep 14, 2023 09:32	5587955	503838	Bigleaf Maple	4	Herb 1	20	52
					Black Cottonwood	1	Herb 2	19	48
					Blackcap Raspberry	6	Shrub 1	68	137
					Douglas Fir	3	Shrub 2	12	108
					Red Raspberry	52	Tree 1	0	0
					Thimbleberry	29	Tree 2	0	0
						95			
						95			
Ryan Crossing	22	Sep 14, 2023 09:10	5587916	504283	Pacific Dogwood	1	Herb 1	35	50
					Red Elderberry	1	Herb 2	8	45
					Salmonberry	2	Shrub 1	50	95
					Saskatoon	2	Shrub 2	35	105
					Thimbleberry	33	Tree 1	0	0
					Western Red Cedar	3	Tree 2	0	0
						42			
						42			
						1746			

Appendix B. Representative Water Temperature and Air Temperature Site Photographs, 2023

LIST OF FIGURES

1. UPPER LILLOOET RIVER

Figure 1. Looking upstream at ULL-USWQ04 on October 06, 2023

Figure 2. Looking downstream at ULL-USWQ04 on October 06, 2023.

Figure 3. Looking at ULL-USAT03 on October 06, 2023.

Figure 4. Looking upstream at ULL-DVWQ01 on May 09, 2023.

Figure 5. Looking downstream at ULL-DVWQ01 on May 09, 2023.

Figure 6. Looking upstream at ULL-DVWQ01 on October 06, 2023.

Figure 7. Looking downstream at ULL-DVWQ01 on October 06, 2023.

Figure 8. Looking RR-RL at ULL-TAILWQ on May 09, 2023.

Figure 9. Looking downstream at ULL-TAILWQ on May 09, 2023.

Figure 10. Looking upstream at ULL-TAILWQ on October 06, 2023.

Figure 11. Looking downstream at ULL-TAILWQ on October 06, 2023.

Figure 12. Looking RR-RL at ULL-TAILWQ on October 06, 2023.

Figure 13. Looking upstream at ULL-DSWQ on October 06, 2023.

Figure 14. Looking downstream at ULL-DSWQ on October 06, 2023.

Figure 15. Looking RL-RR at ULL-DSWQ on October 06, 2023.

Figure 16. Looking at ULL-DSAT on October 06, 2023.

2. BOULDER CREEK

Figure 17. Looking RL to RR at BDR-USWQ2 on October 06, 2023.

Figure 18. Looking upstream at BDR-USWQ2 on October 06, 2023.

Figure 19. Looking upstream at NTH-USWQ1 on October 06, 2023.

Figure 20. Looking RR to RL at NTH-USWQ1 on October 06, 2023.

Figure 21. Looking upstream at BDR-DVWQ on May 09, 2023.

Figure 22. Looking upstream at BDR-DVWQ on October 27, 2023.

Figure 23. Looking RR to RL at BDR-DVWQ on October 27, 2023.

Figure 24. Looking downstream at BDR-TAILWQ on May 09, 2023.

Figure 25. Looking upstream at BDR-TAILWQ on October 27, 2023.

Figure 26. Looking downstream at BDR-TAILWQ on October 27, 2023.

Figure 27. Looking upstream at Tidbit 1 at BDR-DSWQ on May 09, 2023.

Figure 28. Looking upstream at Tidbit 2 at BDR-DSWQ on May 09, 2023.

Figure 29. Looking upstream at Tidbit 2 at BDR-DSWQ on October 28, 2023.

Figure 30. Looking upstream at Tidbit 1 at BDR-DSWQ on October 28, 2023.

Figure 31. Looking at BDR-DVAT on May 09, 2023.

Figure 32. Looking at BDR-DVAT on October 27, 2023.

Appendix C. Water Temperature Guidelines and Data Summary

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. WATER TEMPERATURE GUIDELINES

Table 1. Water temperature guidelines for the protection of freshwater aquatic life (Oliver and Fidler 2001; BC ENV 2023).

Category	Guideline[1]
All Streams	the rate of temperature change in natural water bodies not to exceed 1°C/hr
	temperature metrics to be described by the mean weekly maximum temperature (MWMxT)
Streams with Known Fish Presence	mean weekly maximum water temperatures should not exceed ±1°C beyond the optimum temperature range for each life history phase of the most sensitive salmonid species present[1]
Streams with Bull Trout or Dolly Varden	maximum daily temperature is 15°C
	maximum incubation temperature is 10°C
	minimum incubation temperature is 2°C
	maximum spawning temperature is 10°C
Streams with Unknown Fish Presence	salmonid rearing temperatures not to exceed MWMxT of 18°C
	maximum daily temperature not to exceed 19°C
	maximum temperature for salmonid incubation from June until August not to exceed 12°C

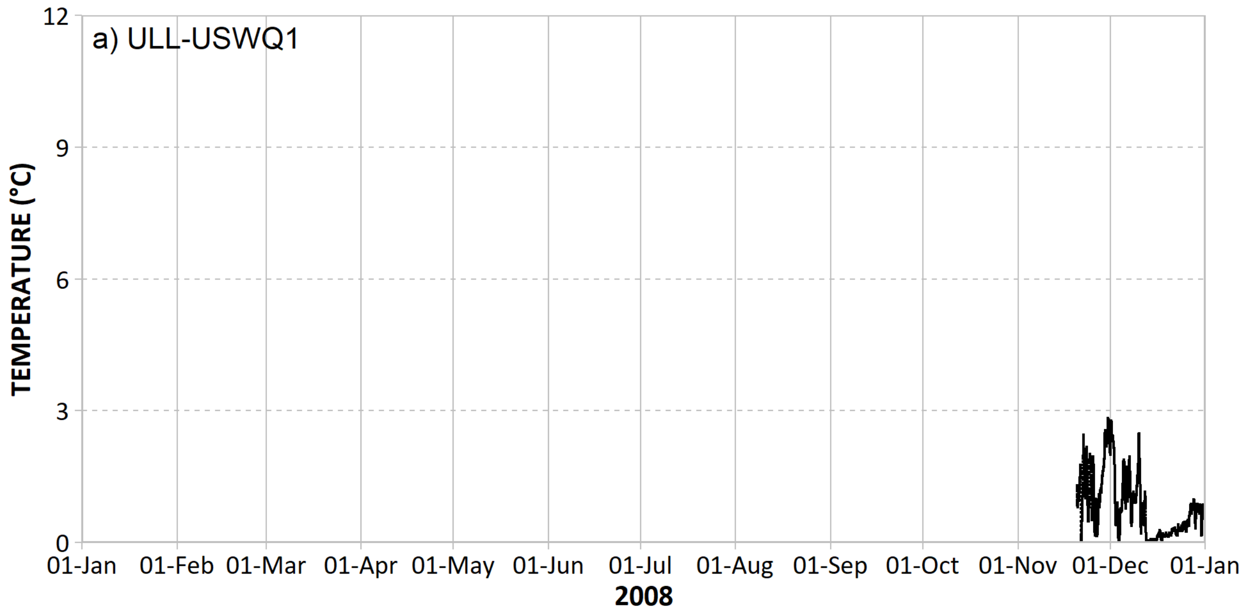
[1] The guidelines state that "the natural temperature cycle characteristic of the site should not be altered in amplitude or frequency by human activities". Accordingly, it is implied that when conditions are naturally outside of guidelines, human activities should not increase the magnitude and/or frequency to which conditions are outside of guidelines.

2. WATER TEMPERATURE DATA

2.1. Upper Lillooet River

2.1.1. Baseline Conditions

Figure 1. Baseline water temperature at ULL-USWQ1 from 2008 to 2013. Black dots show water temperature at intervals of 15 minutes.



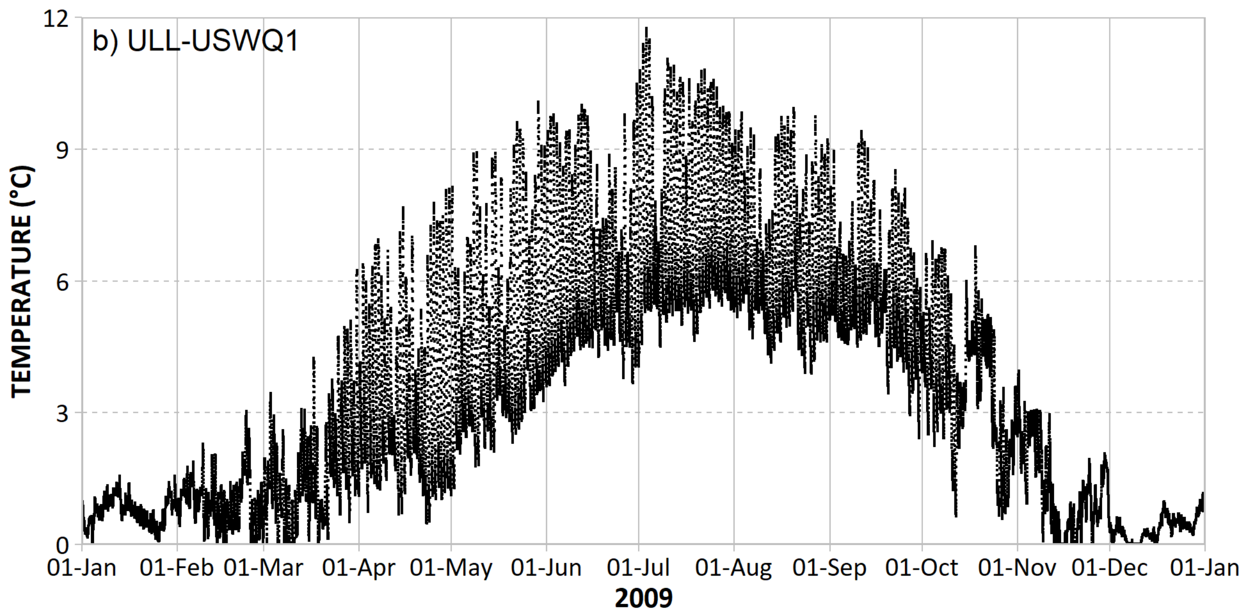
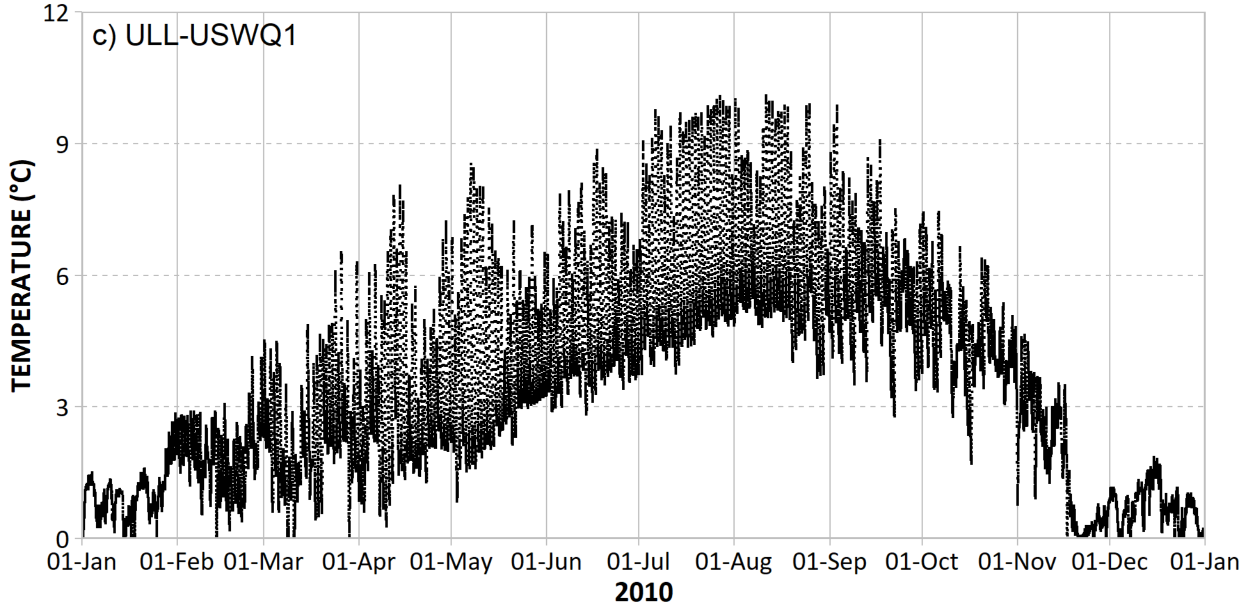


Figure 1. Continued.



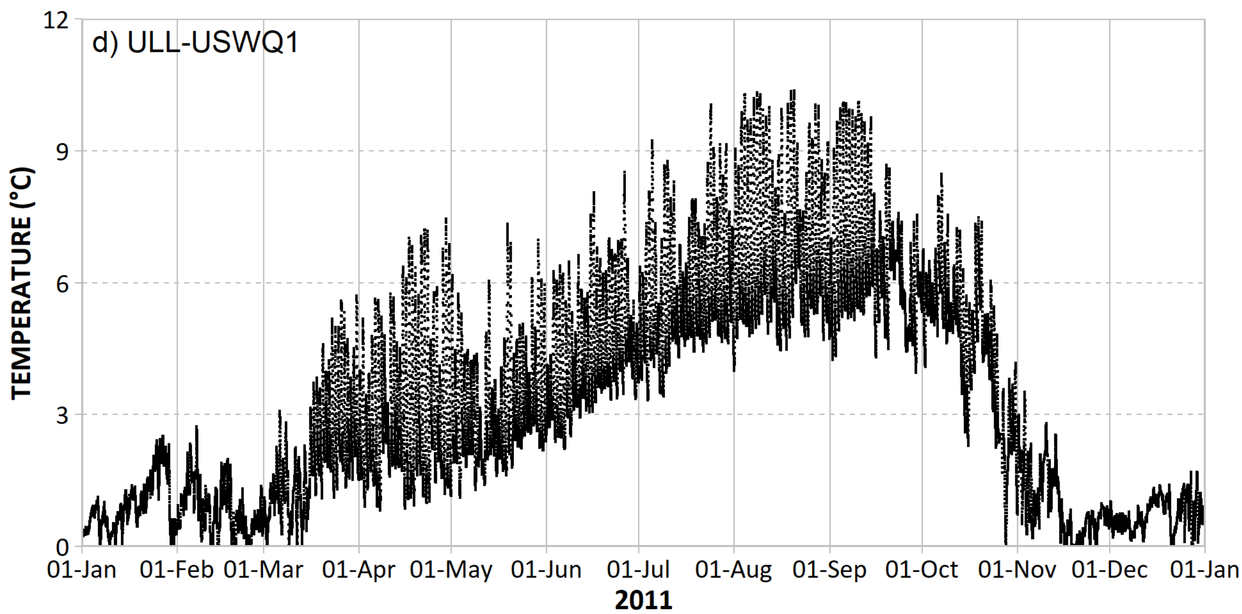
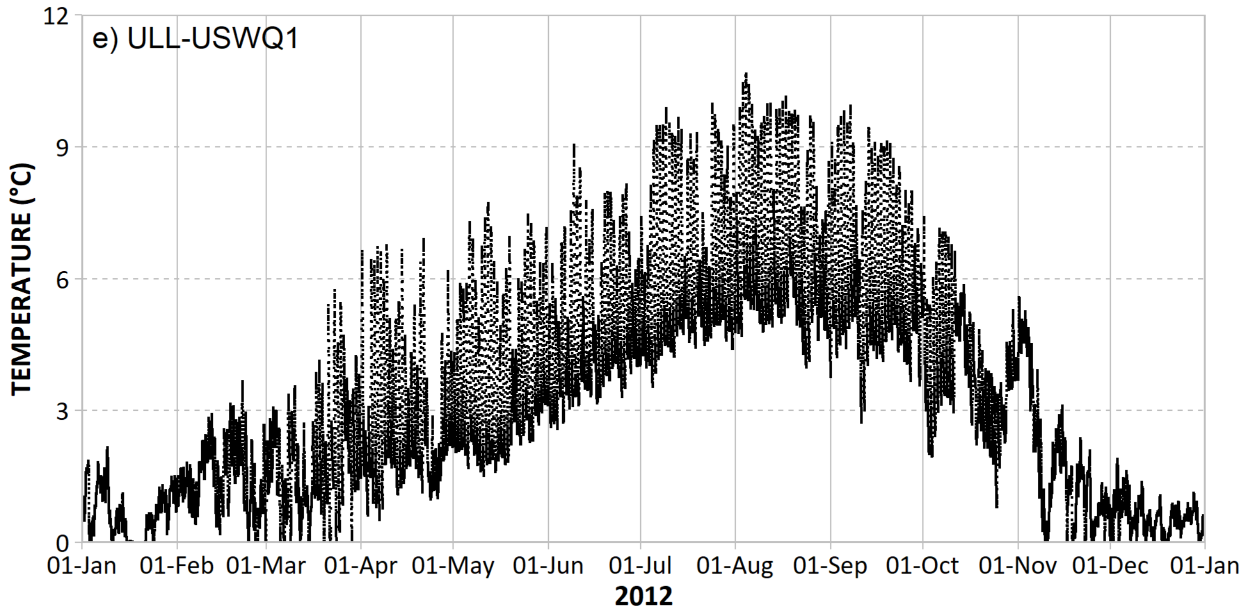


Figure 1. Continued.



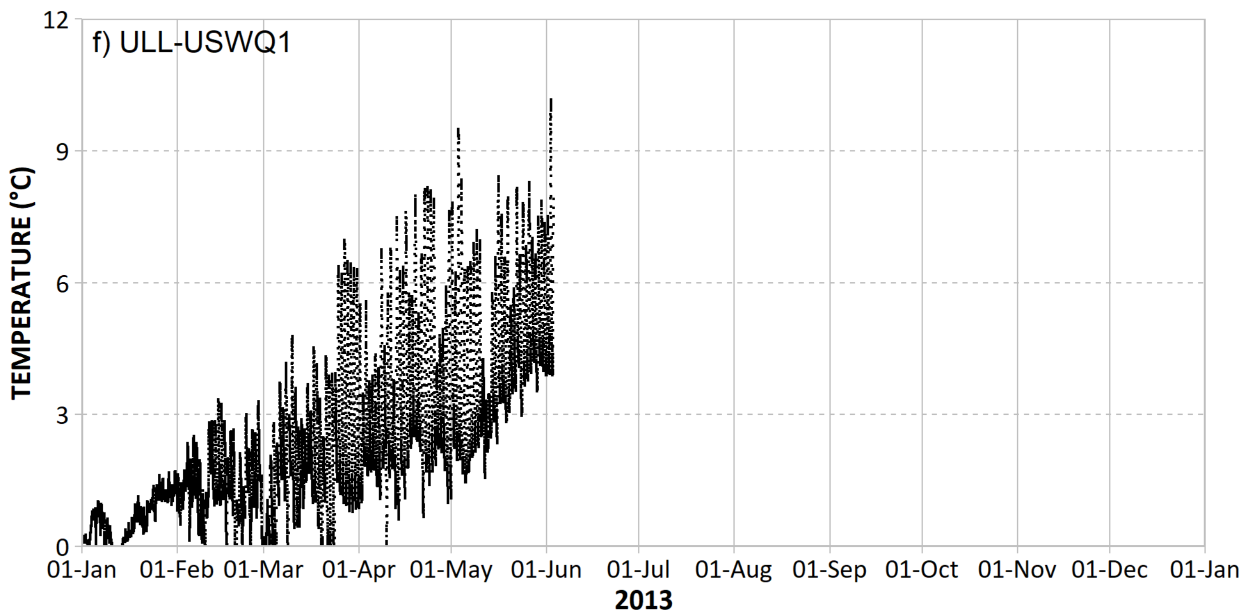


Figure 2. Operational water temperature at ULL-USWQ02 from 2018 to 2019. Black dots show water temperature at intervals of 15 minutes.

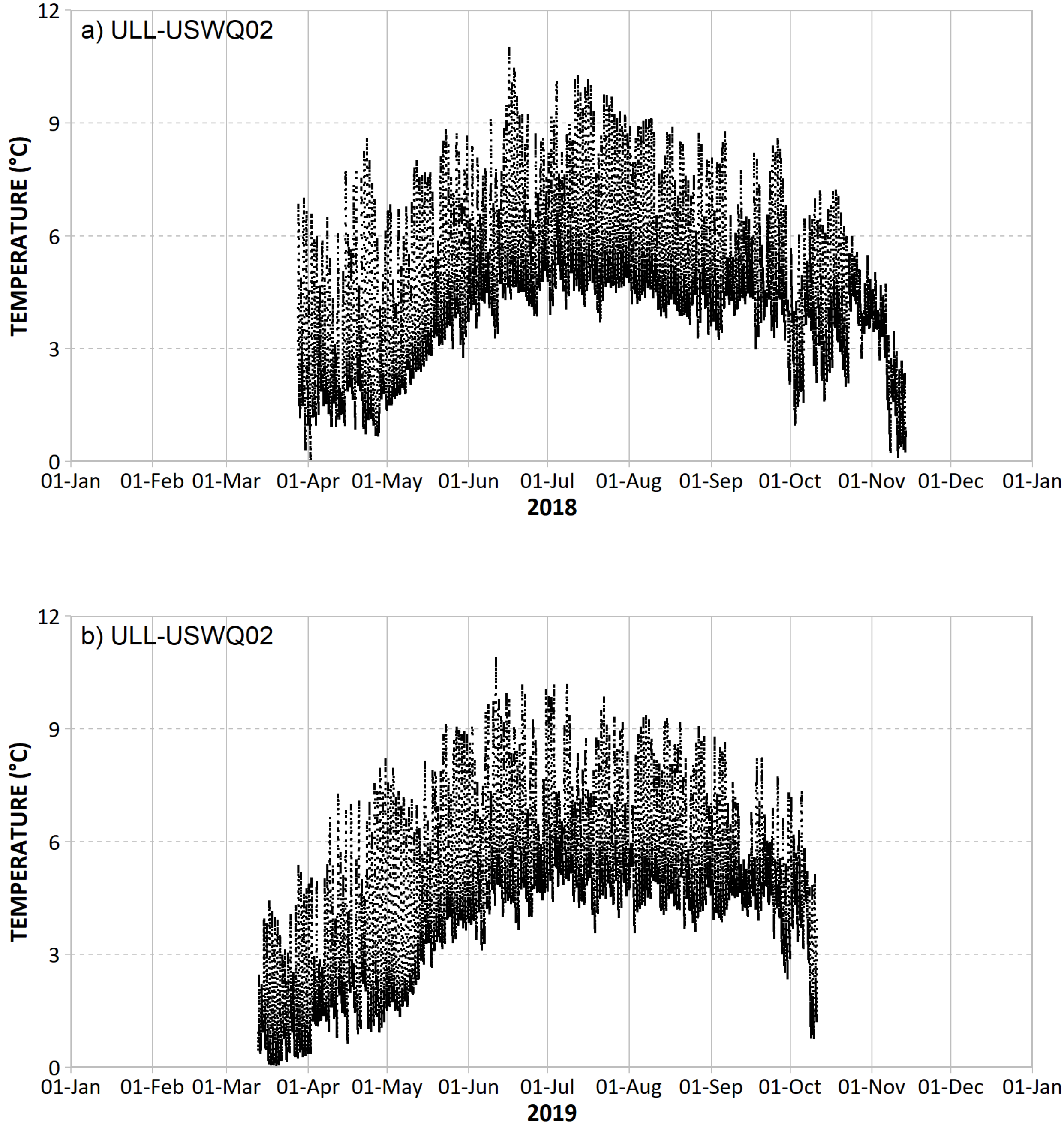


Figure 3. Operational water temperature at ULL-USWQ03 from 2018 to 2021. Black dots show water temperature at intervals of 15 minutes.

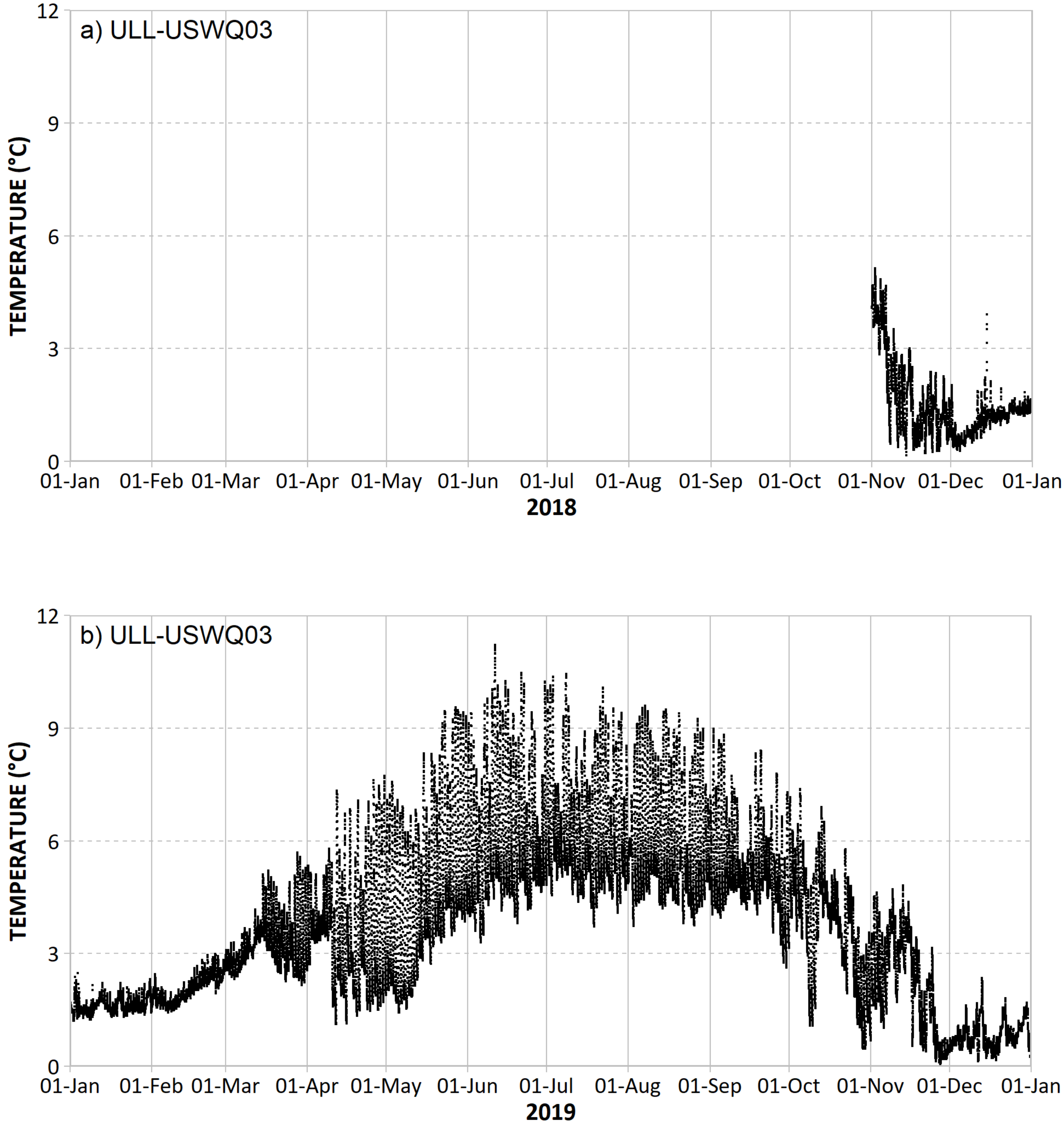
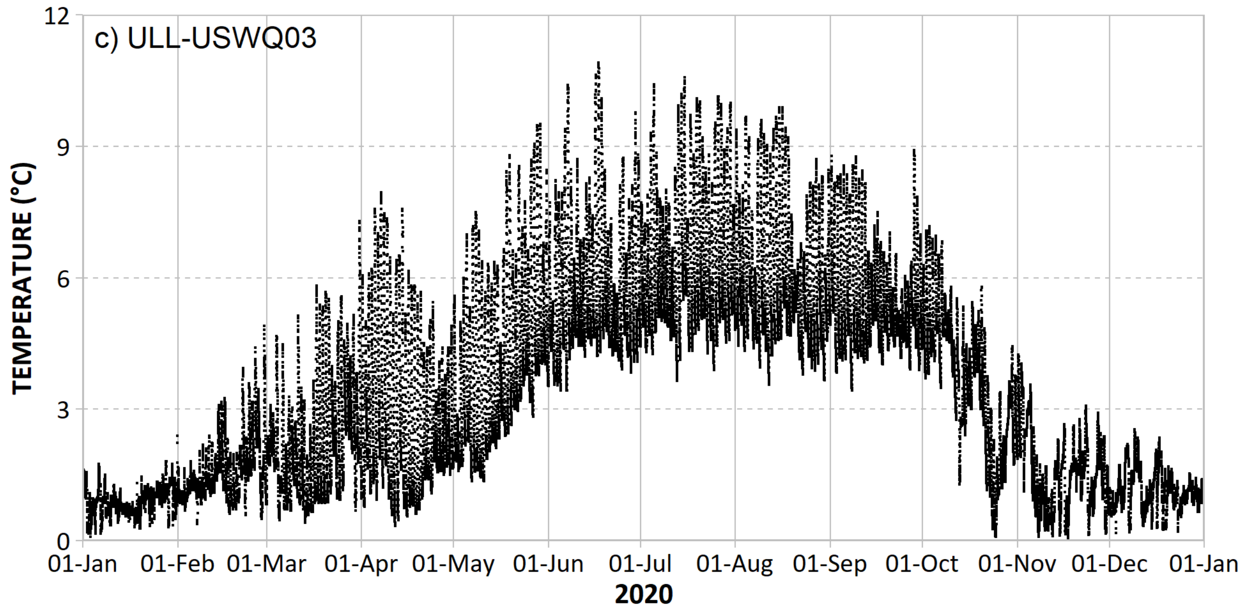


Figure 3. Continued.



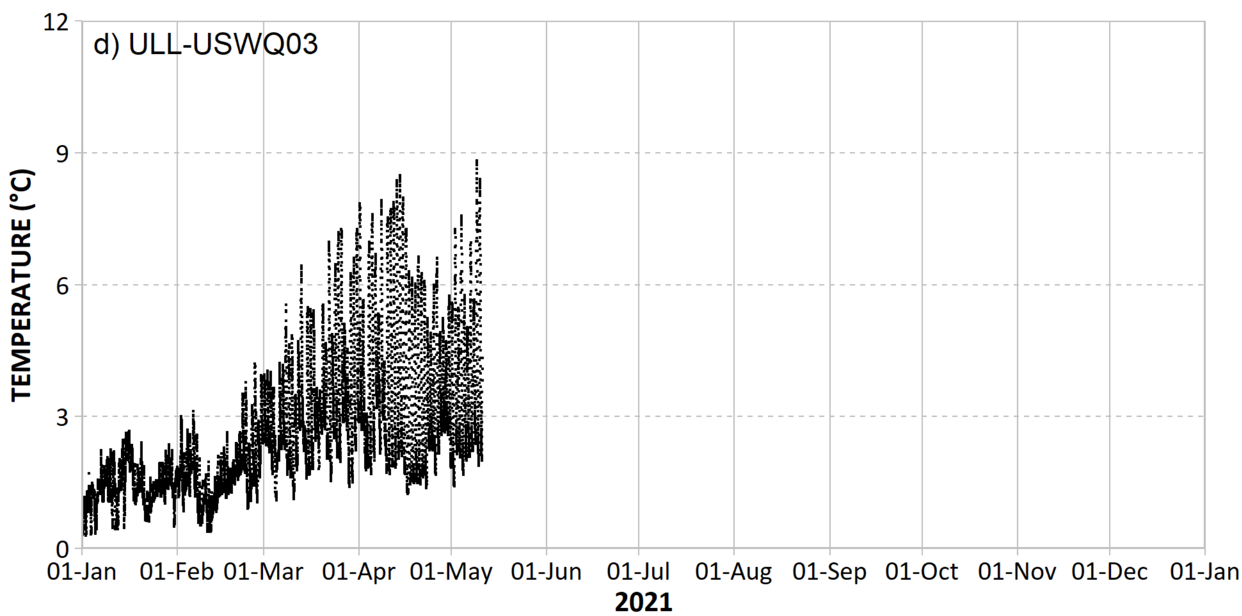
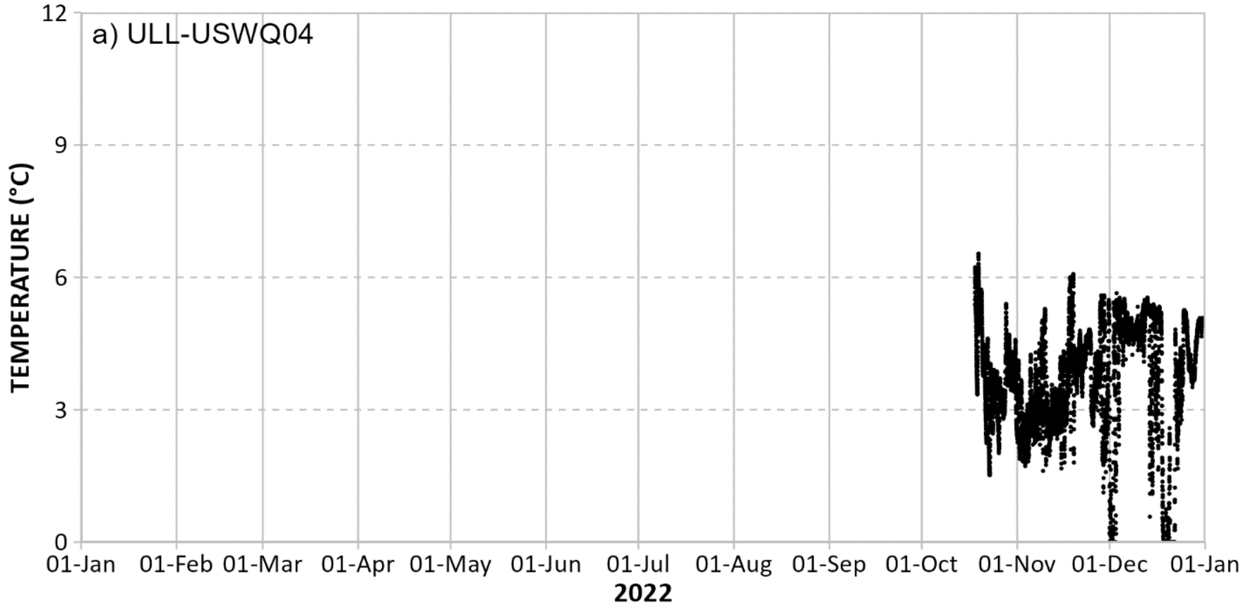


Figure 4. **Operational water temperature at ULL-USWQ04 from 2022 to 2023. Black dots show water temperature at intervals of 15 minutes.**



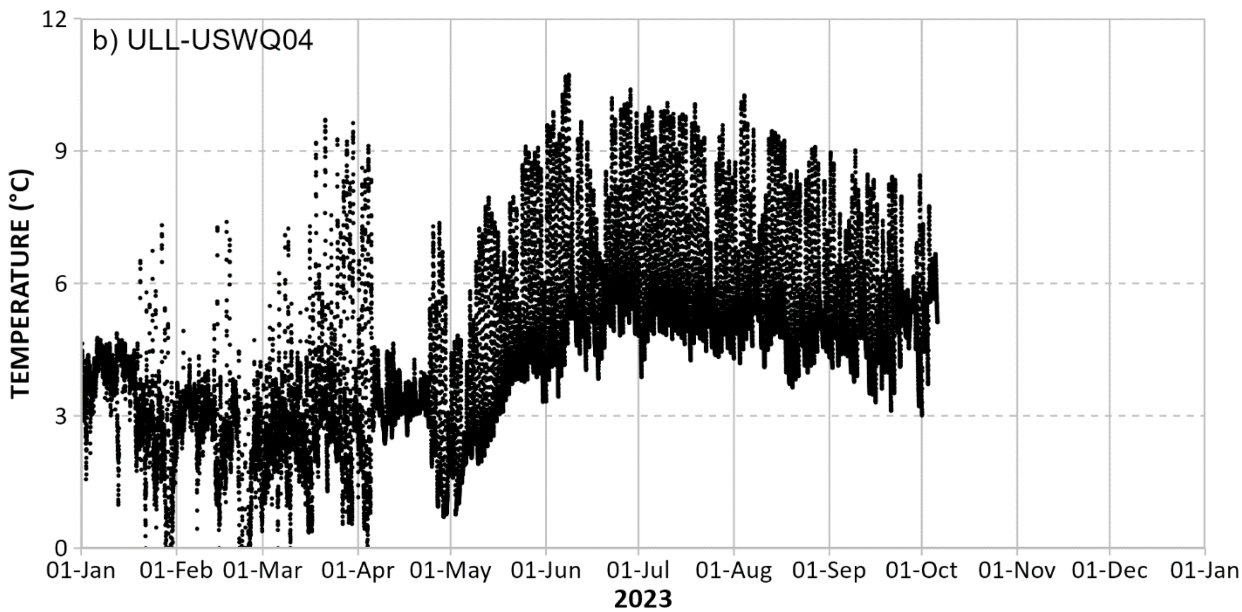
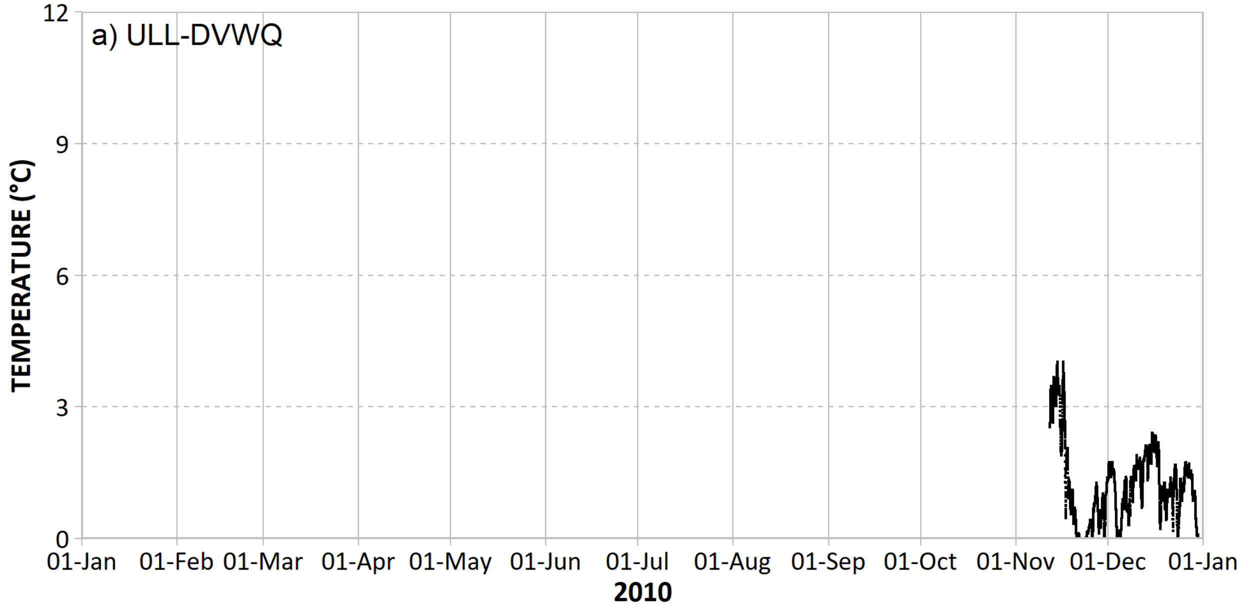


Figure 5. Baseline water temperature at ULL-DVWQ from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.



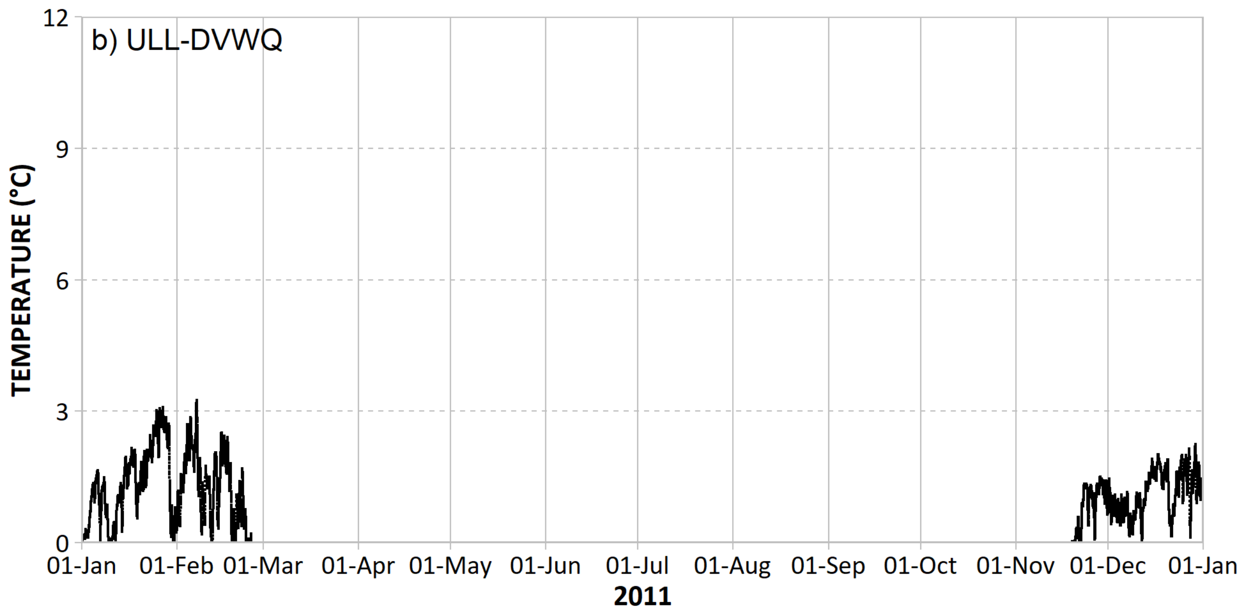
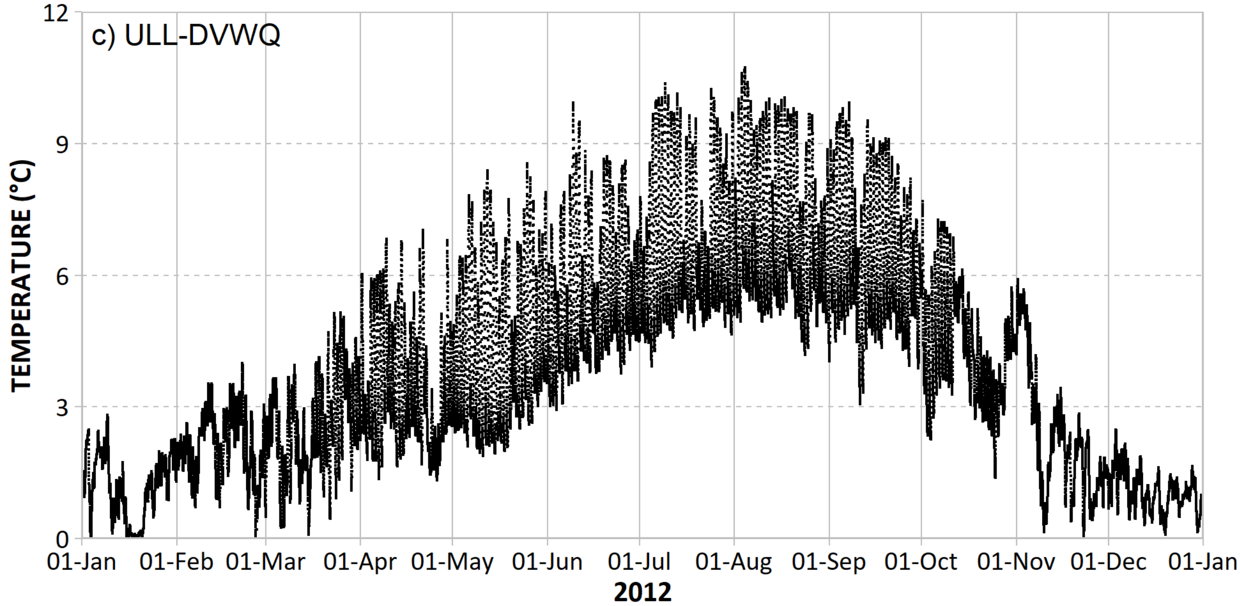


Figure 5. Continued.



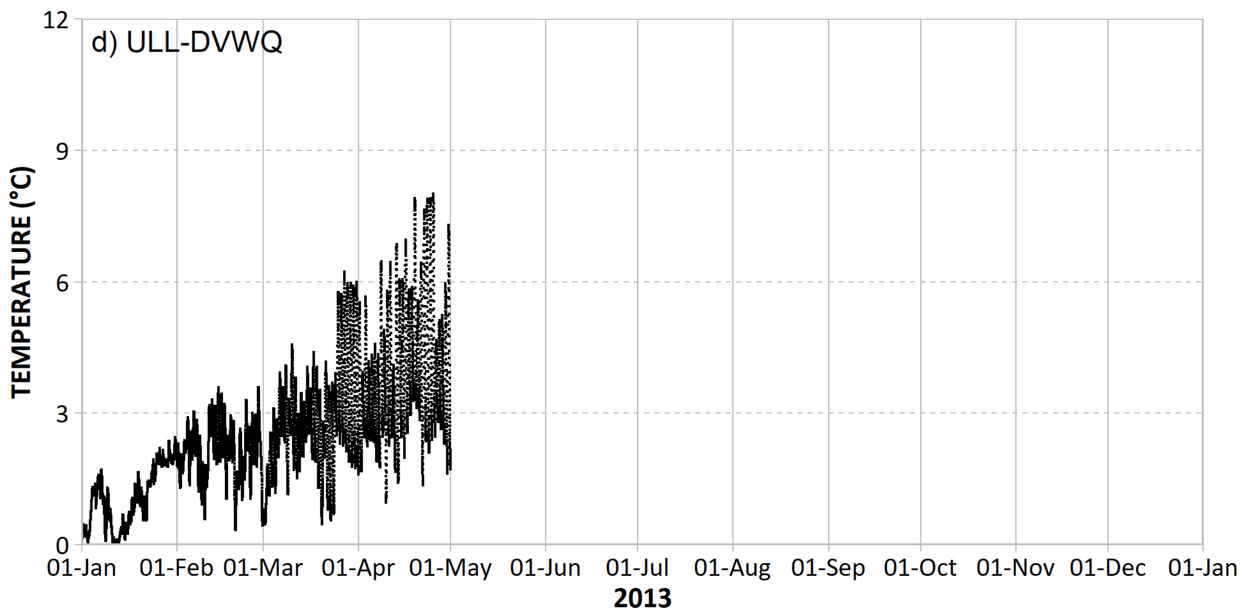
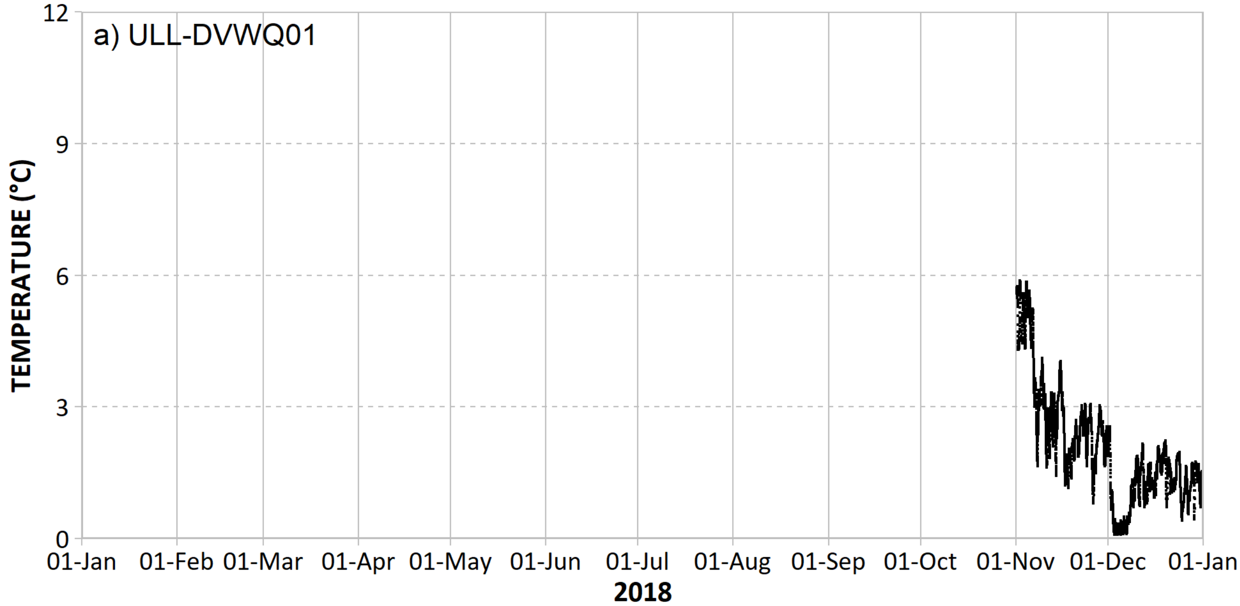
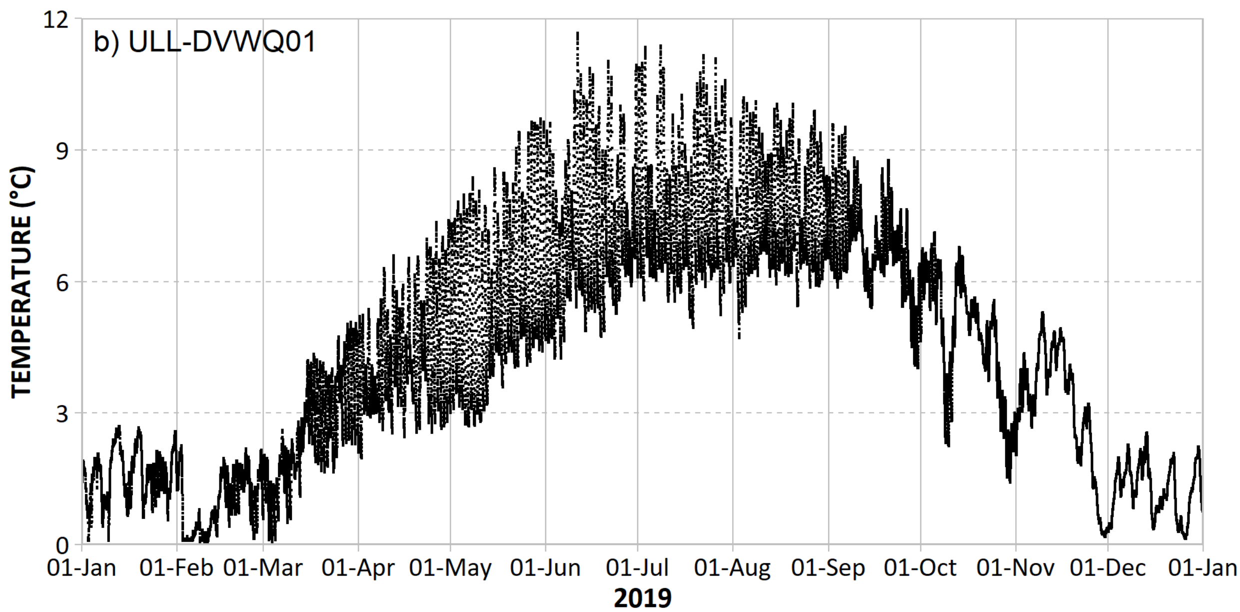


Figure 6. **Operational water temperature at ULL-DVWQ01 from 2018 to 2023. Black dots show water temperature at intervals of 15 minutes.**





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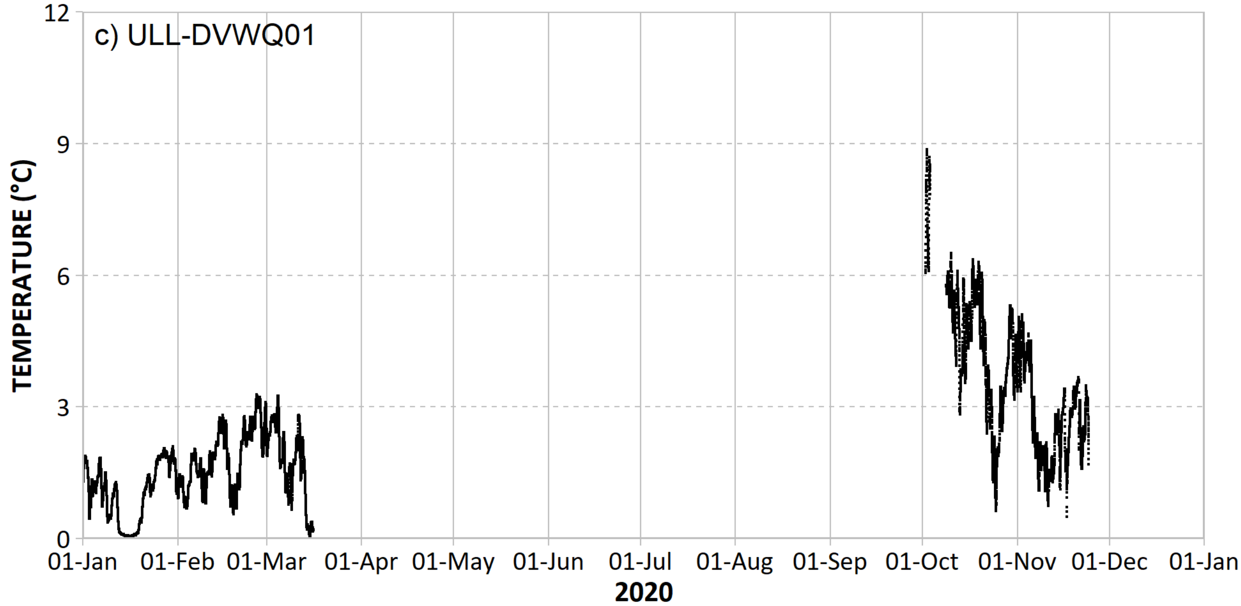

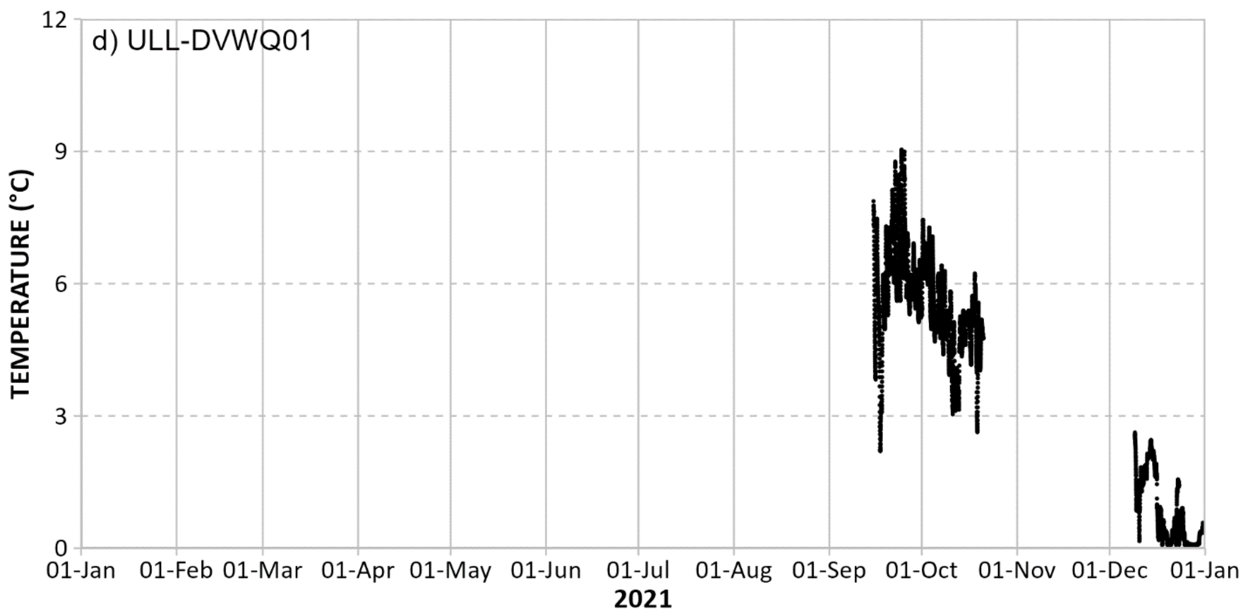

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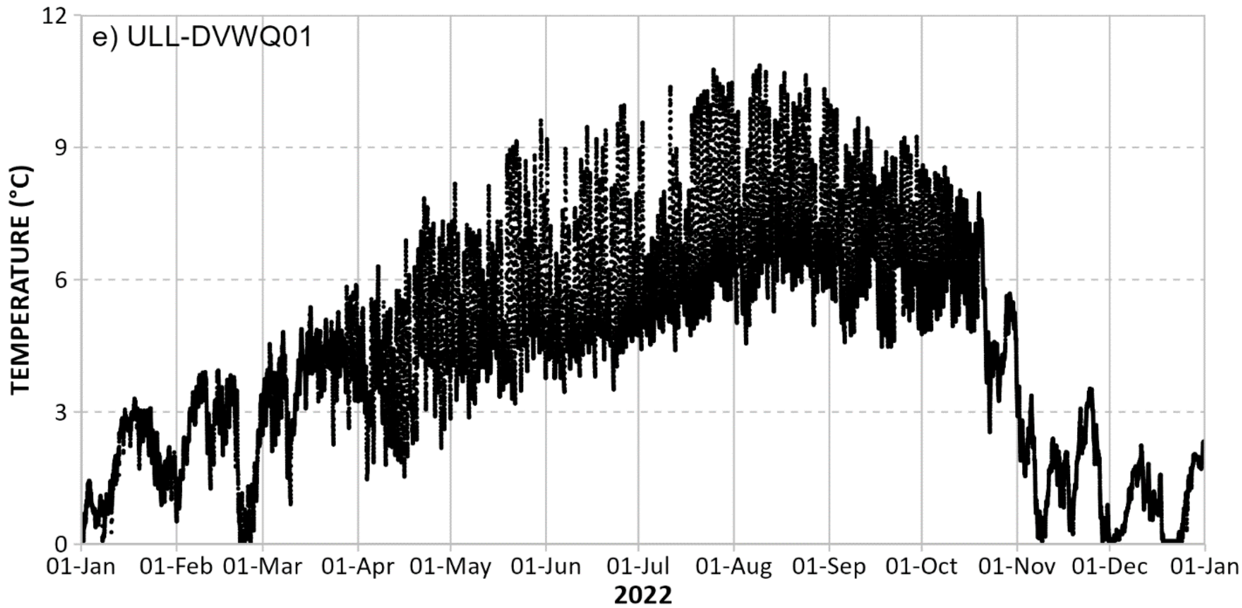


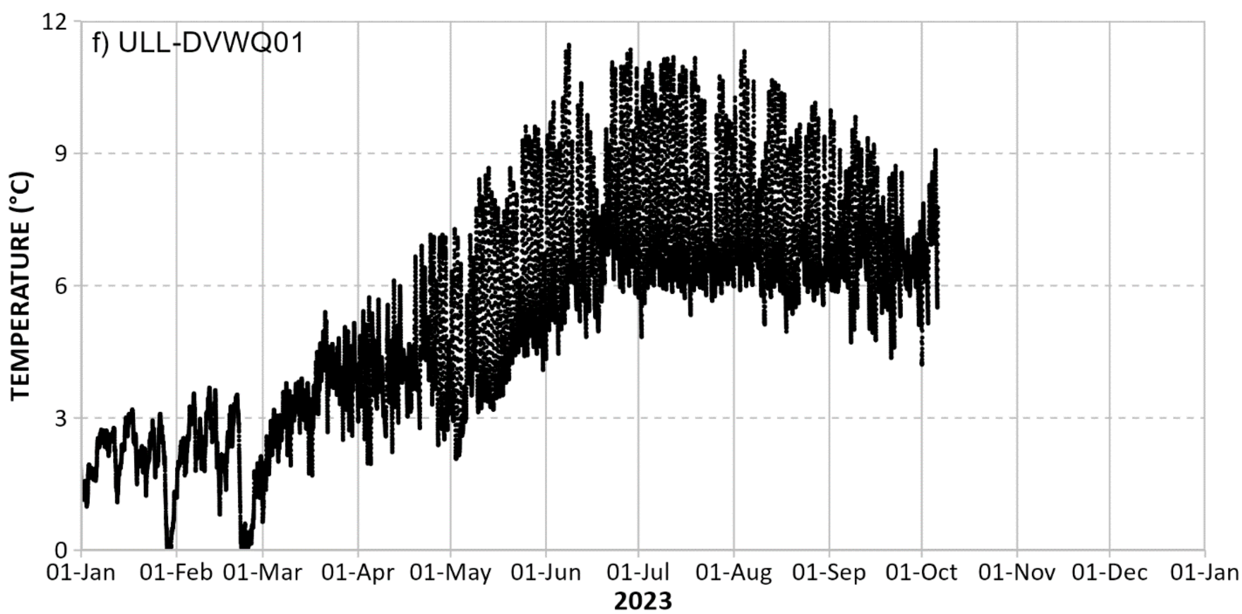
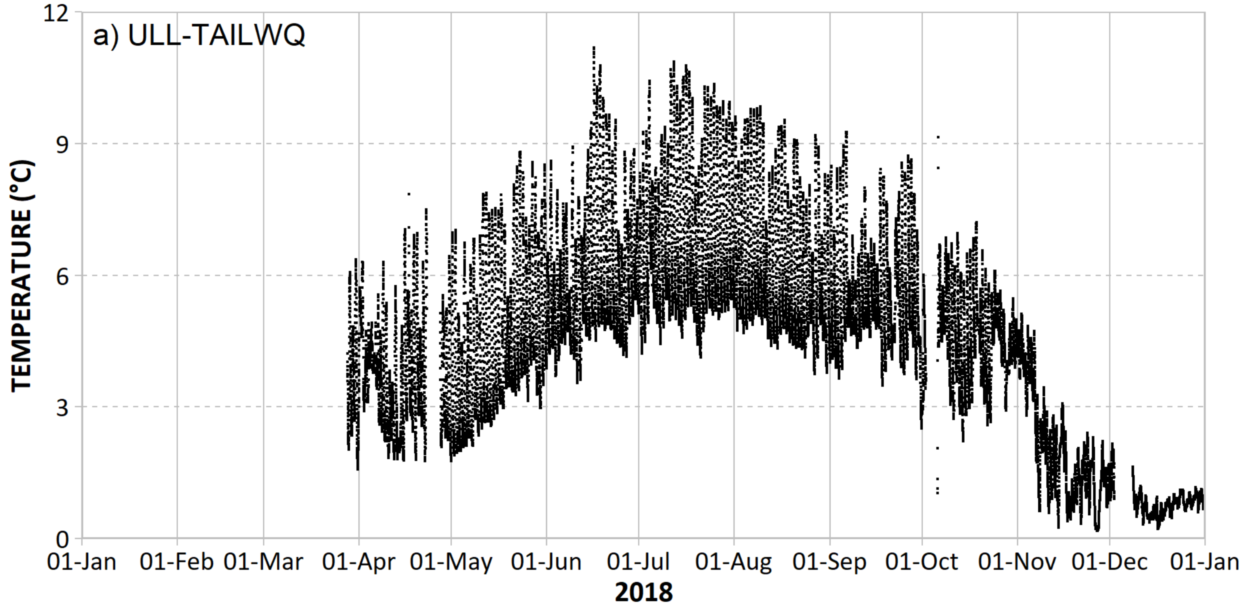
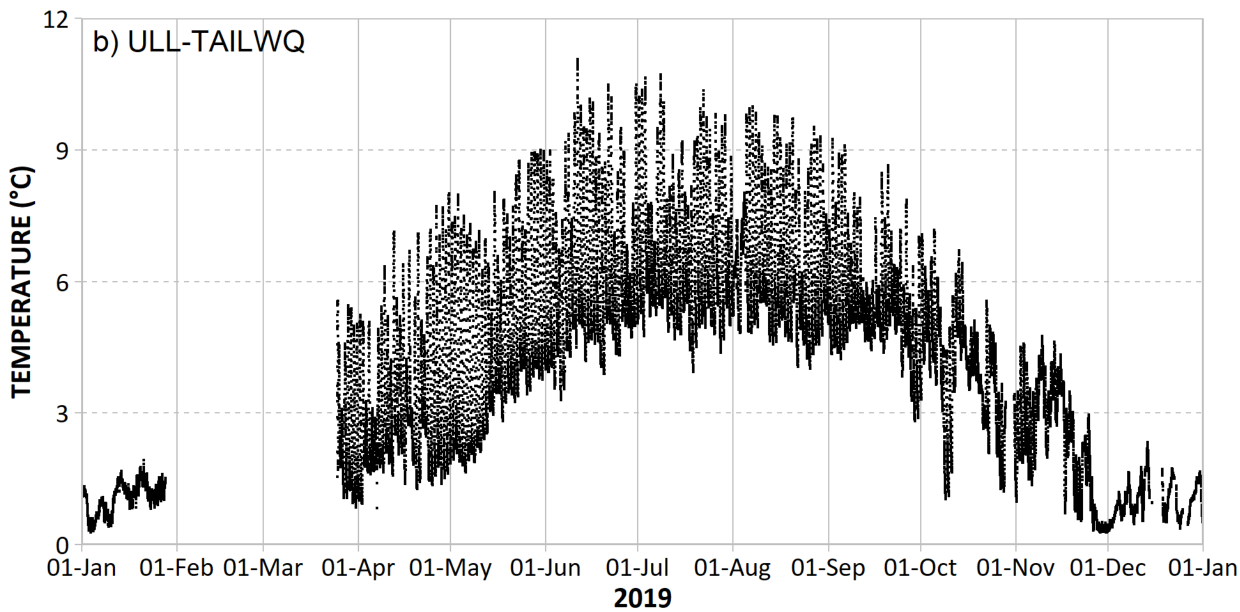


Figure 7. **Operational water temperature at ULL-TAILWQ from 2018 to 2022. Black dots show water temperature at intervals of 15 minutes.**





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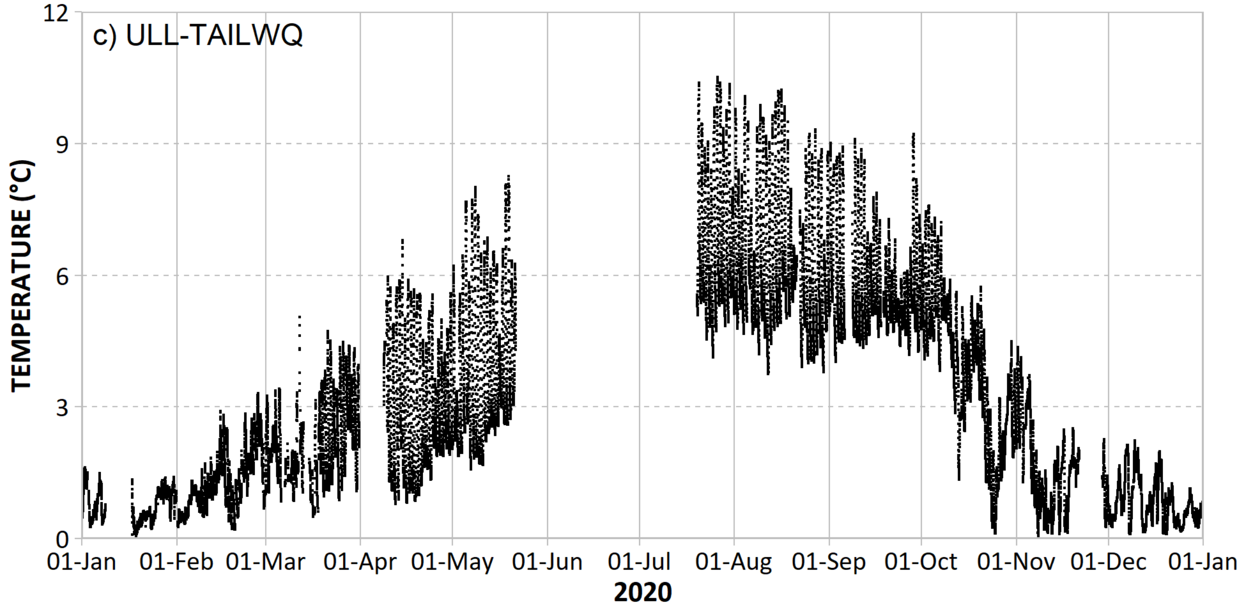


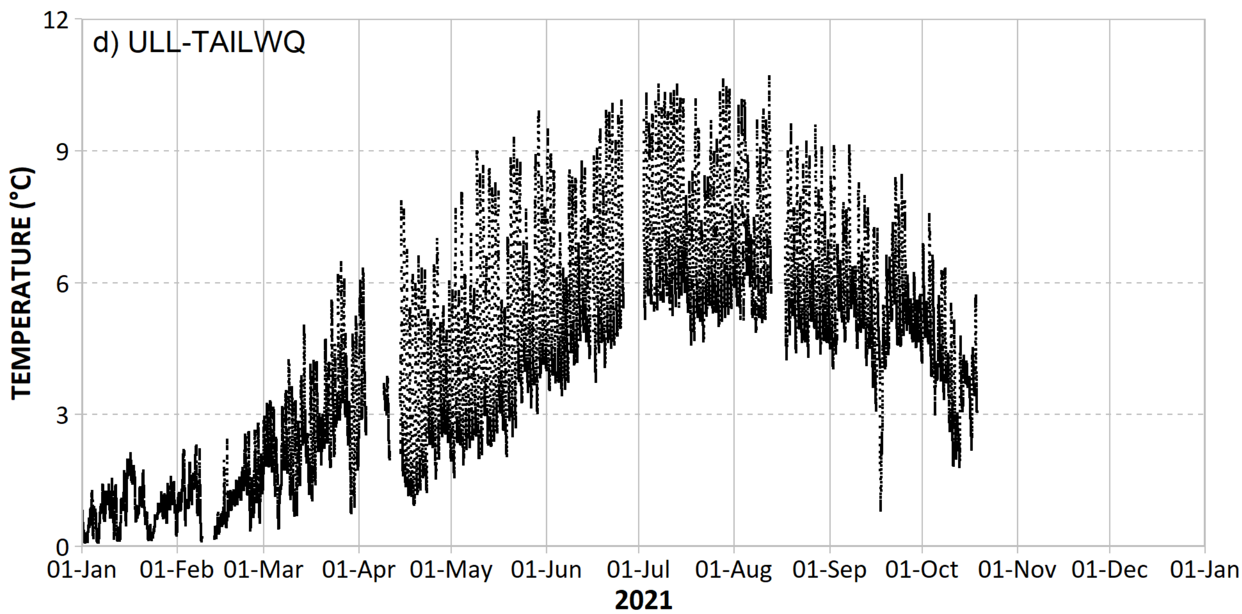
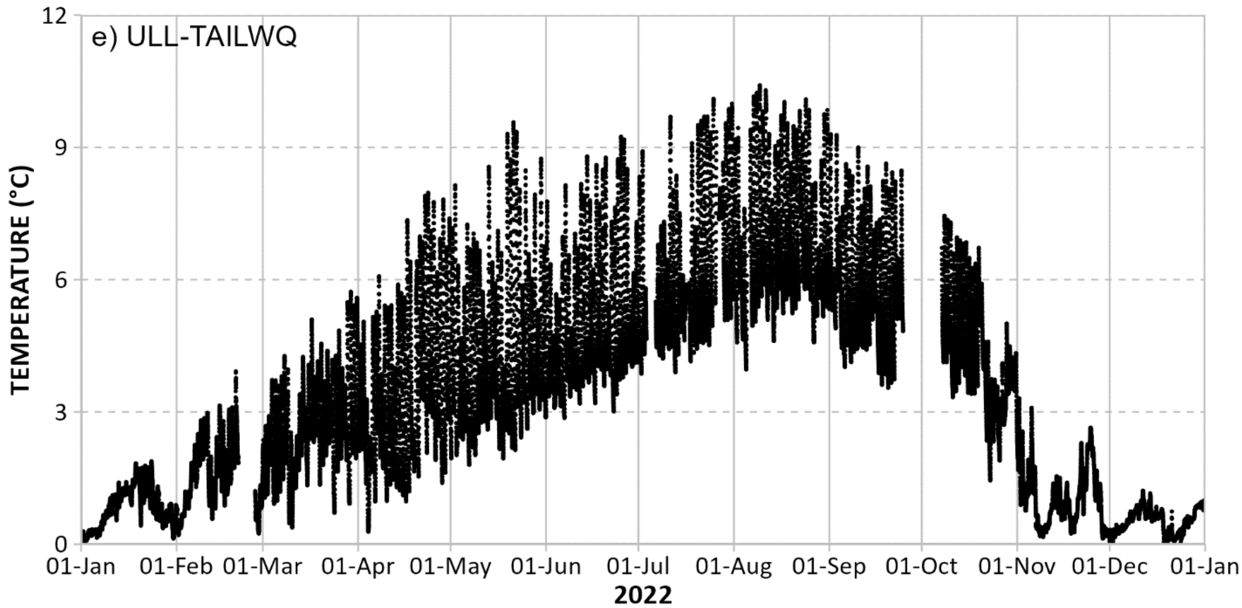


Figure 7. Continued.



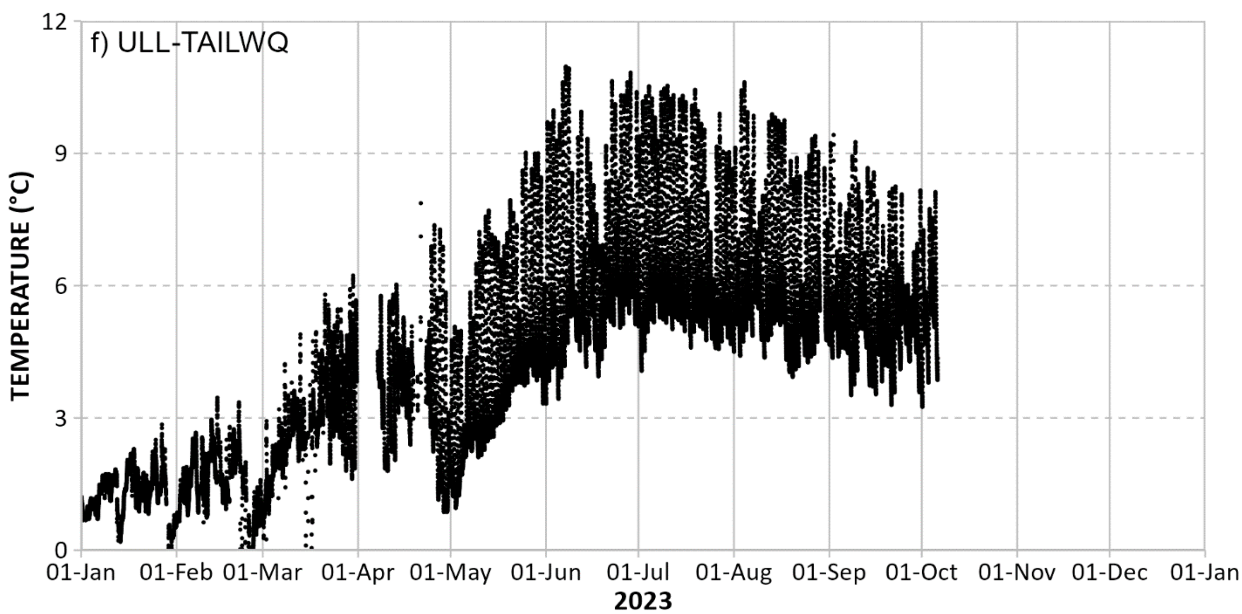
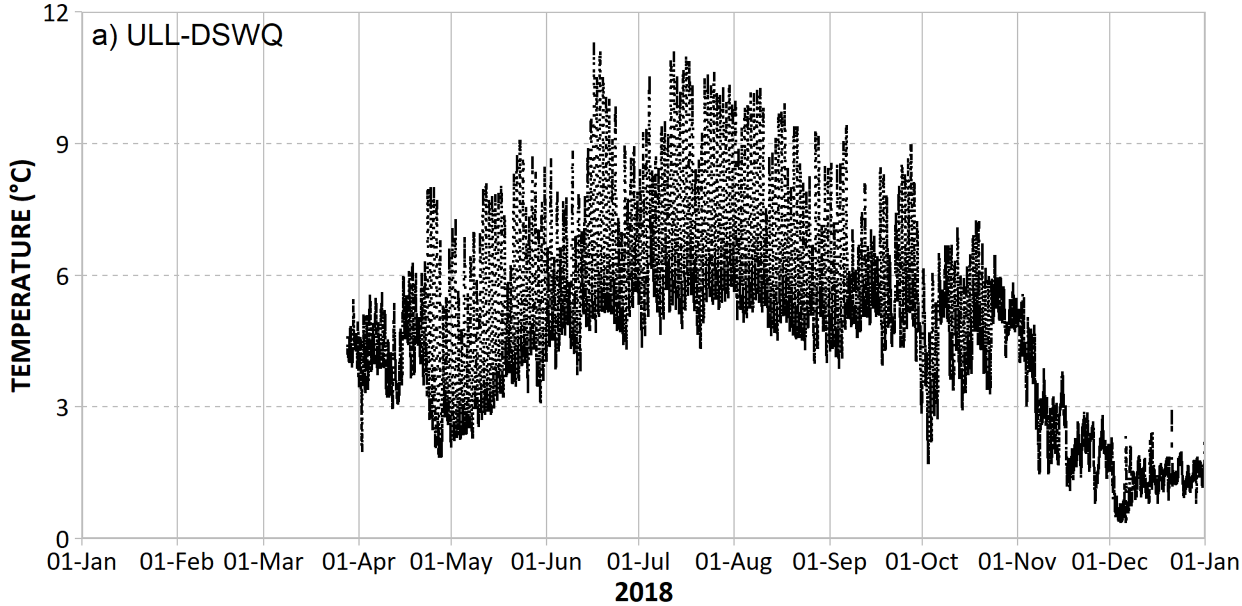
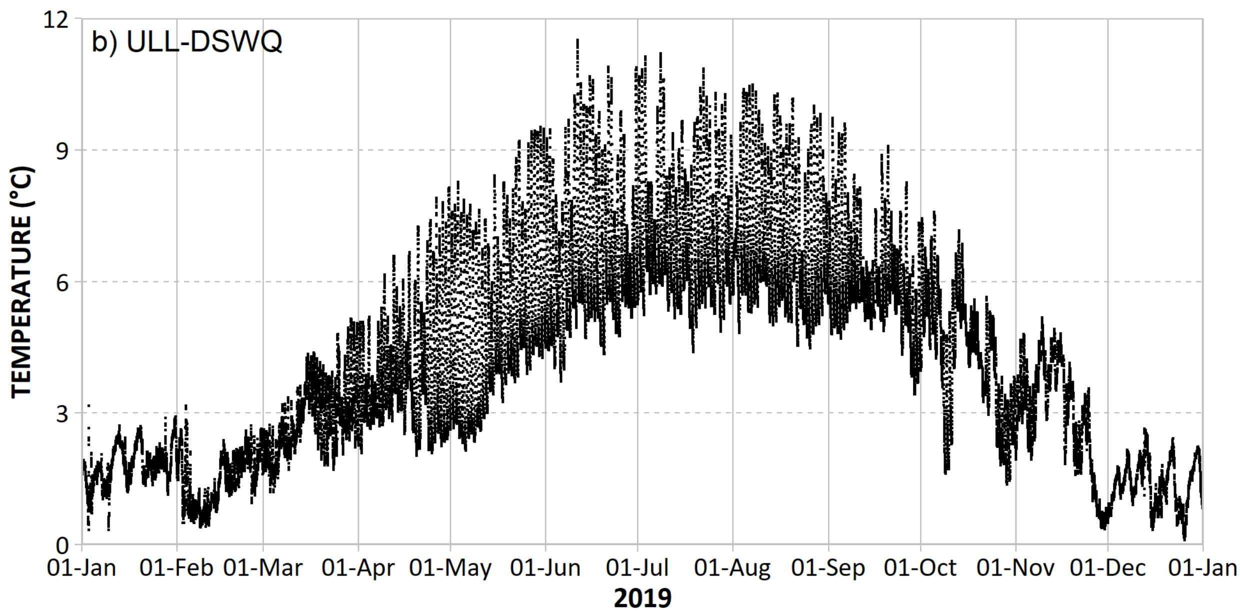


Figure 8. Operational water temperature at ULL-DSWQ from 2018 to 2023. Black dots show water temperature at intervals of 15 minutes.





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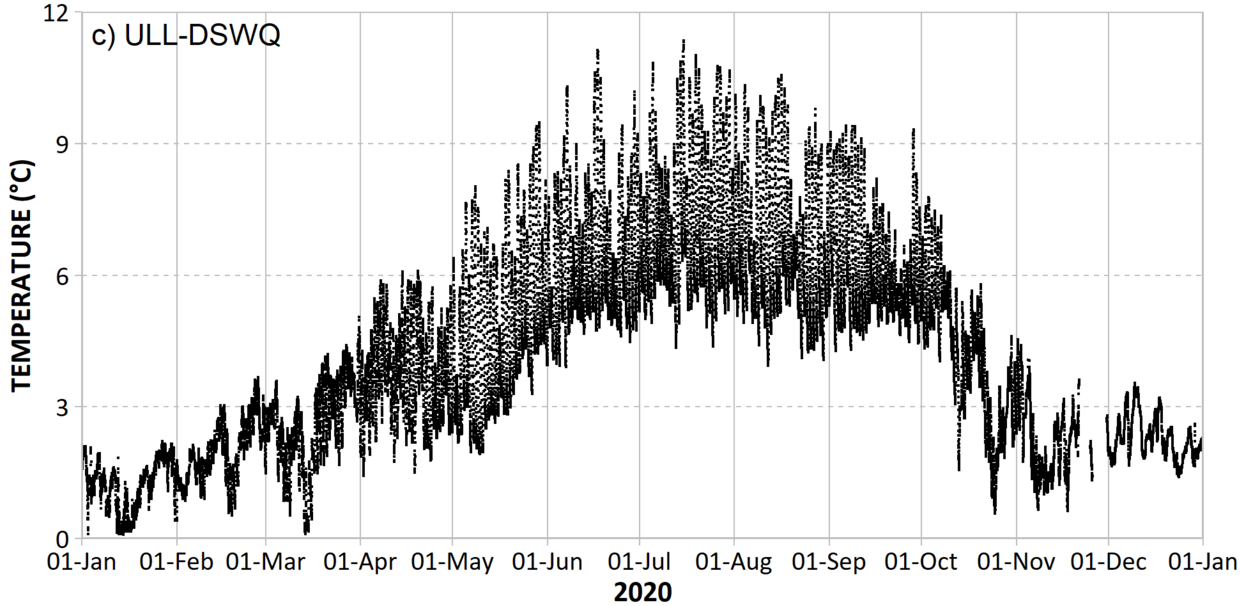

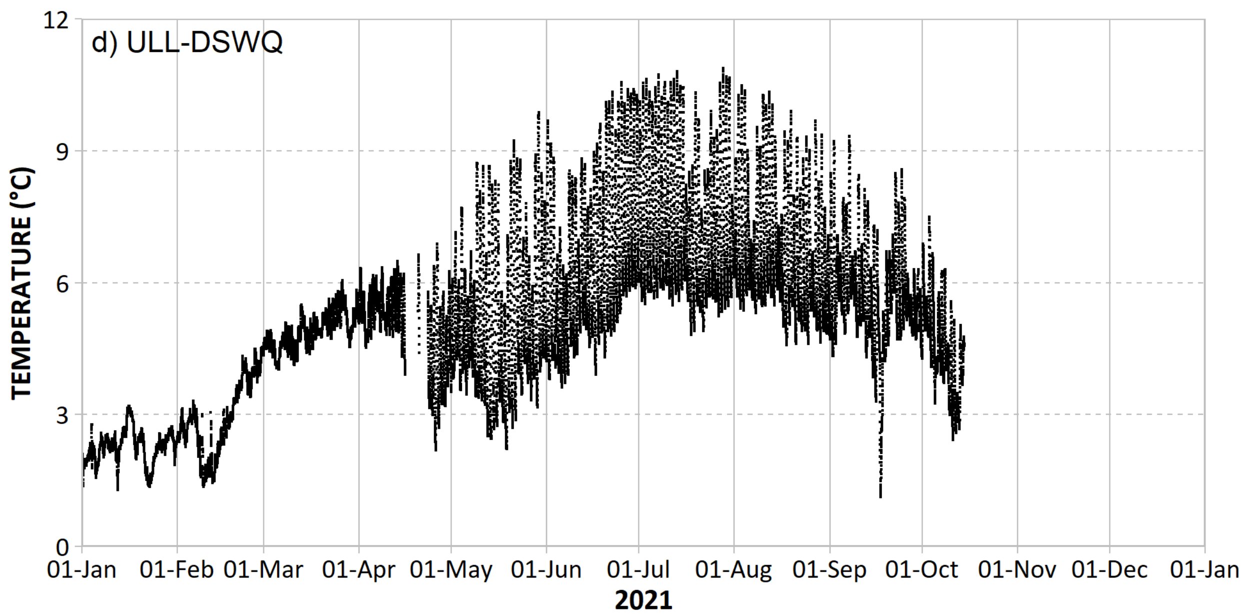

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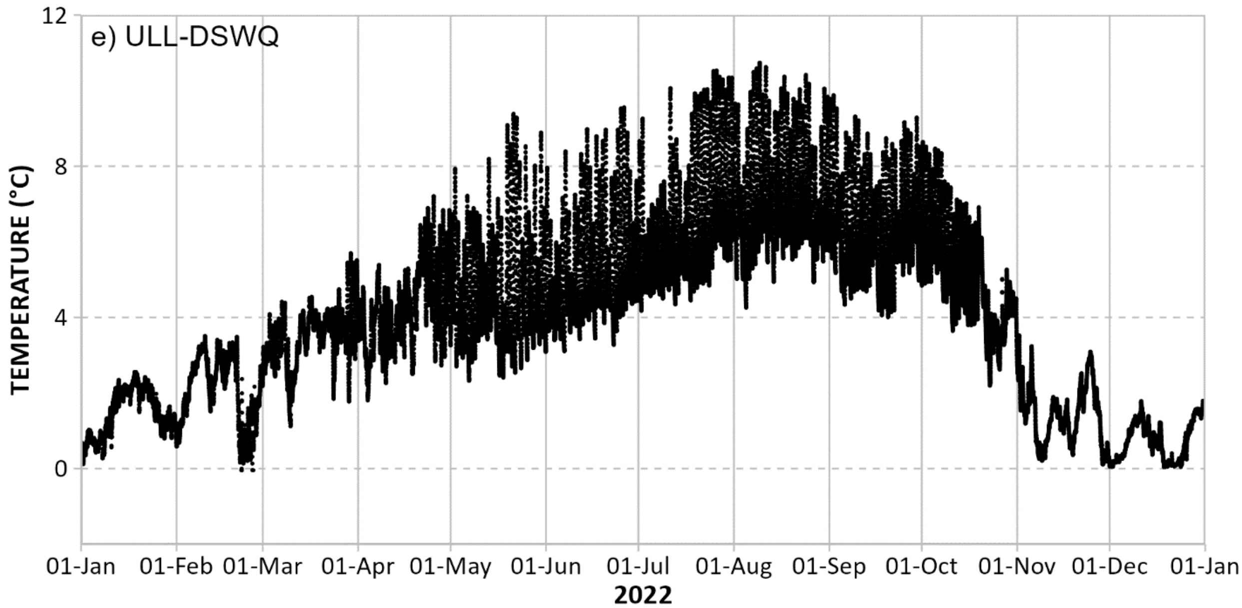
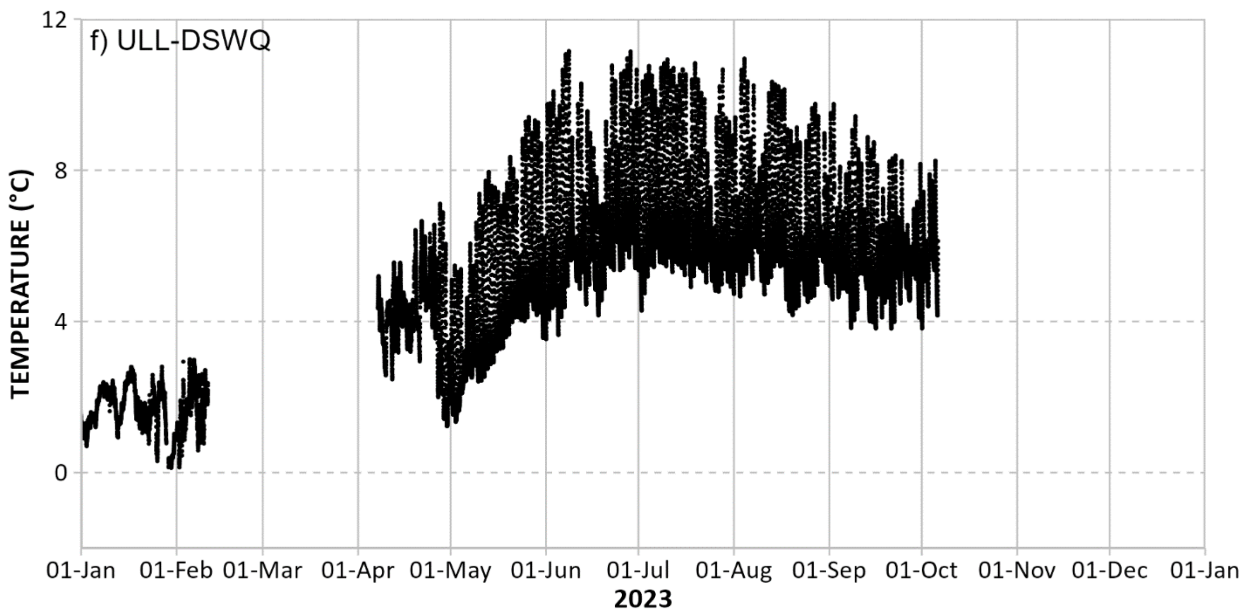
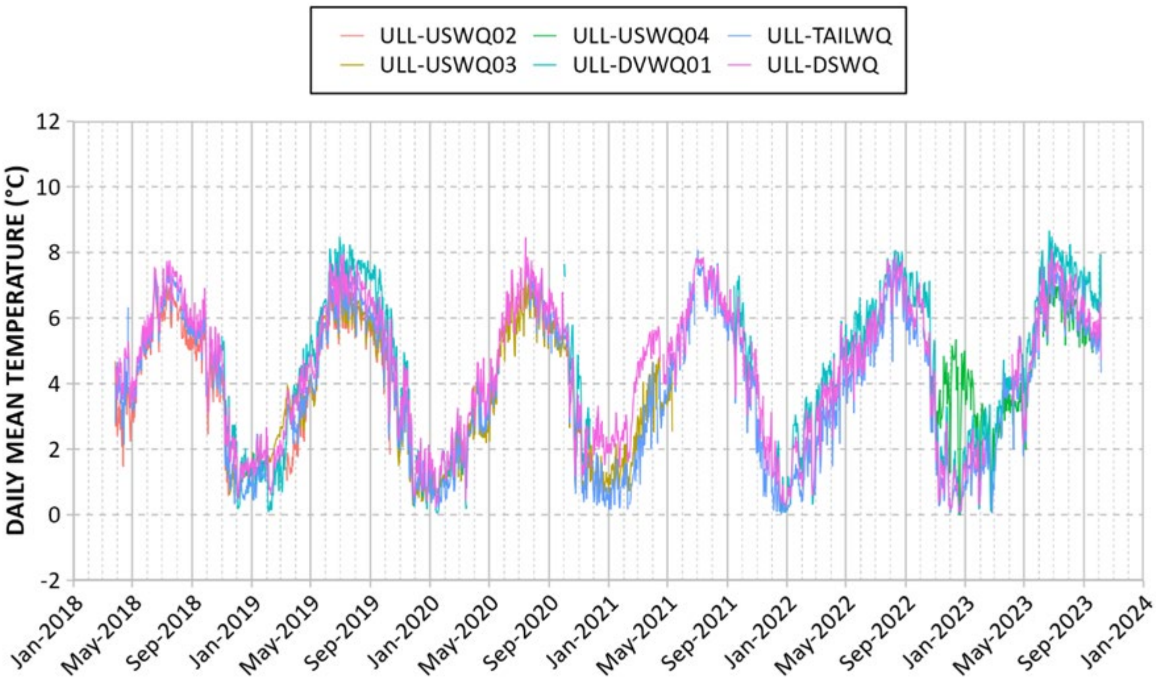




2.1.2. Operational Monitoring

Figure 9. Daily mean, maximum, and minimum water temperature recorded in the Upper Lillooet River during operations (2018 to 2023).

(a) Daily Average



(b) Daily Maximum

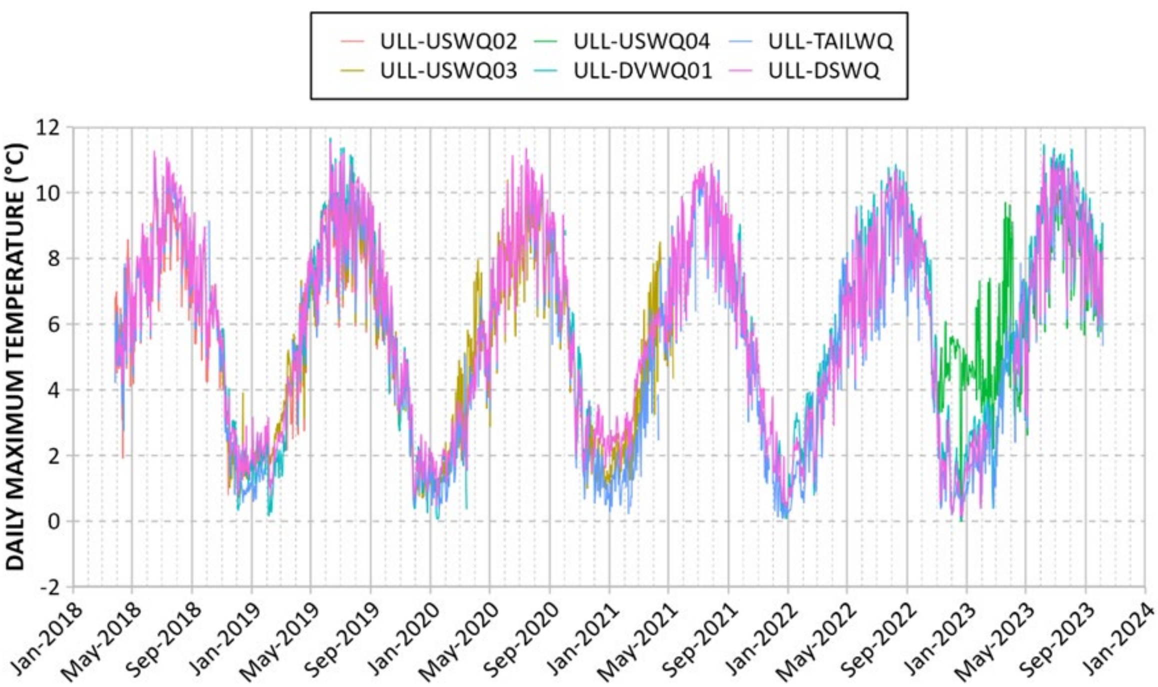
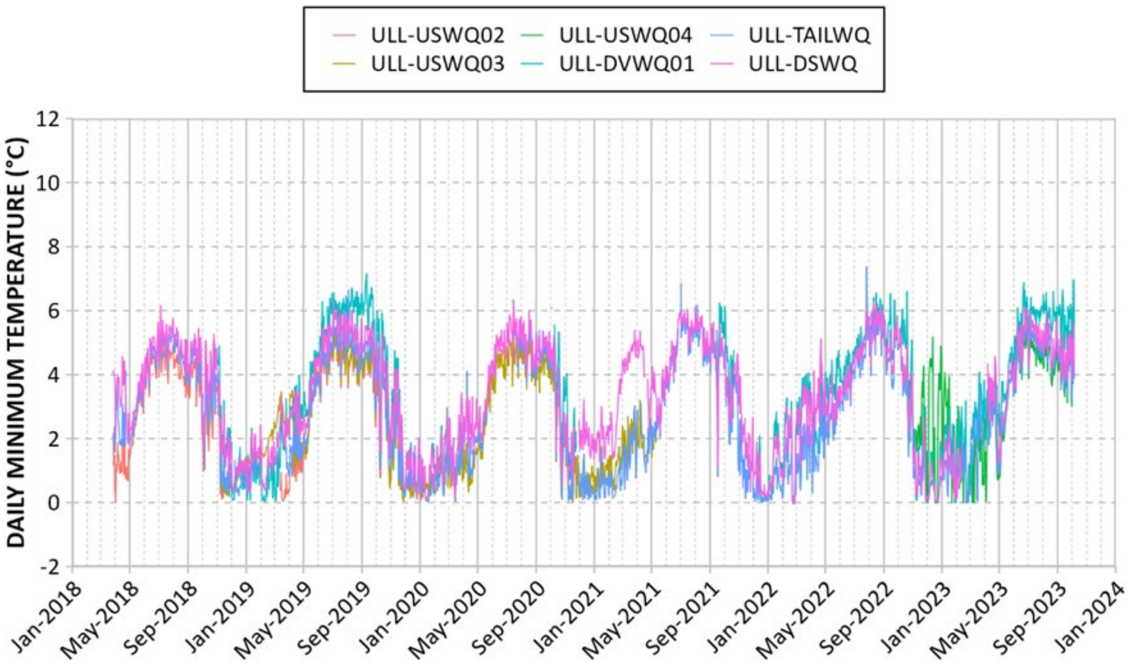


Figure 9. Continued.

(c) Daily Minimum

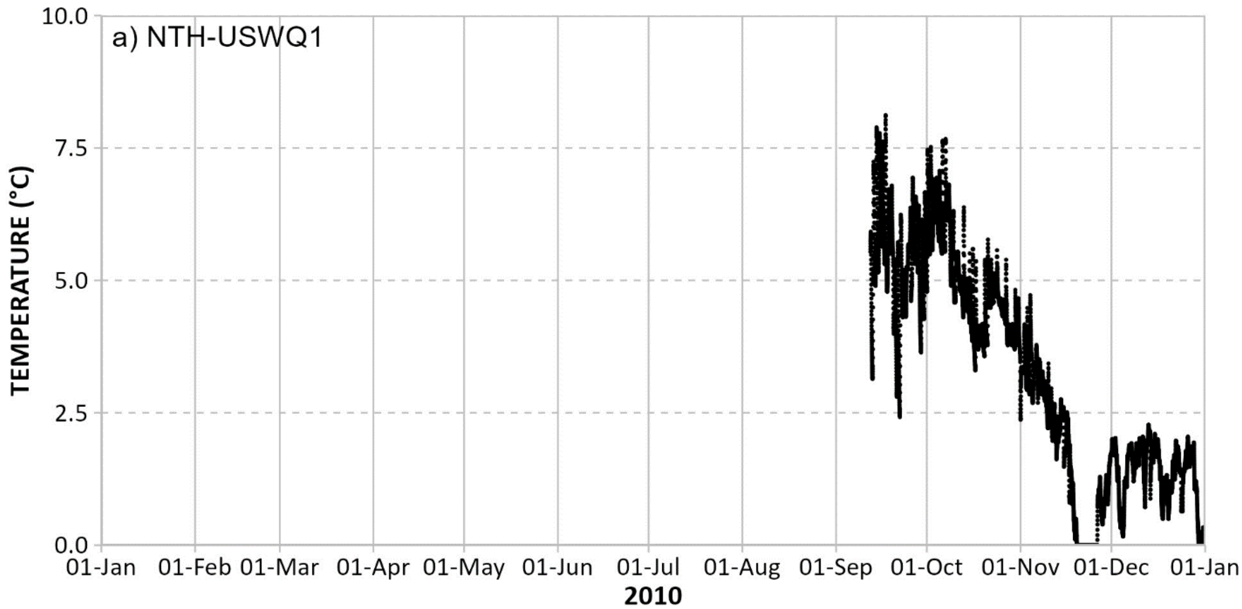


ECOFISH RESEARCH

2.2. Boulder Creek

2.2.1. Baseline Conditions

Figure 10. Baseline water temperature at NTH-USWQ1 from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.



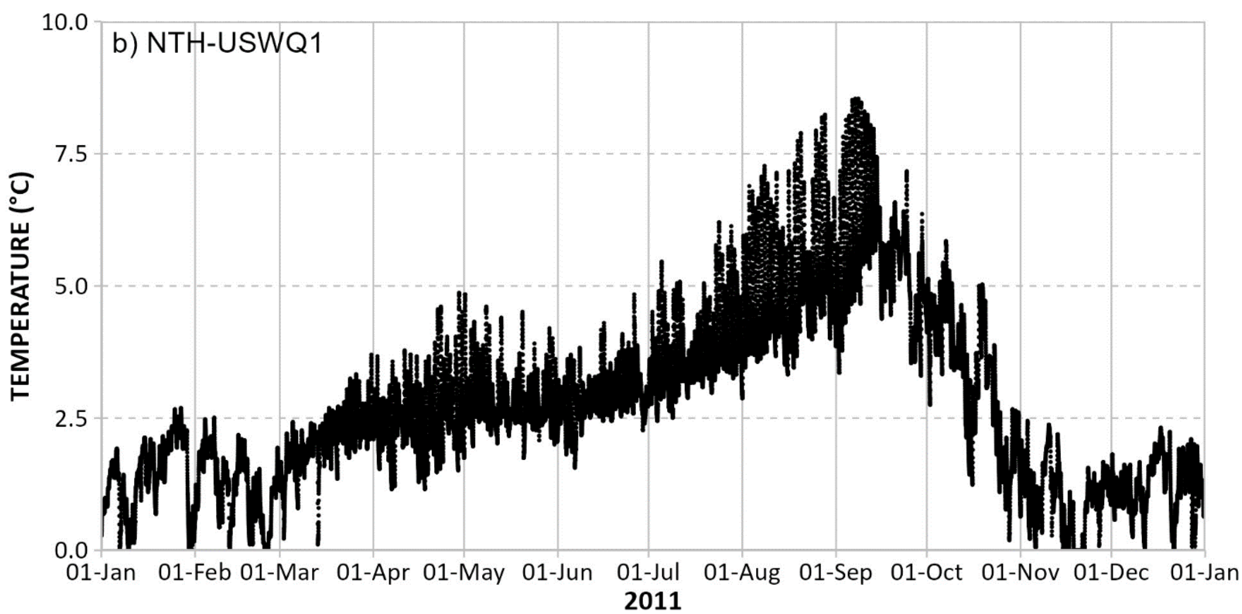
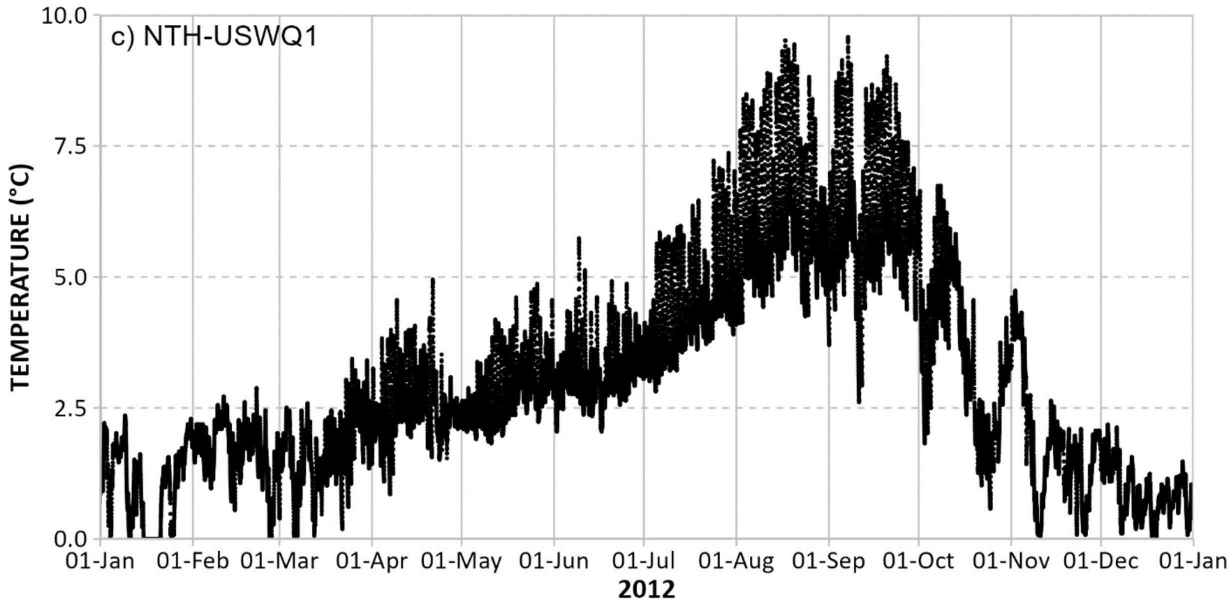


Figure 10. Continued.



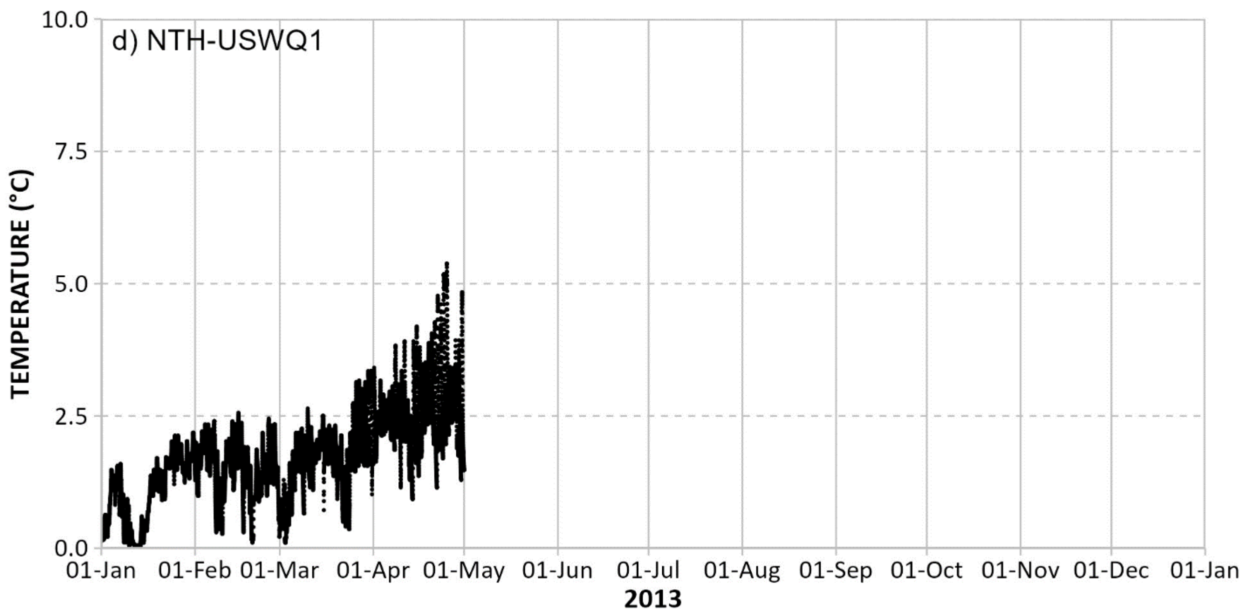
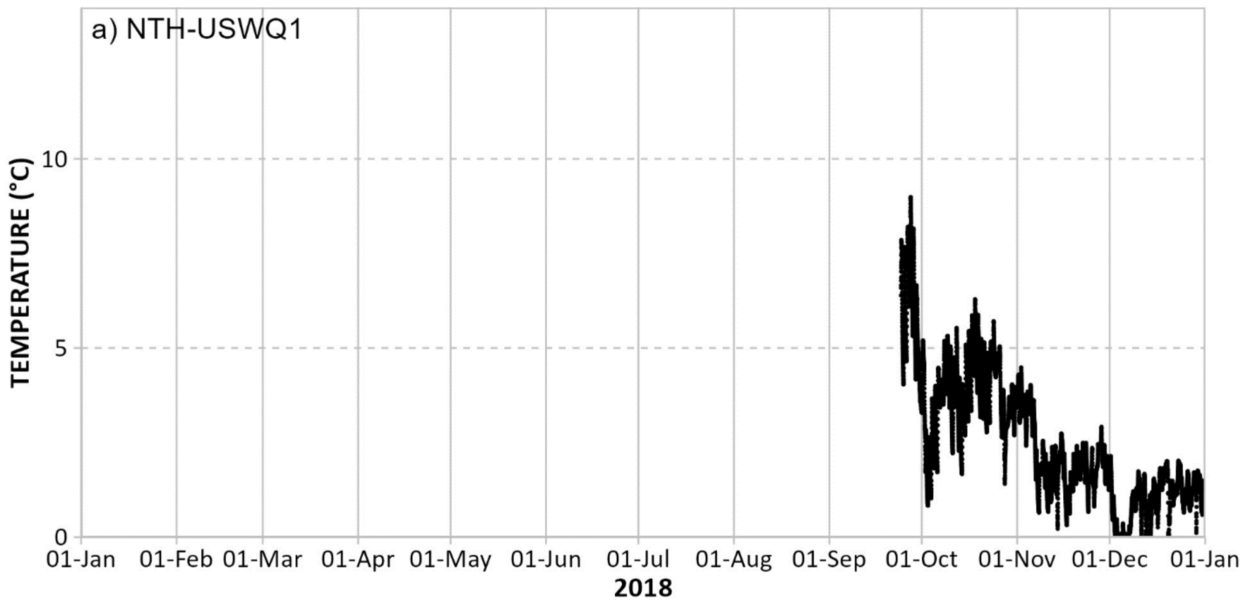


Figure 11. **Operational water temperature at NTH-USWQ1 from 2018 to 2023. Black dots show water temperature at intervals of 15 minutes.**



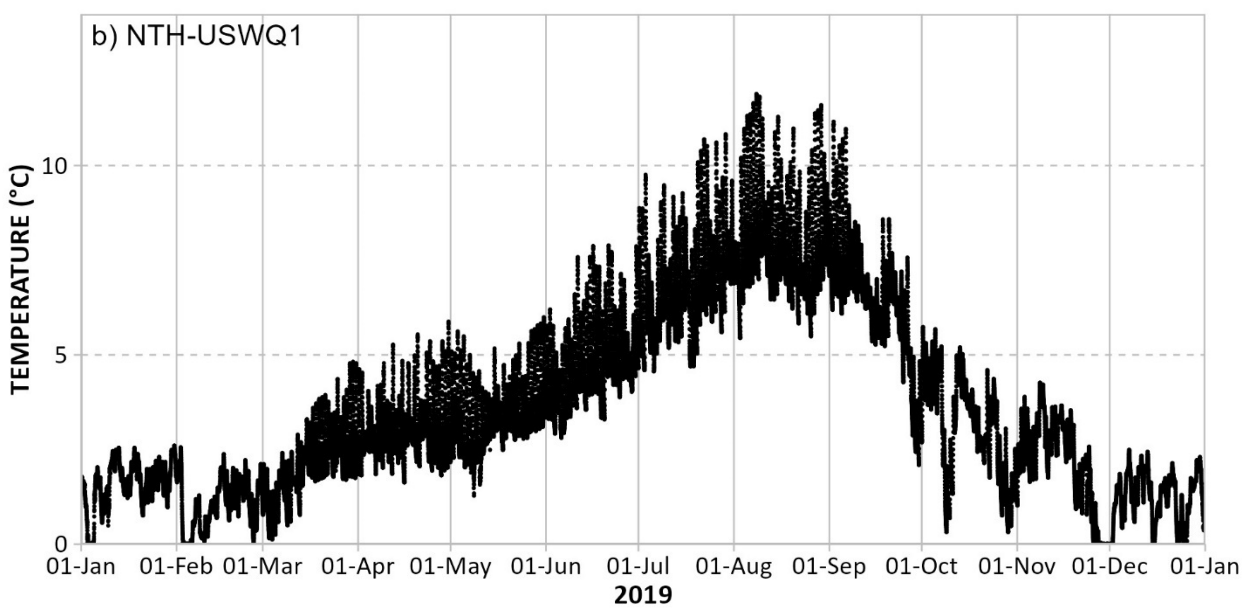
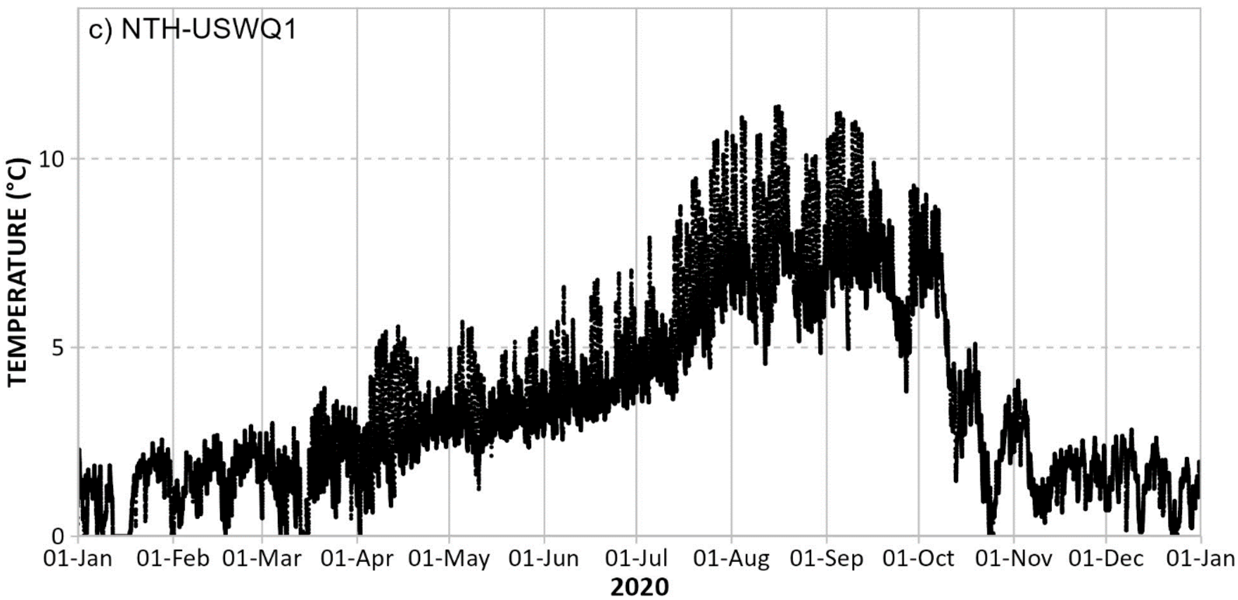


Figure 11. Continued.



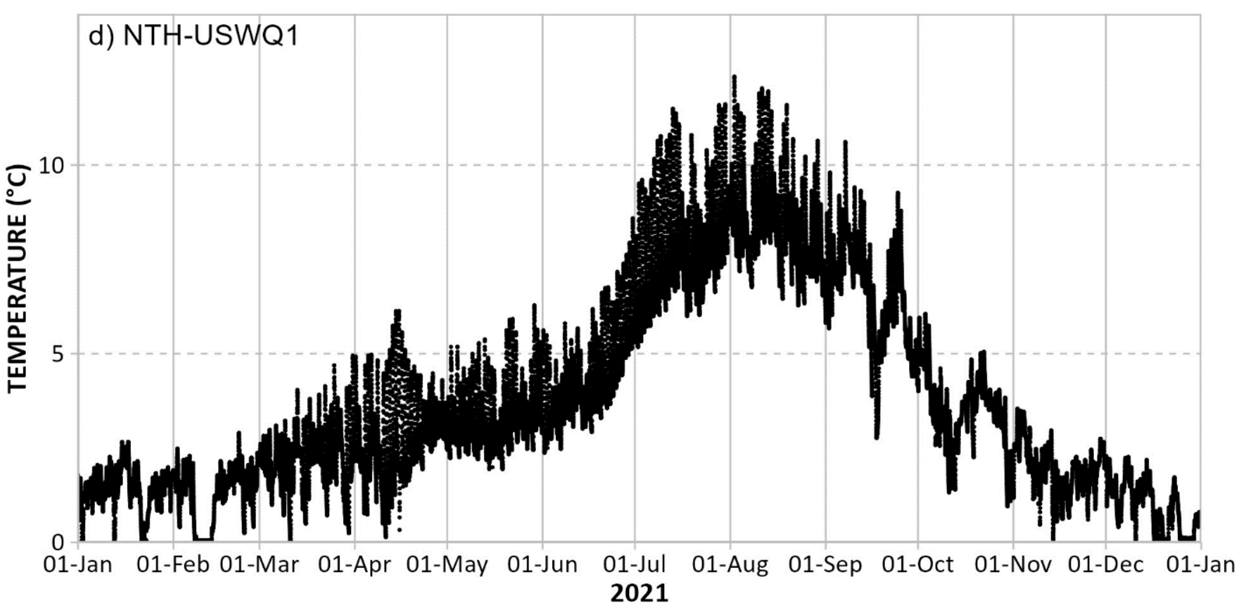
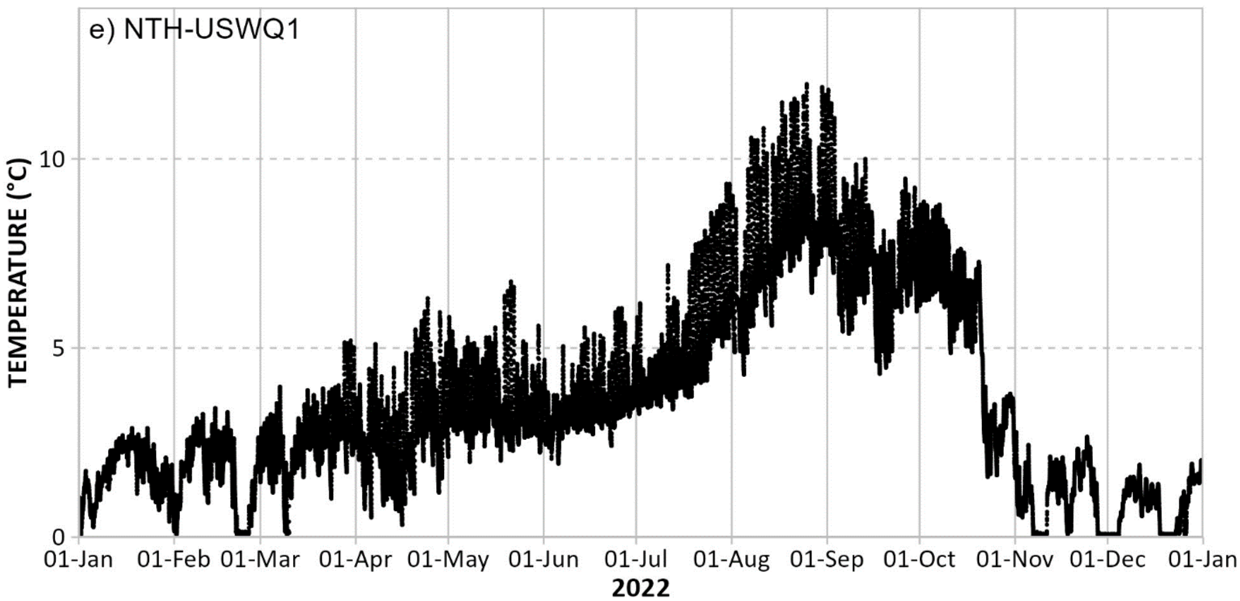


Figure 11. Continued.



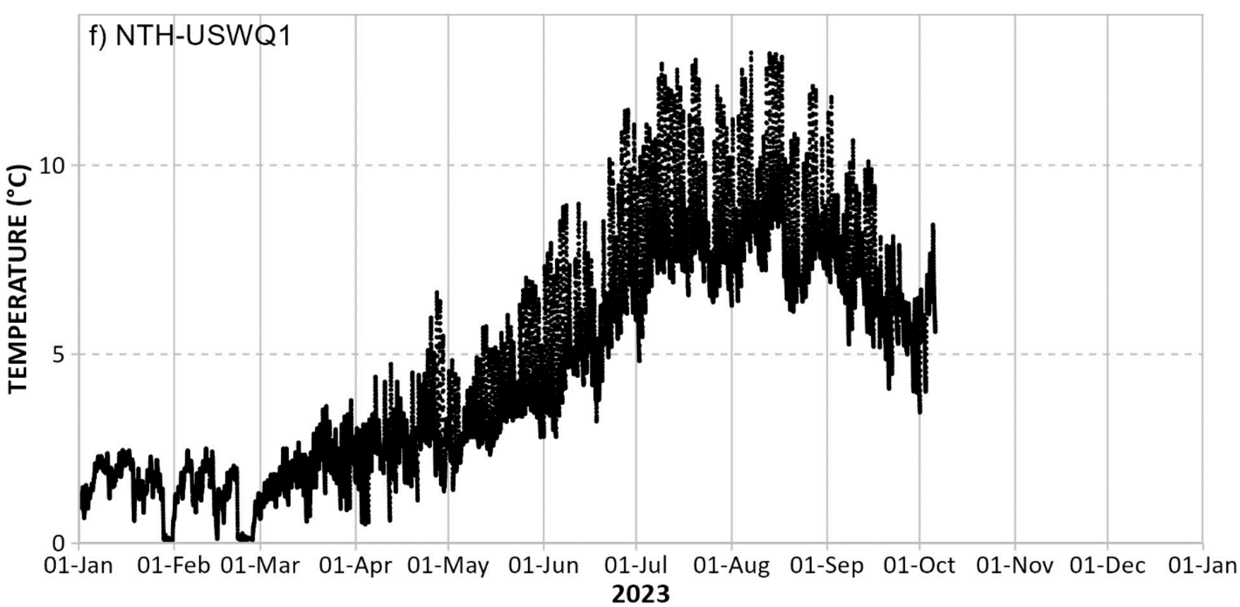
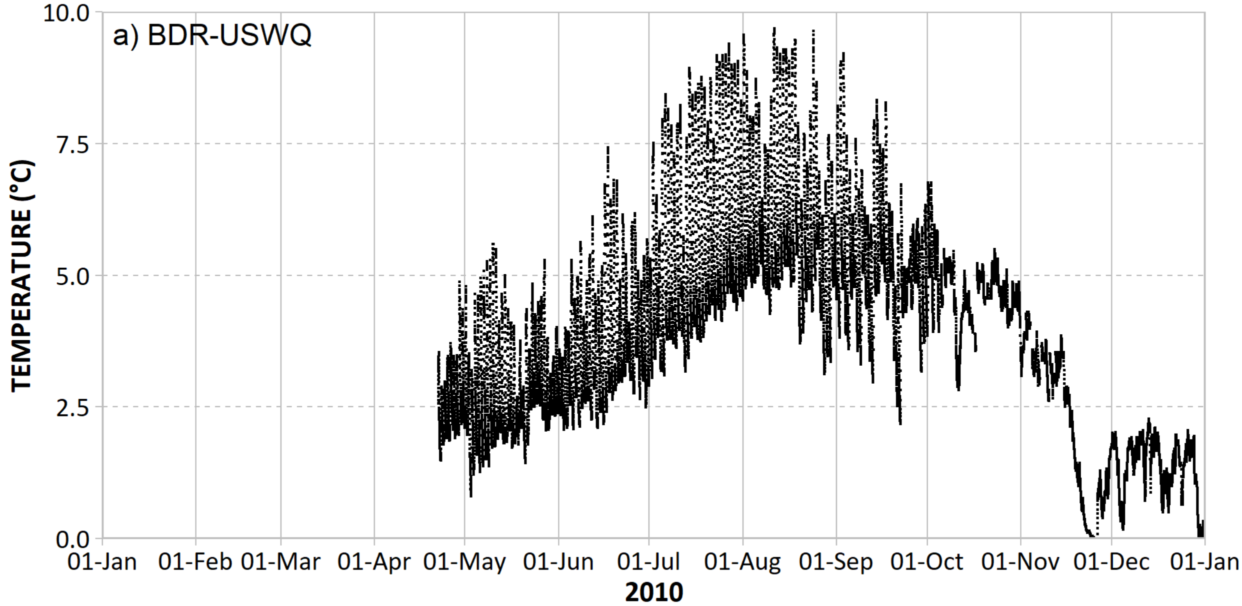


Figure 12. Baseline water temperature at BDR-USWQ from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.



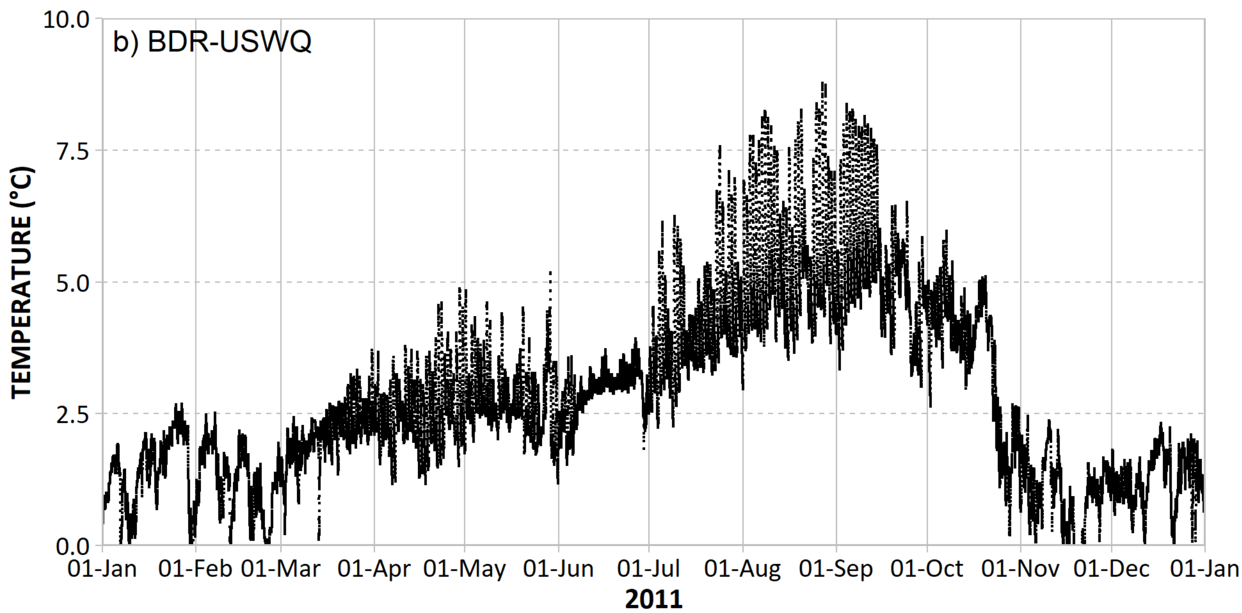
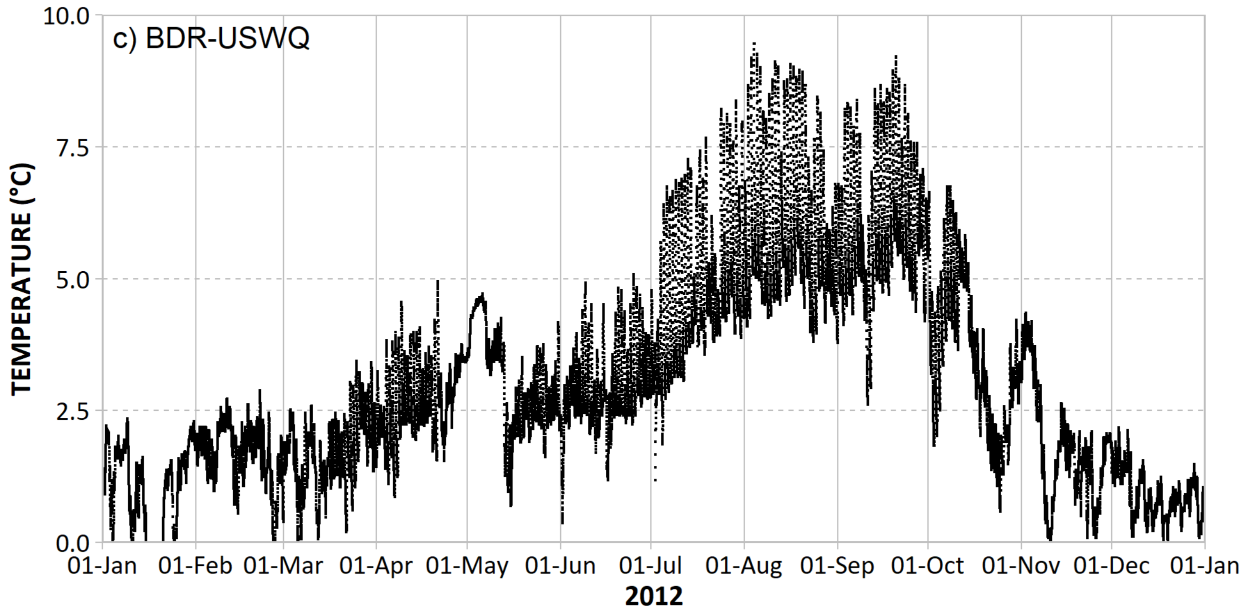


Figure 12. Continued.



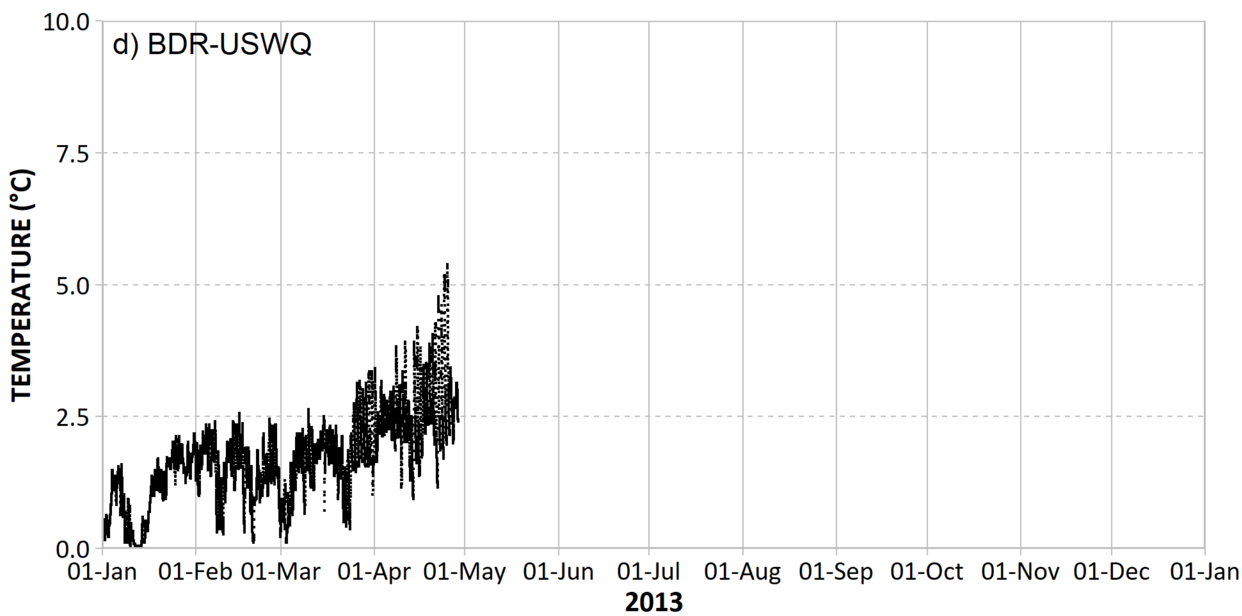
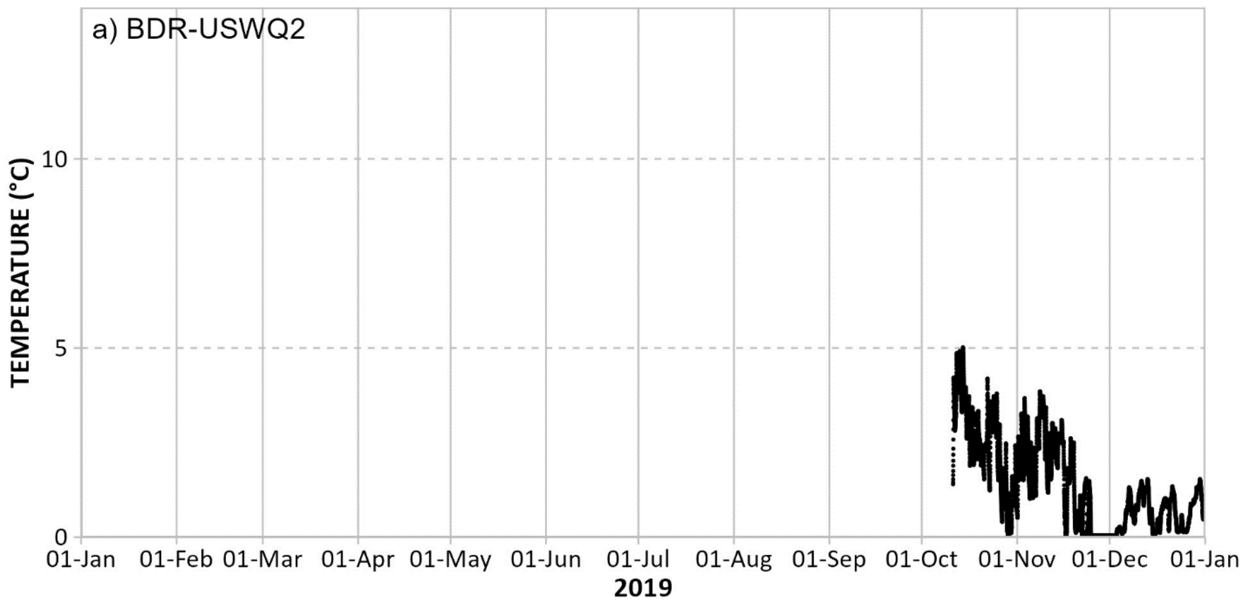


Figure 13. **Operational water temperature at BDR-USWQ2 from 2019 to 2021. Black dots show water temperature at intervals of 15 minutes.**



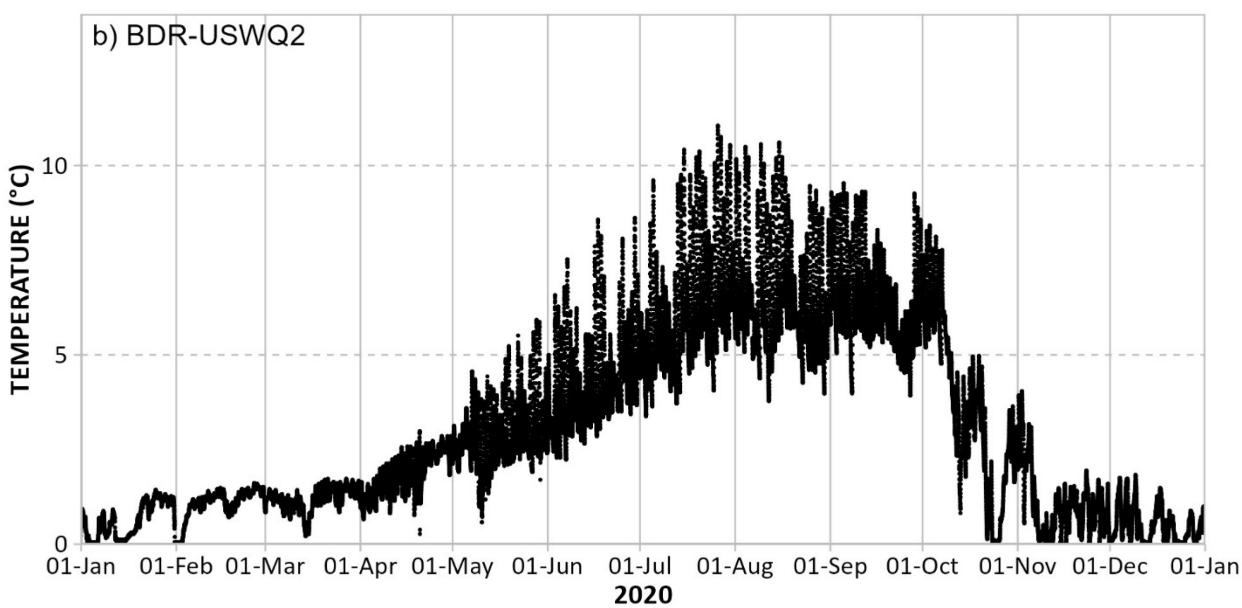
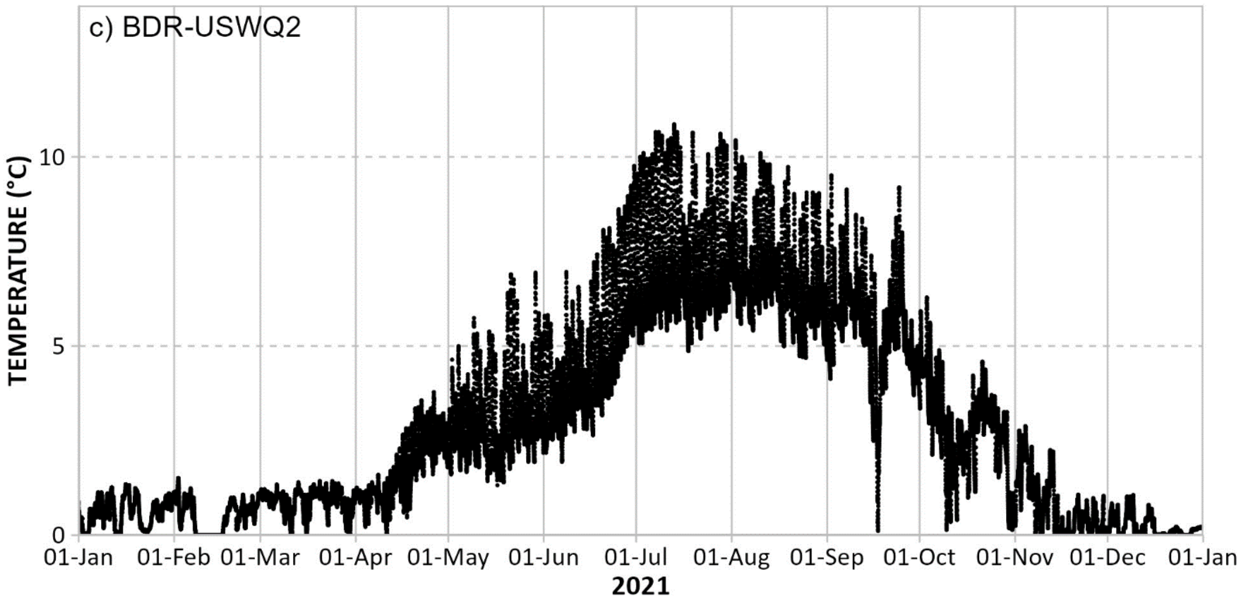


Figure 13. Continued.



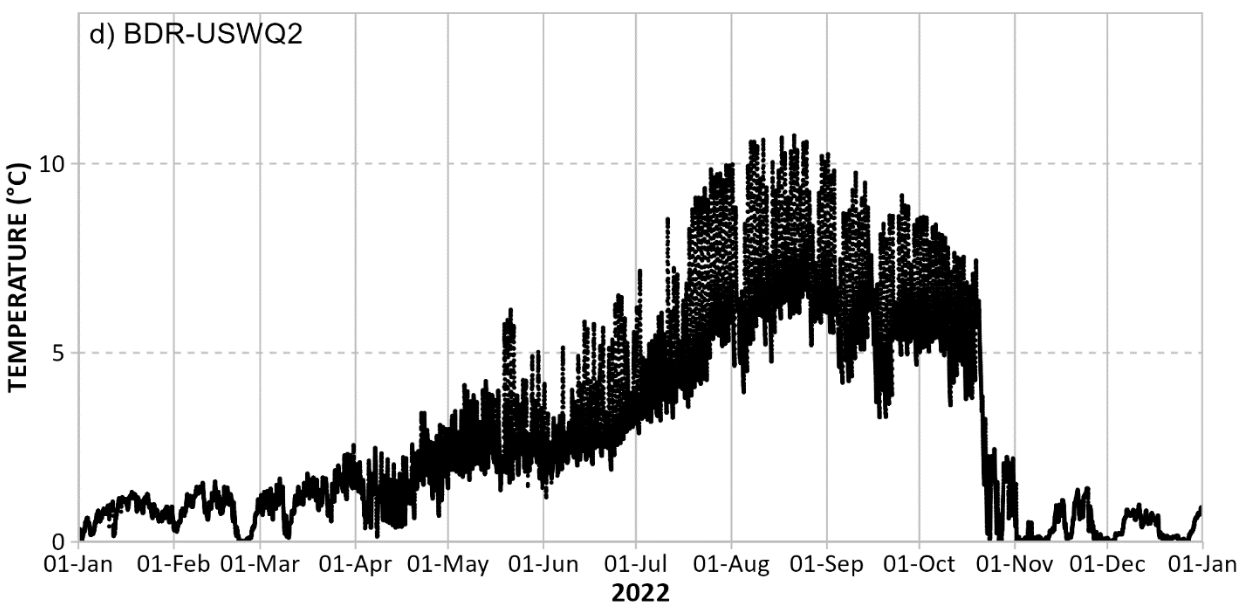


Figure 13. Continued.

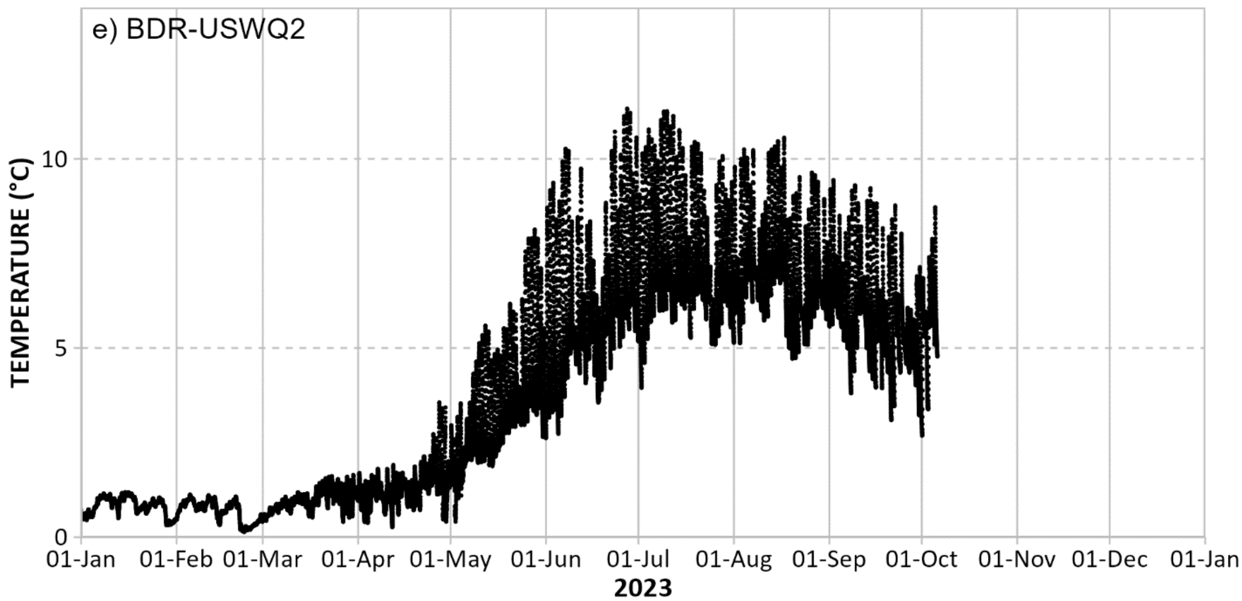
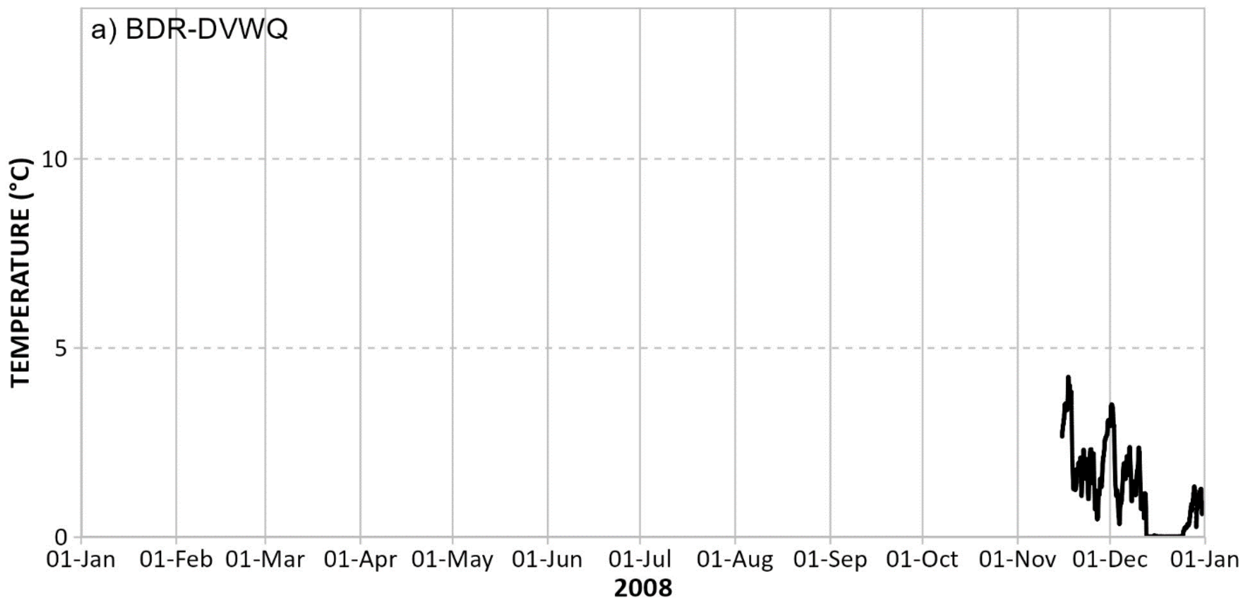


Figure 14. Baseline water temperature at BDR-DVWQ from 2008 to 2013. Black dots show water temperature at intervals of 15 minutes.



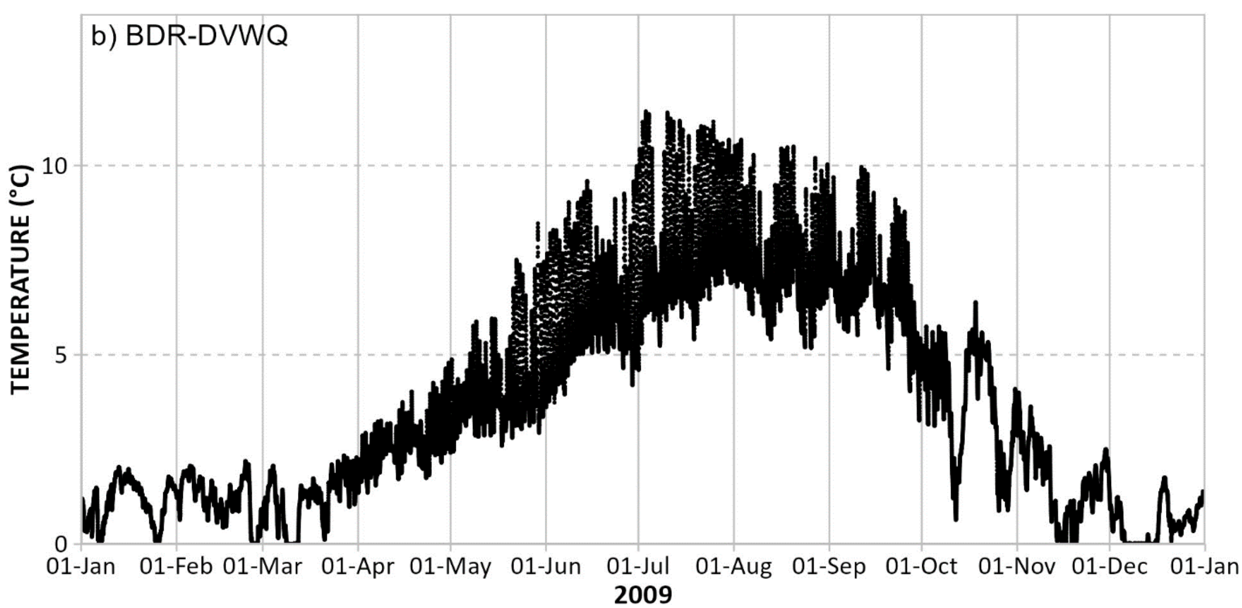
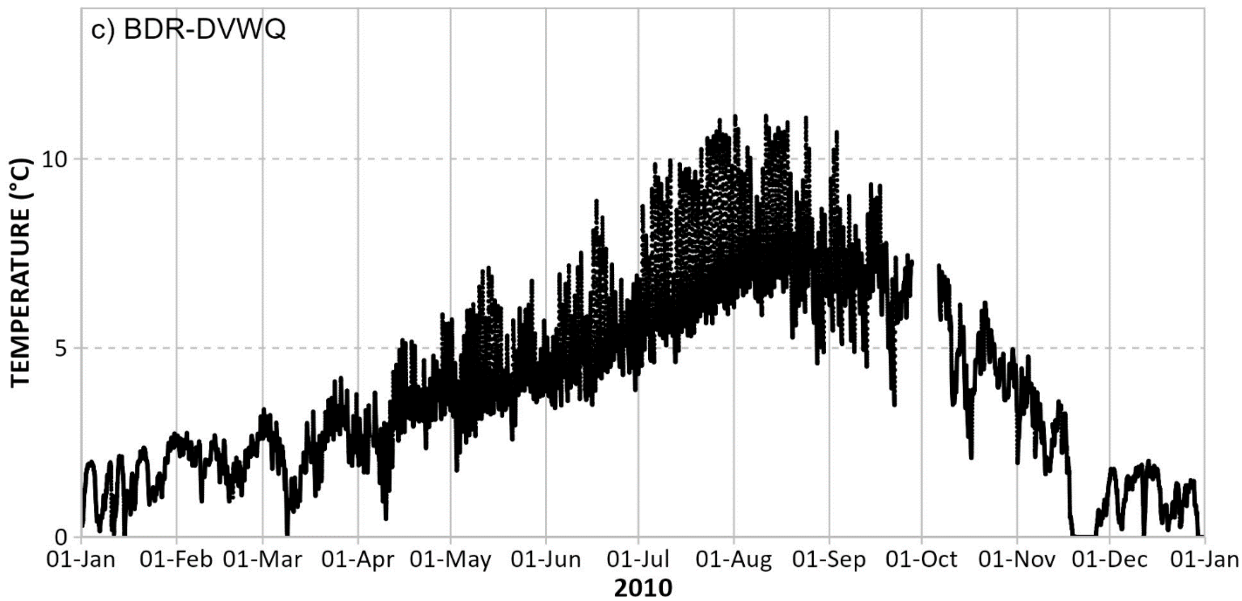
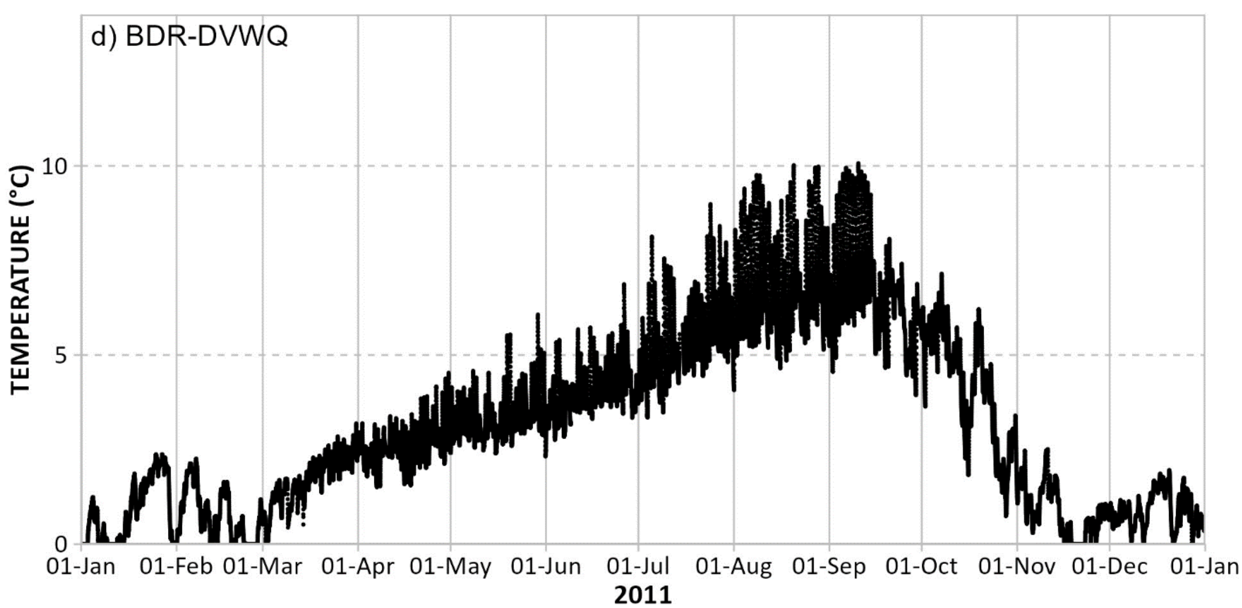


Figure 14. Continued.





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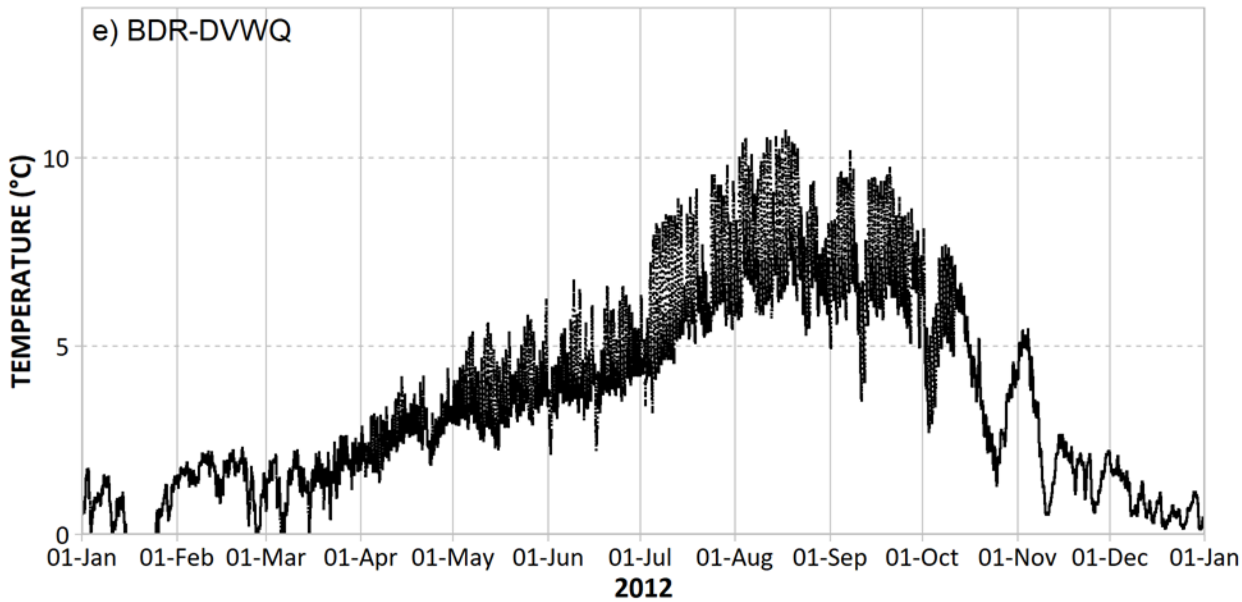


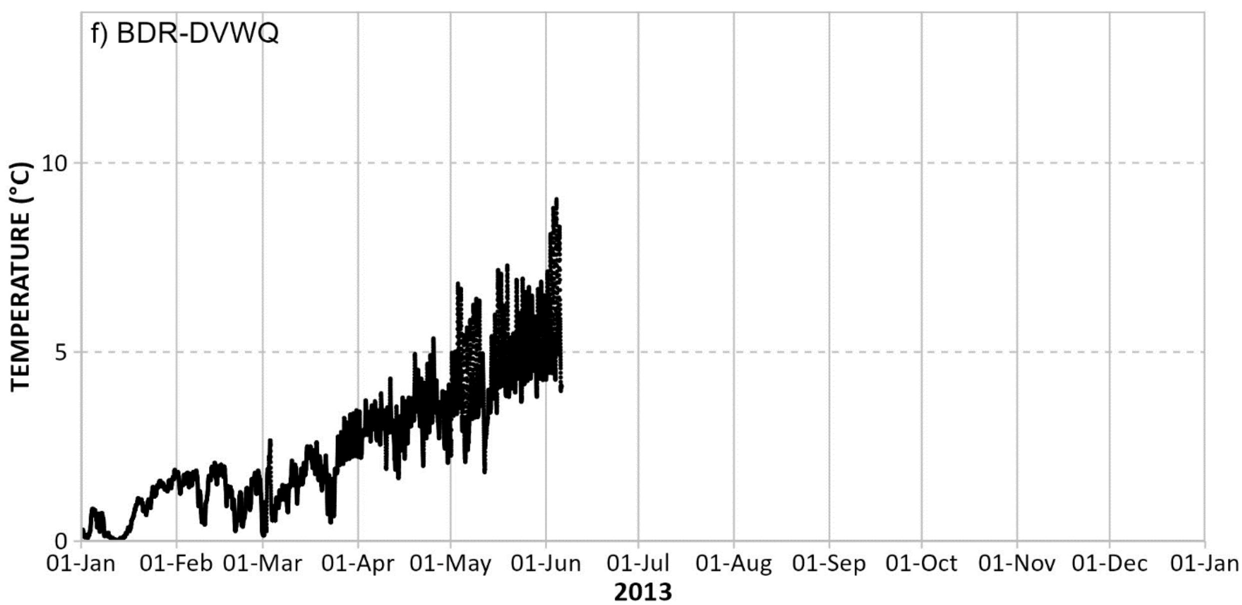
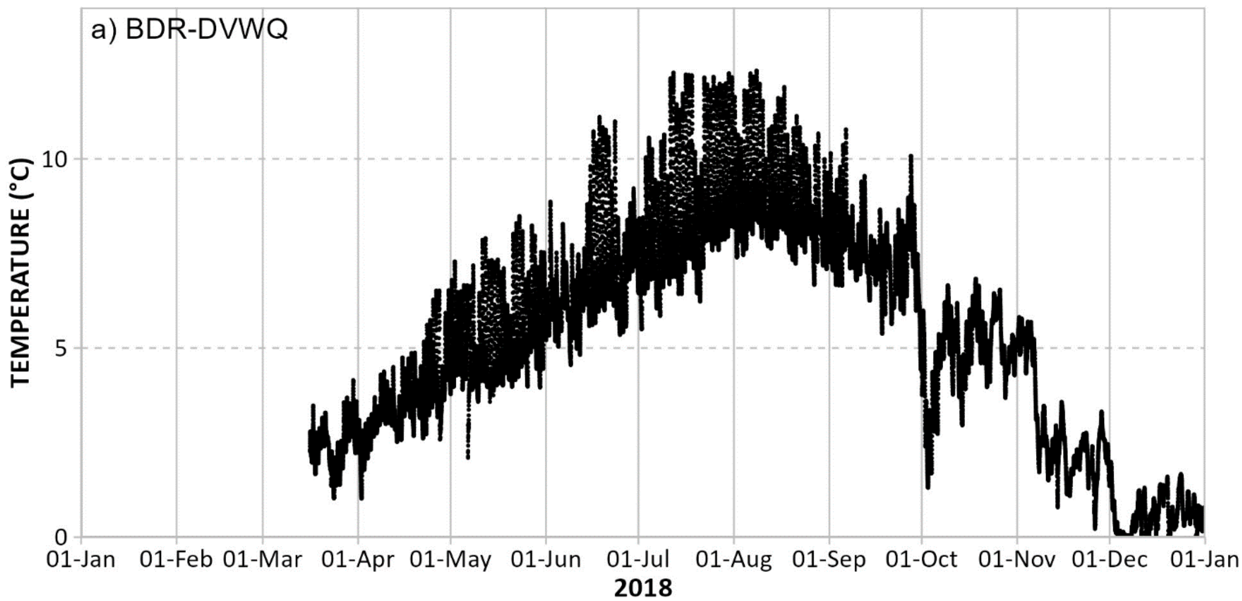


Figure 15. **Operational water temperature at BDR-DVWQ from 2018 to 2023. Black dots show water temperature at intervals of 15 minutes.**



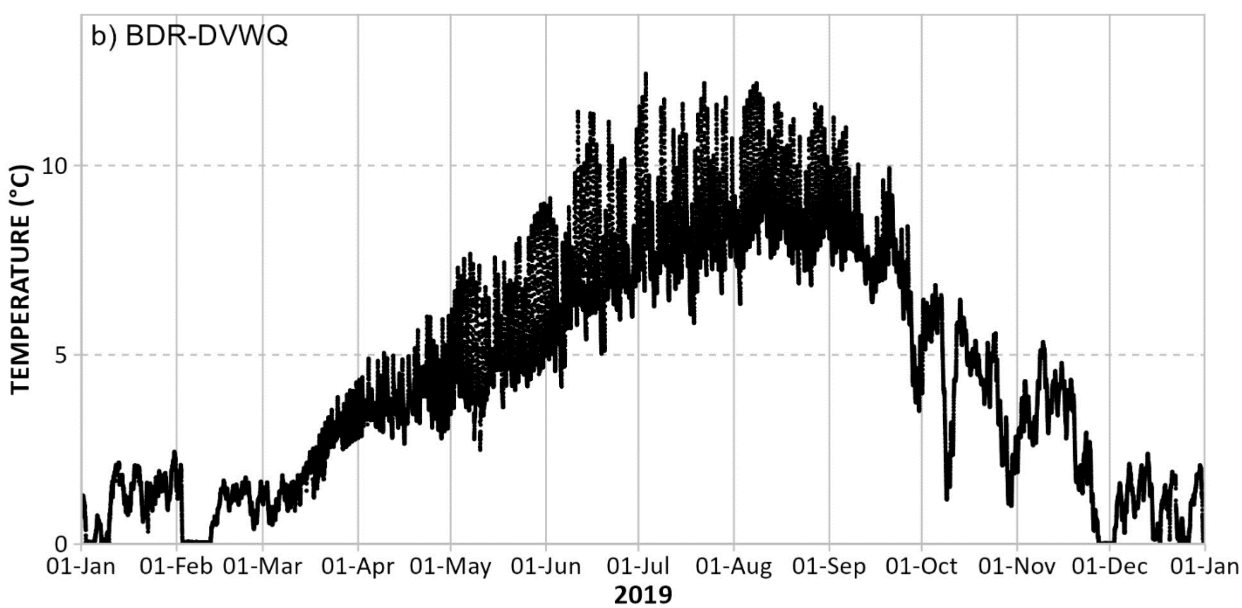
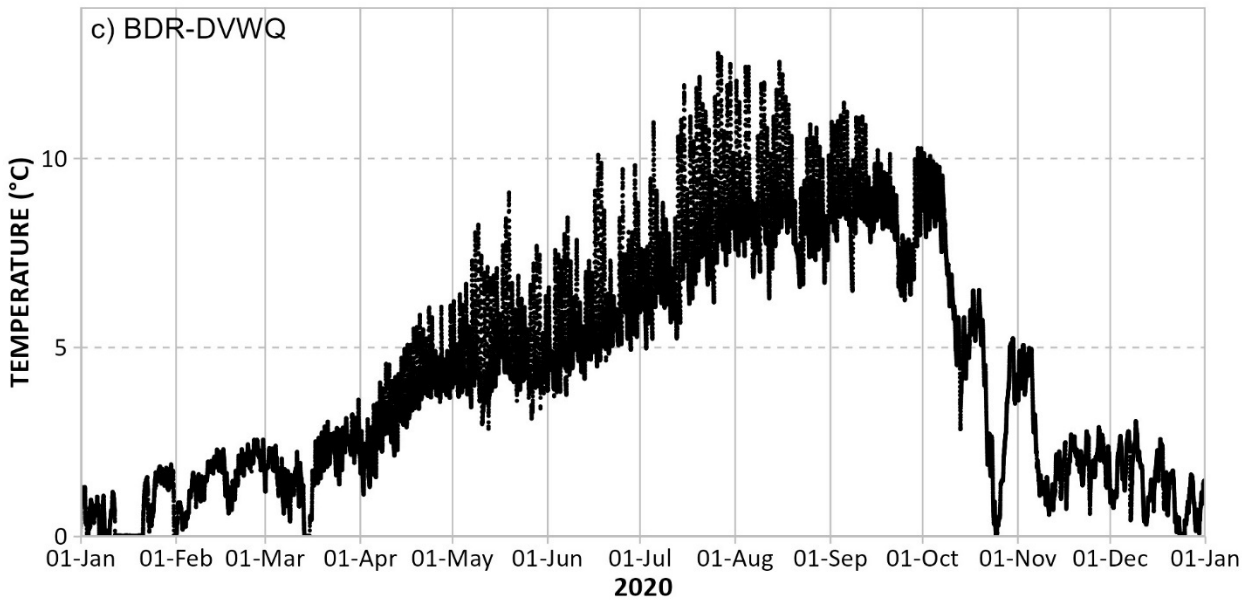


Figure 15. Continued.



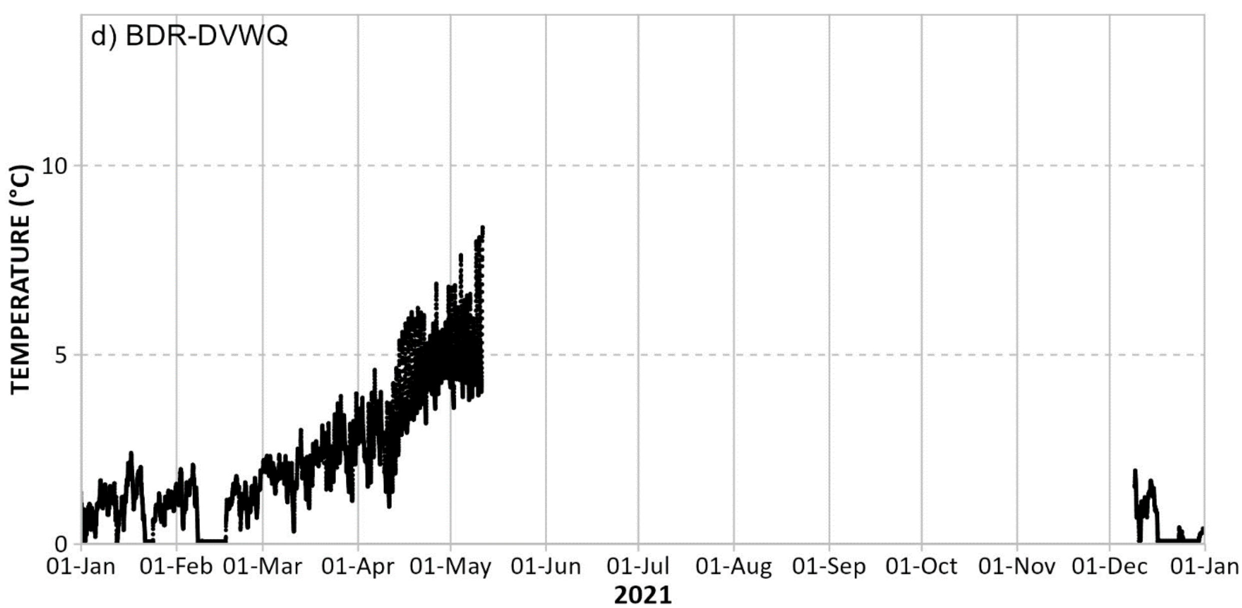
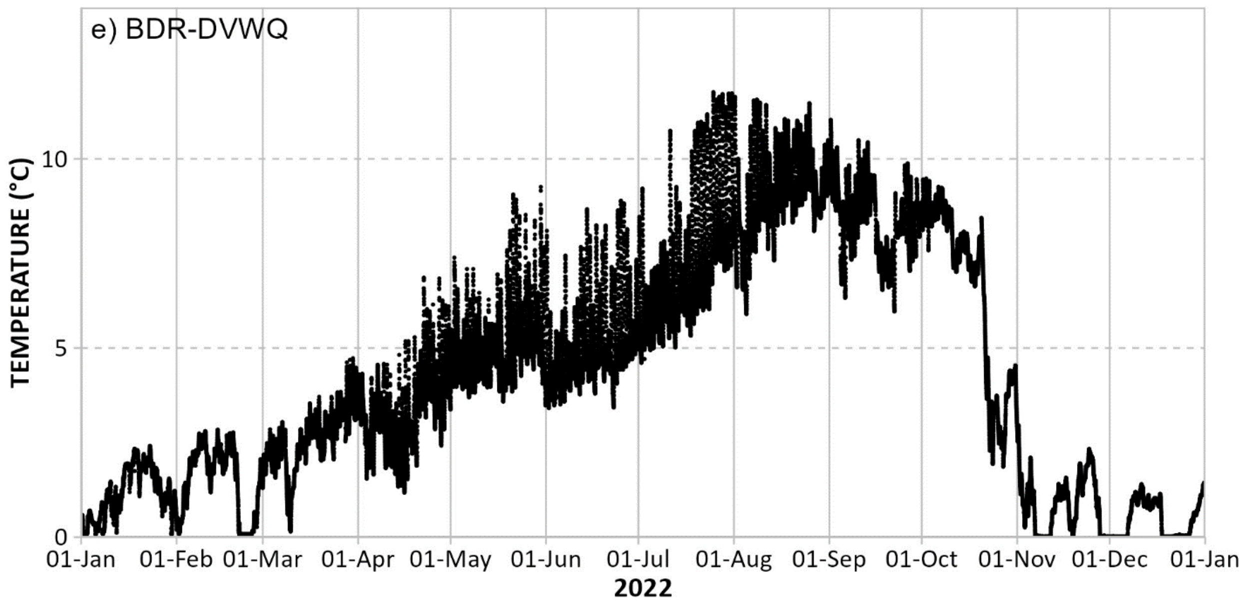


Figure 15. Continued.



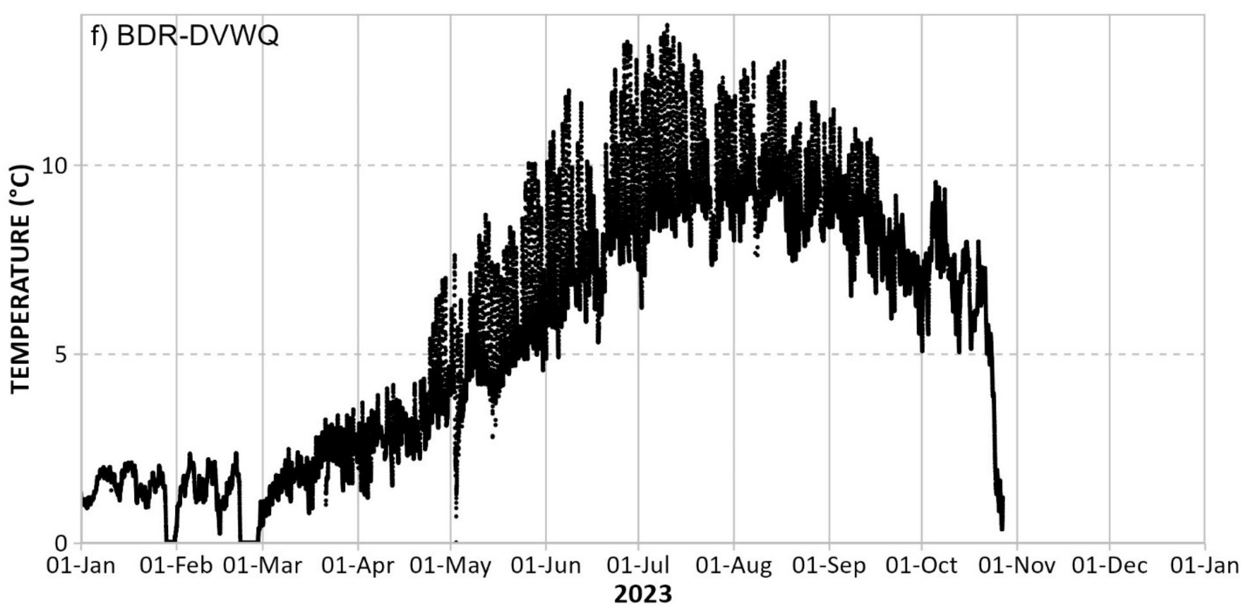
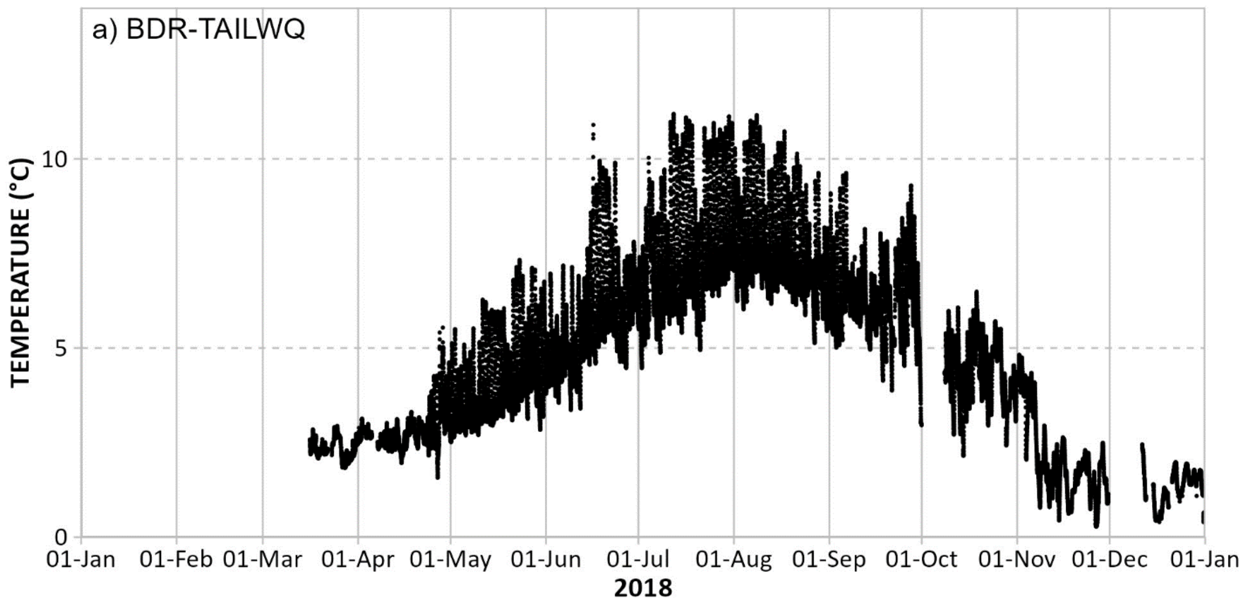


Figure 16. **Operational water temperature at BDR-TAILWQ from 2018 to 2023. Black dots show water temperature at intervals of 15 minutes.**



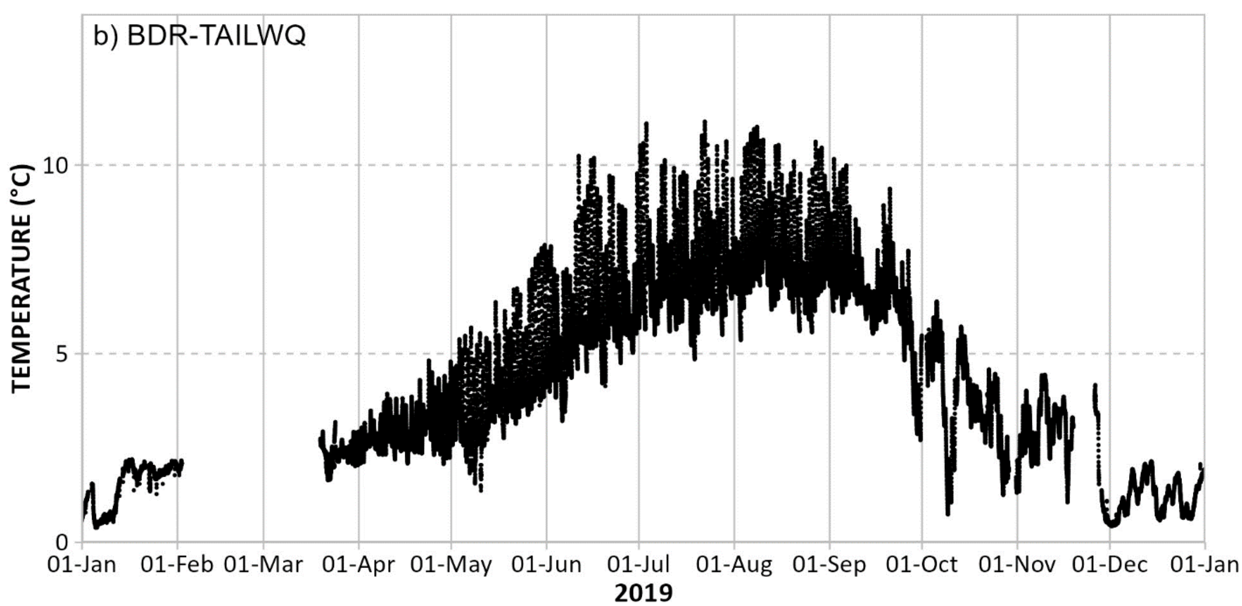
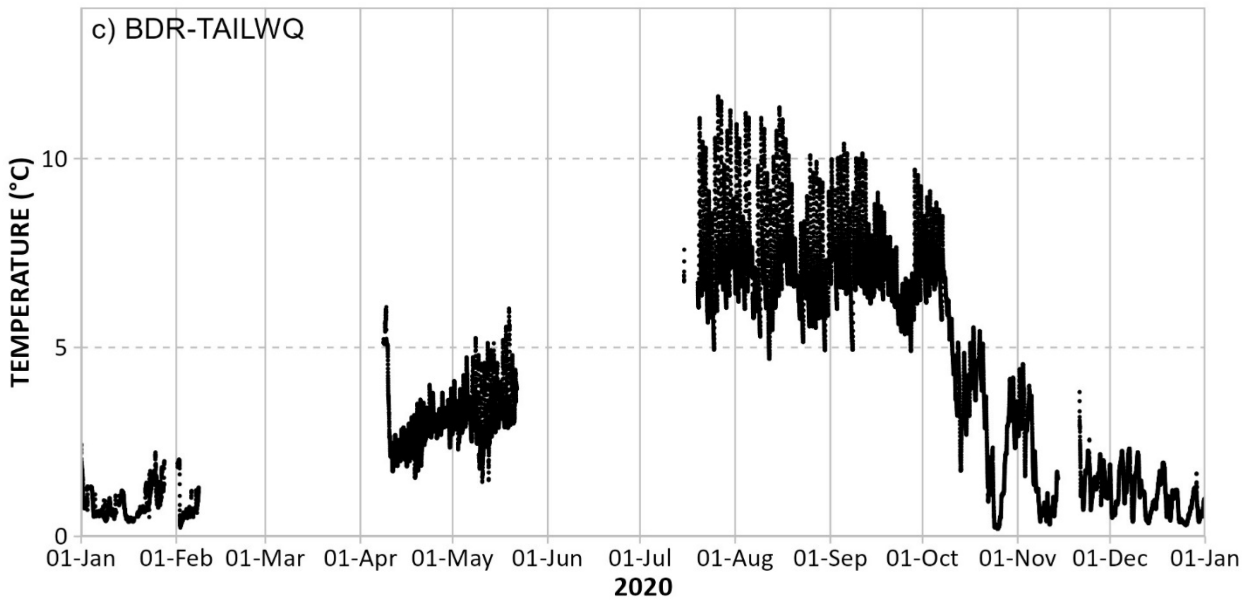


Figure 16. Continued.



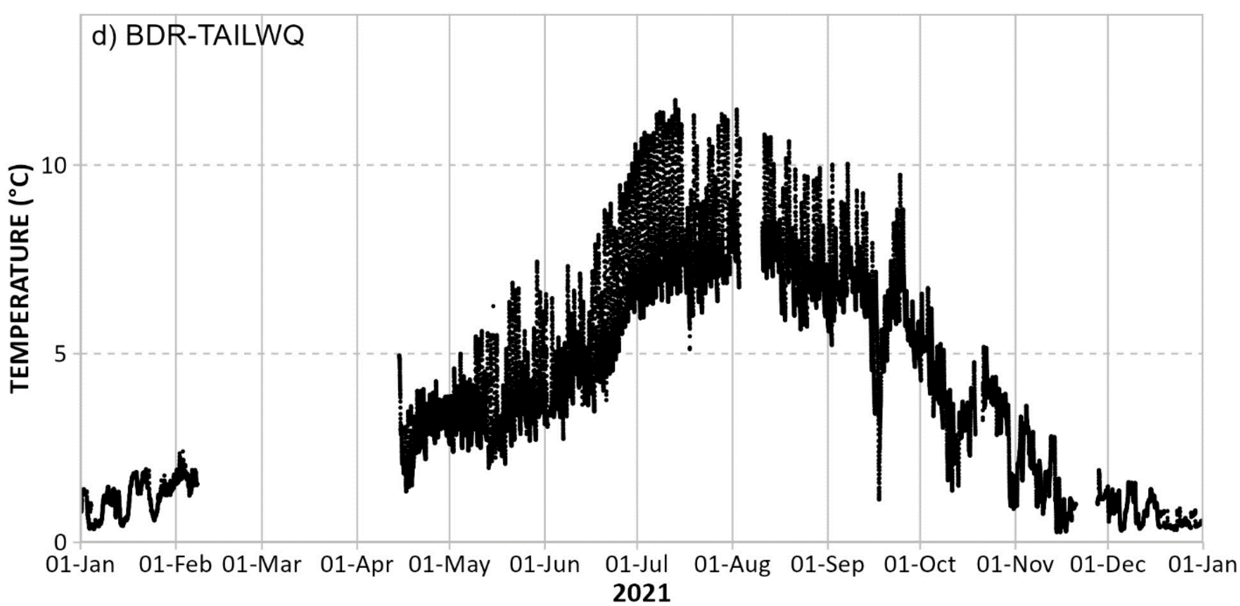
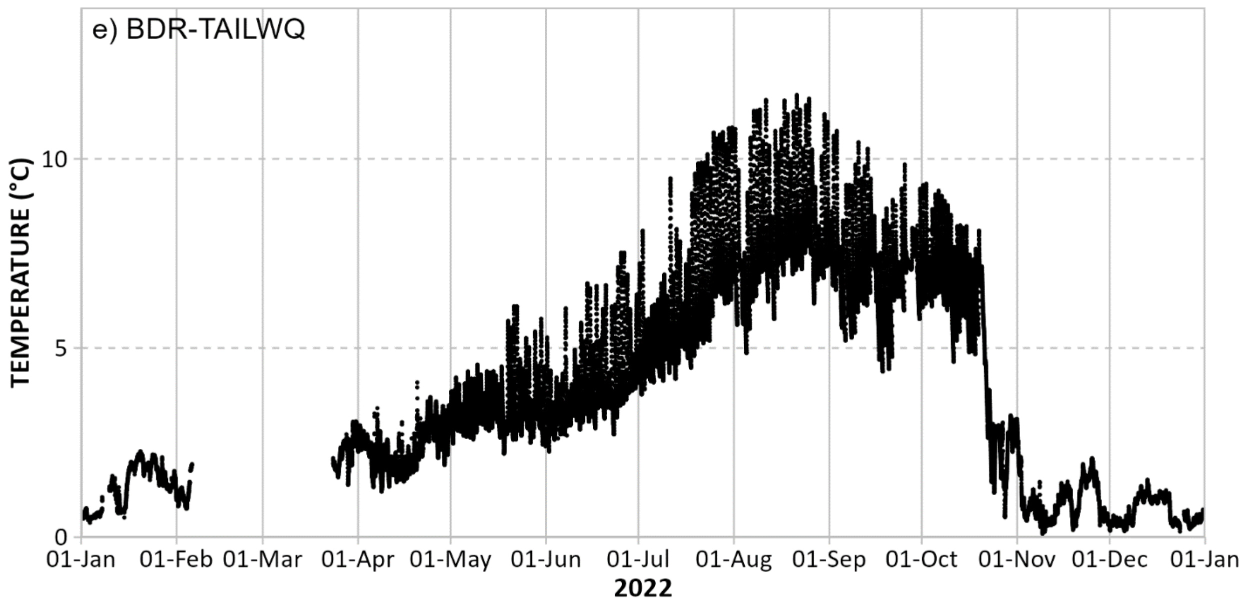


Figure 16. Continued.



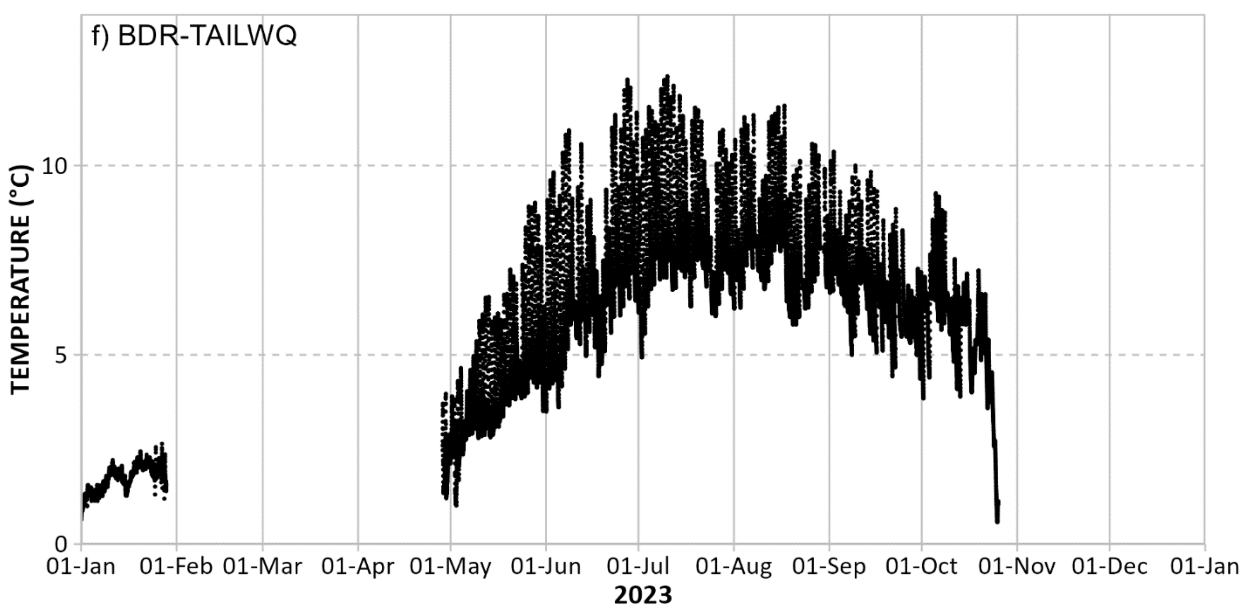
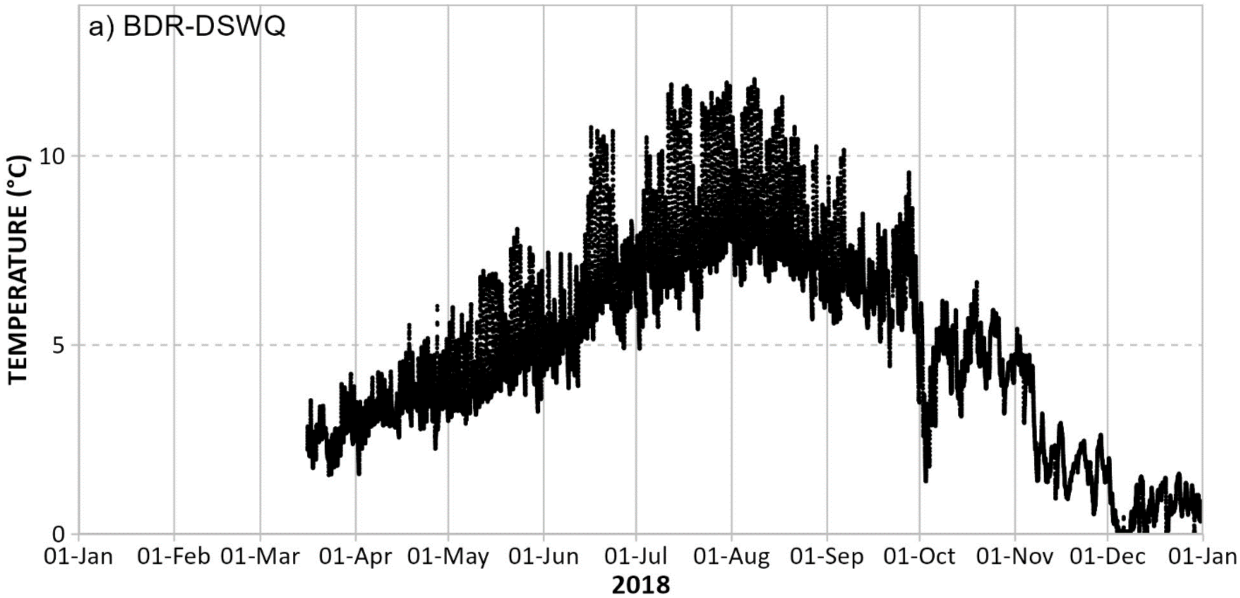


Figure 17. Operational water temperature at BDR-DSWQ from 2018 to 2023. Black dots show water temperature at intervals of 15 minutes.



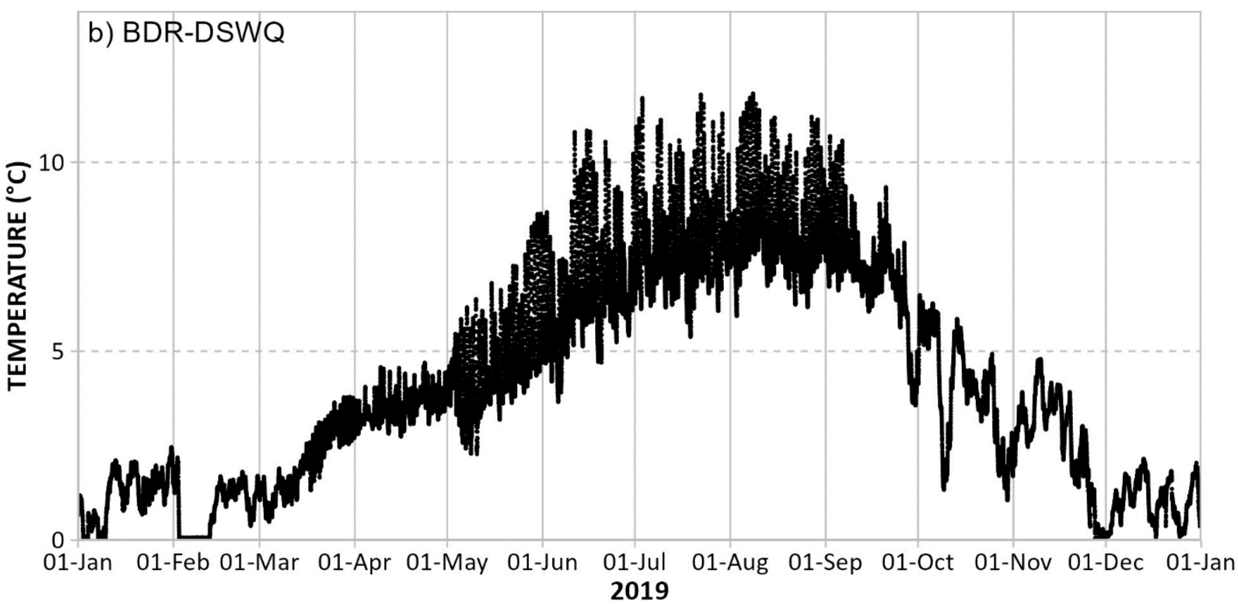
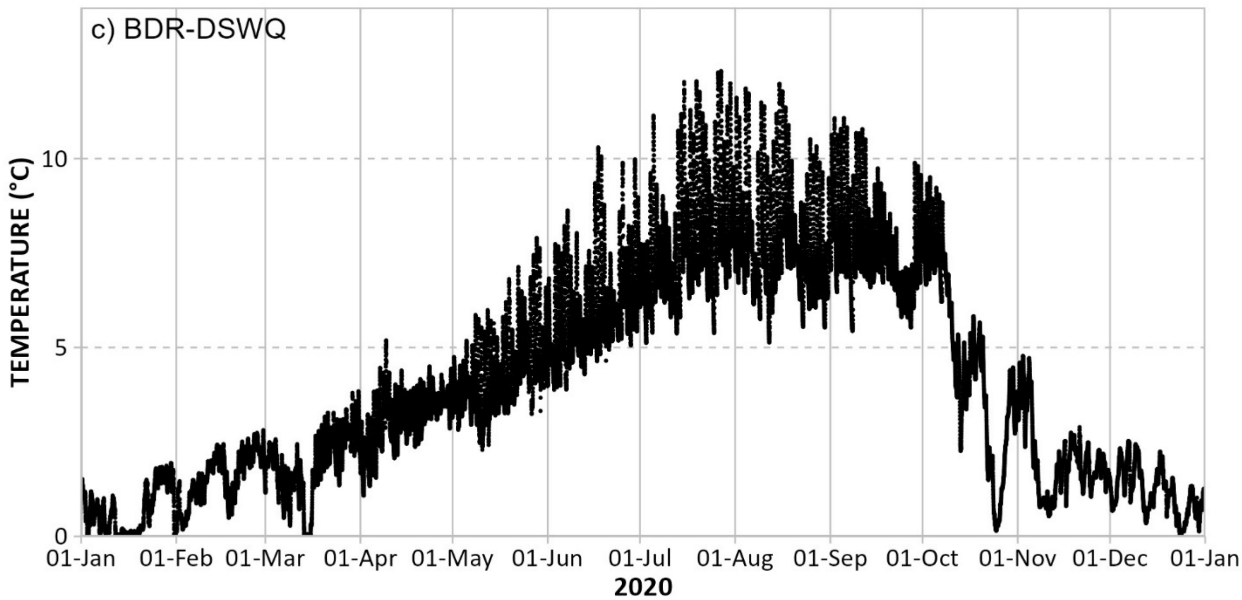


Figure 17. Continued.



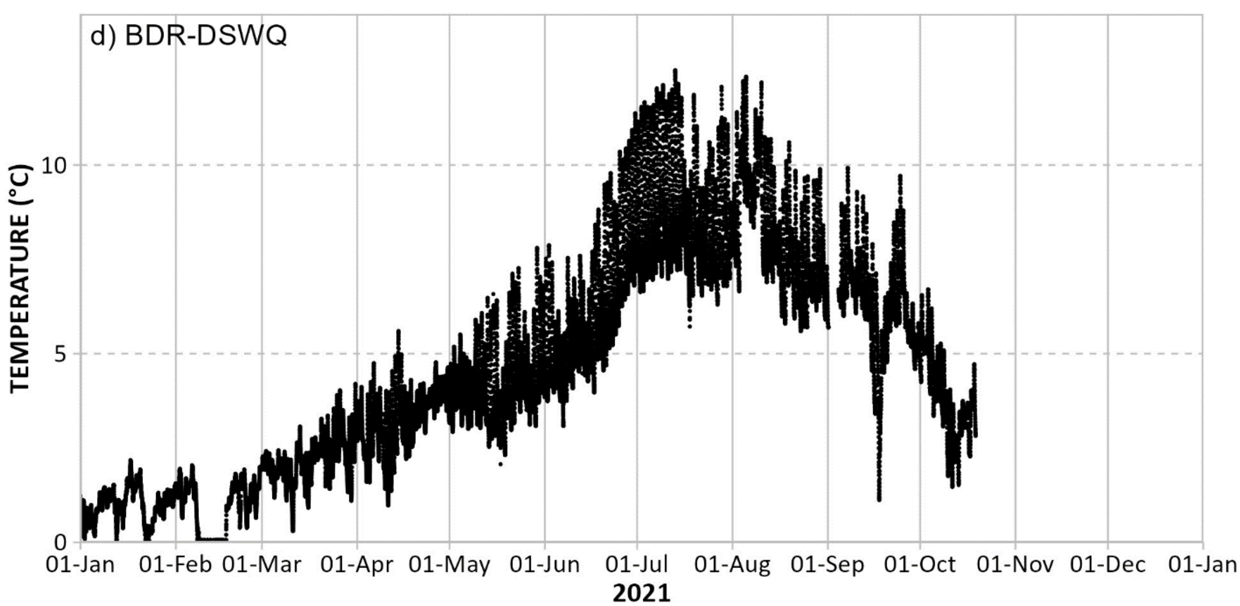
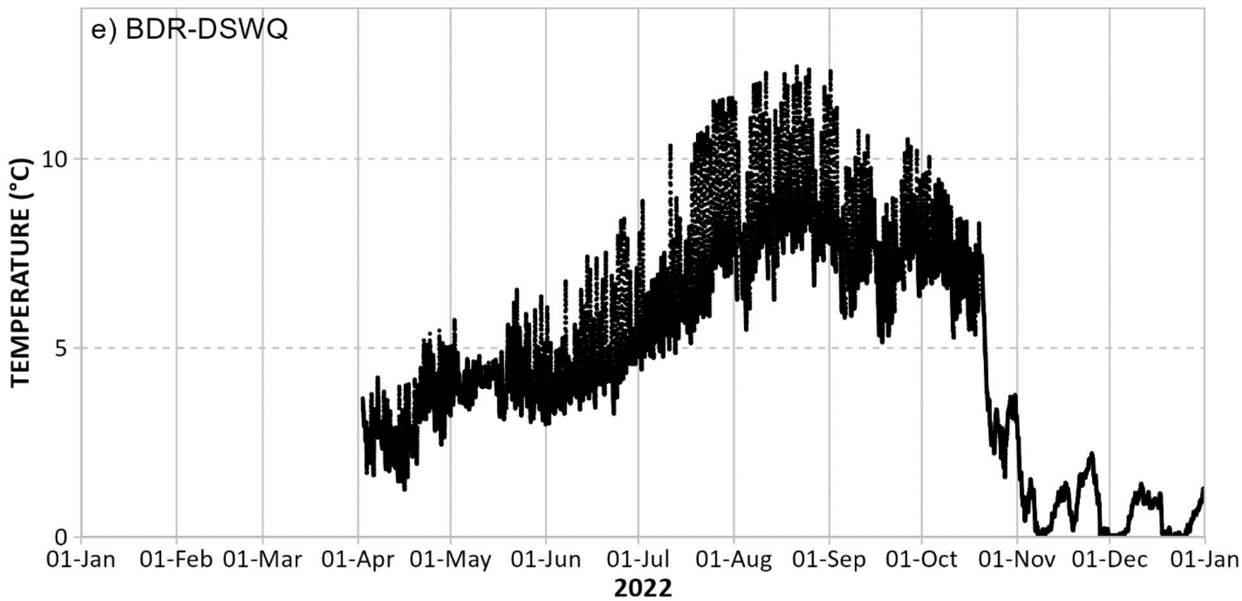
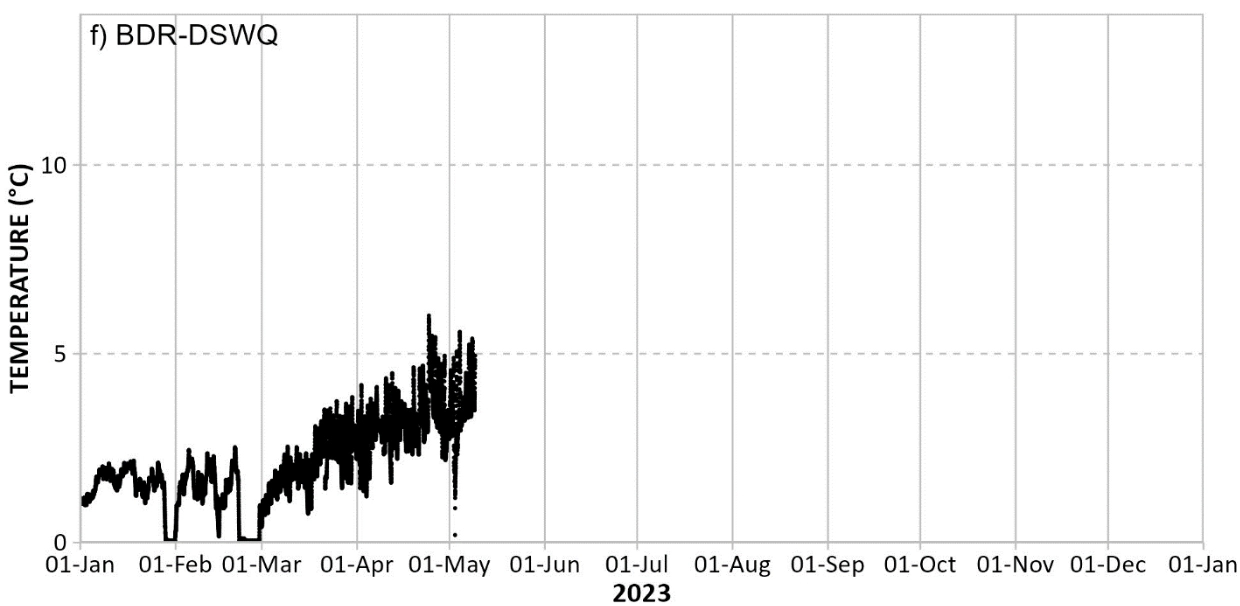


Figure 17. Continued.

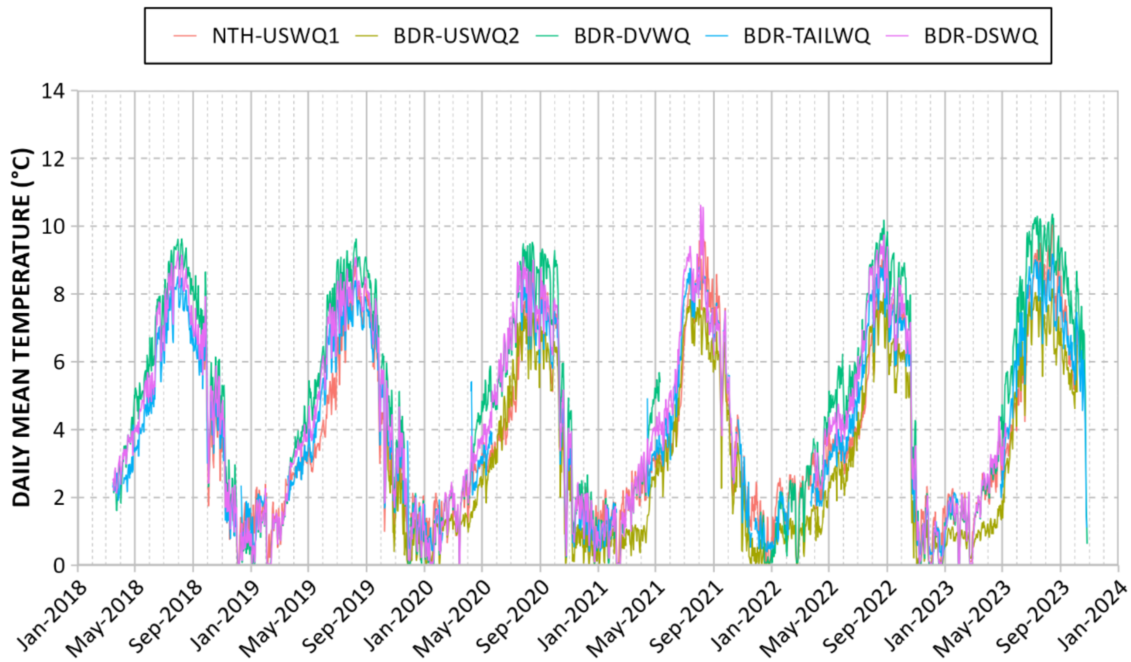




2.2.2. Operational Monitoring

Figure 18. Daily mean, maximum, and minimum water temperature recorded in Boulder Creek during operations (2018 to 2023).

(a) Daily Average



(b) Daily Maximum

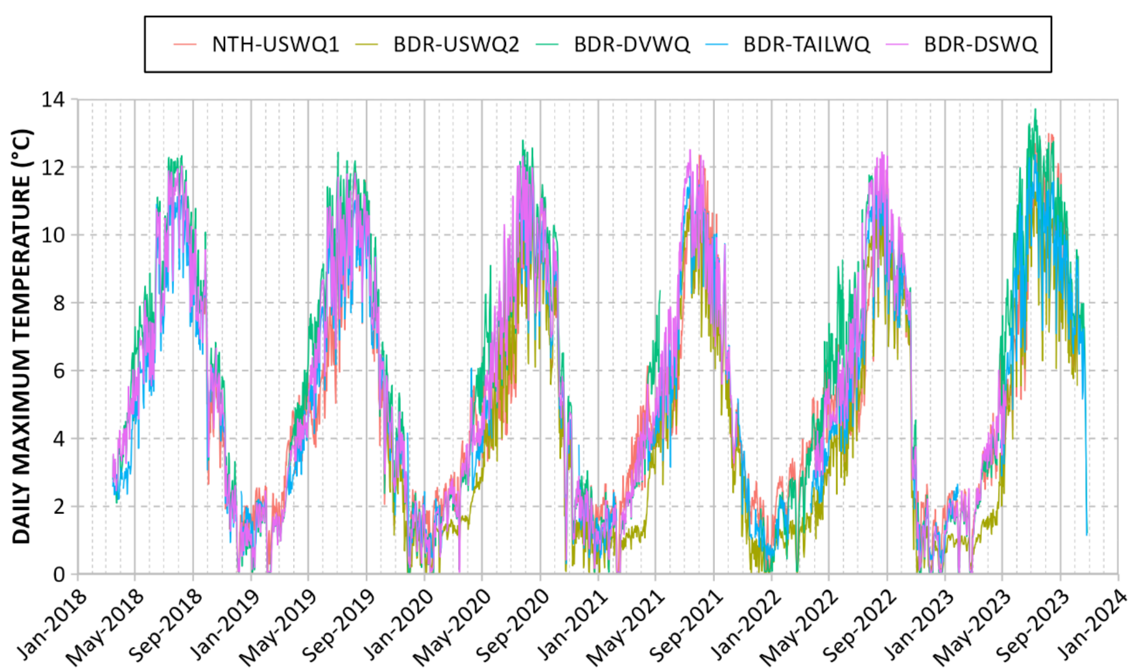
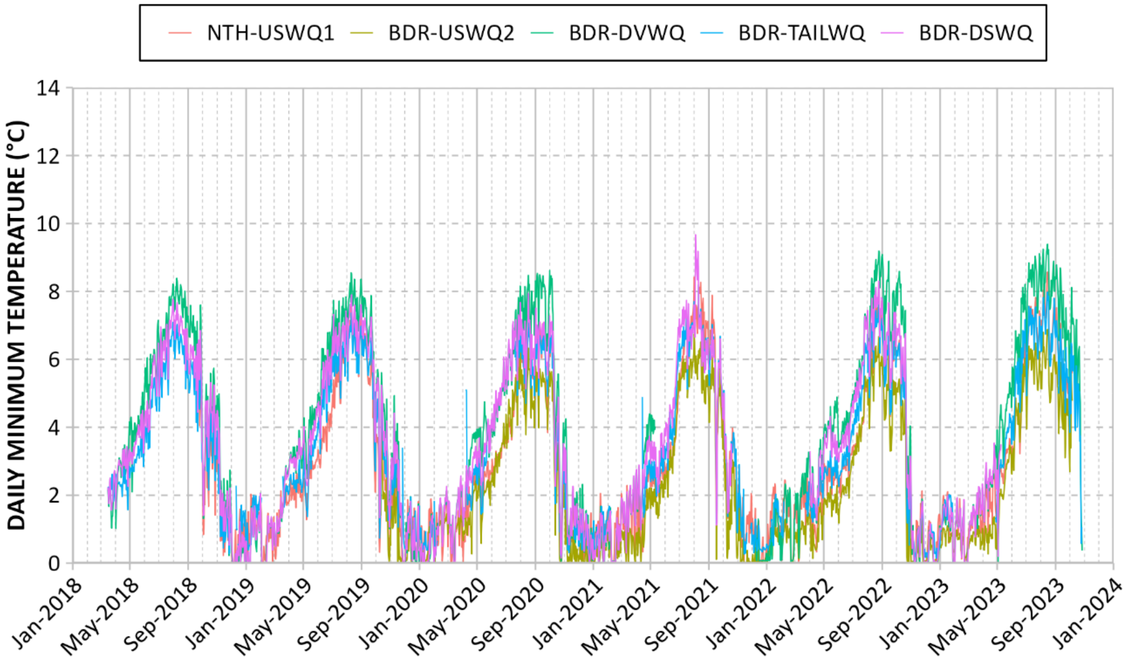


Figure 18. Continued.

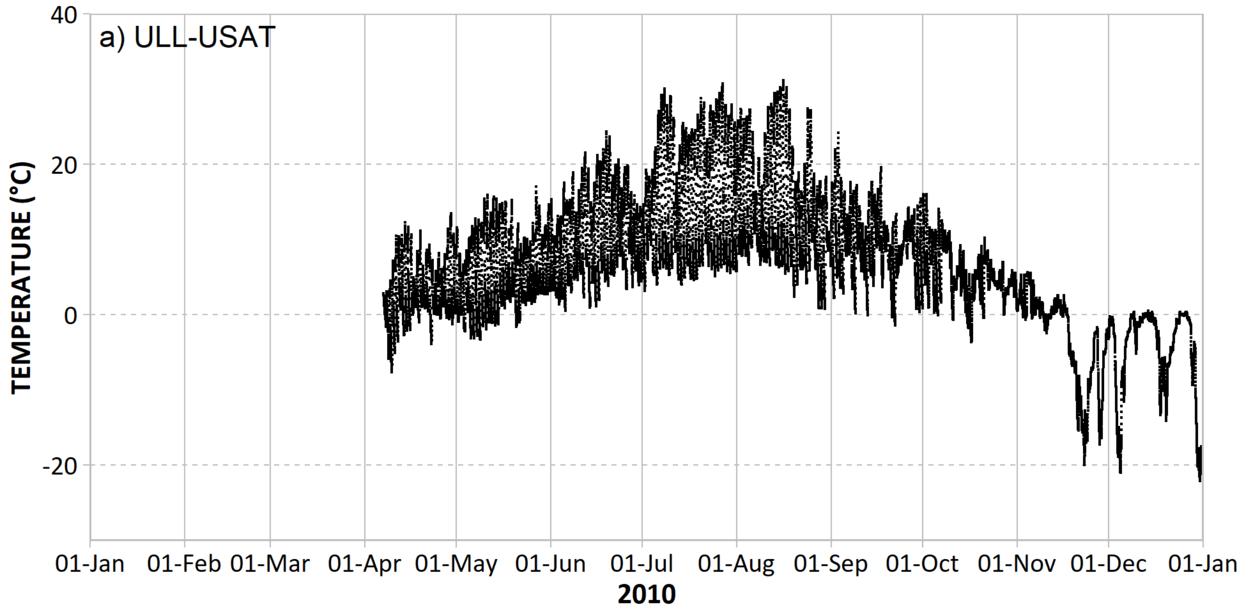
(c) Daily Minimum



3. AIR TEMPERATURE DATA

3.1. Upper Lillooet River

Figure 19. Baseline air temperature at ULL-USAT from 2010 to 2013. Black dots show air temperature at intervals of 15 minutes.



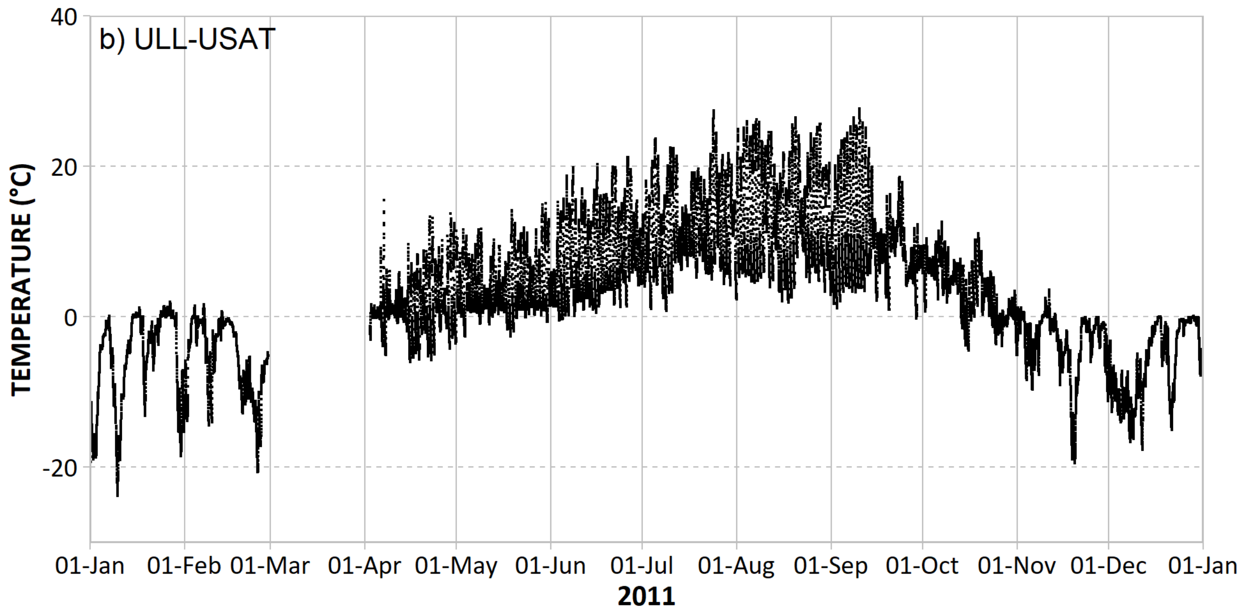
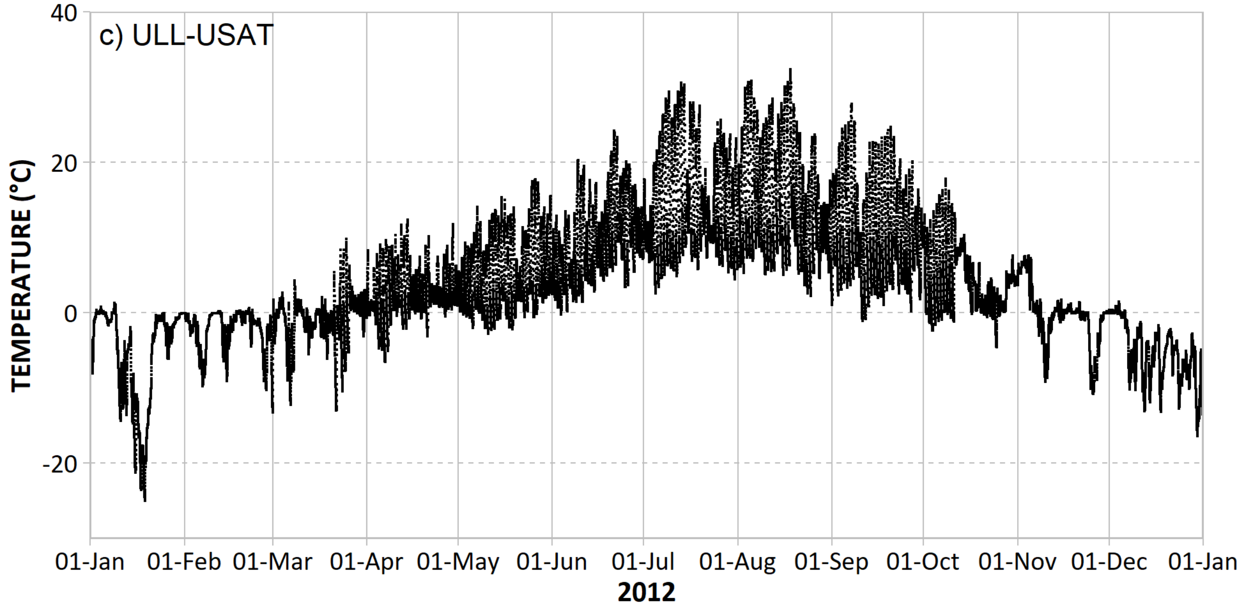


Figure 19. Continued.



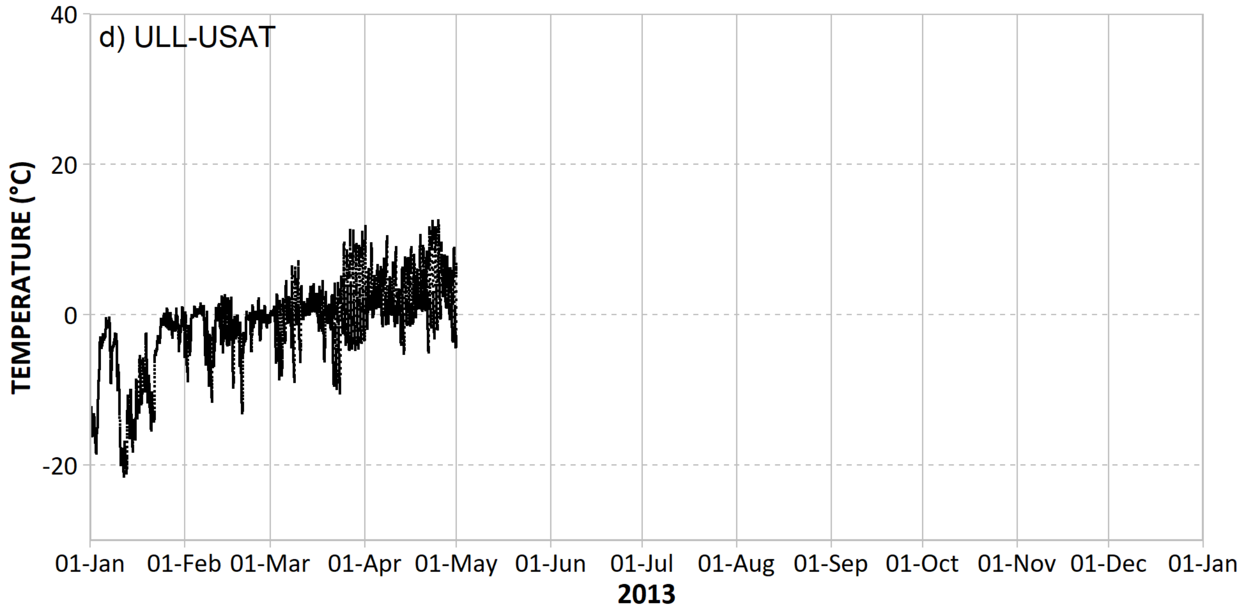


Figure 20. Operational air temperature at ULL-USAT01 from 2018 to 2019. Black dots show air temperature at intervals of 15 minutes.

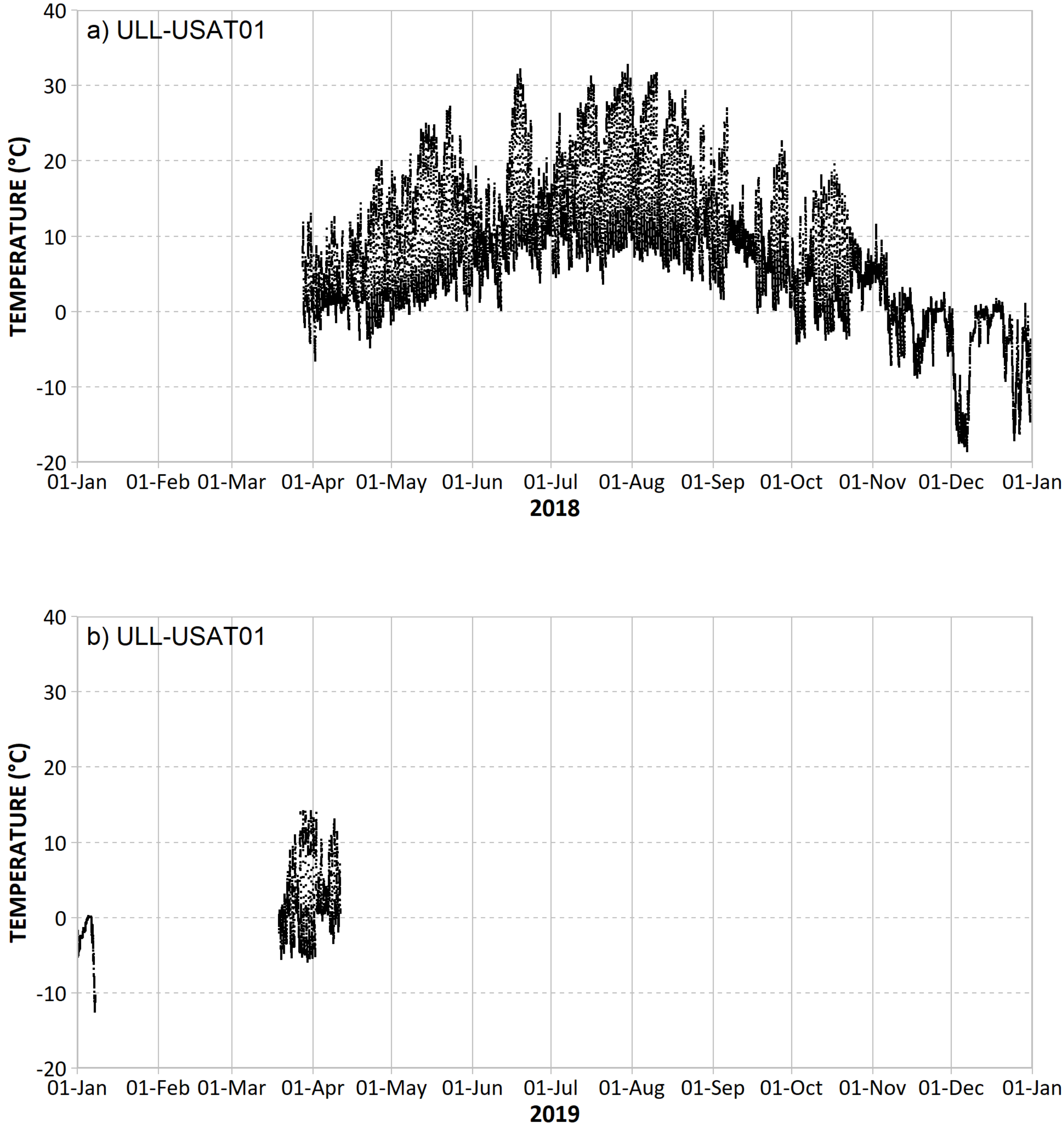
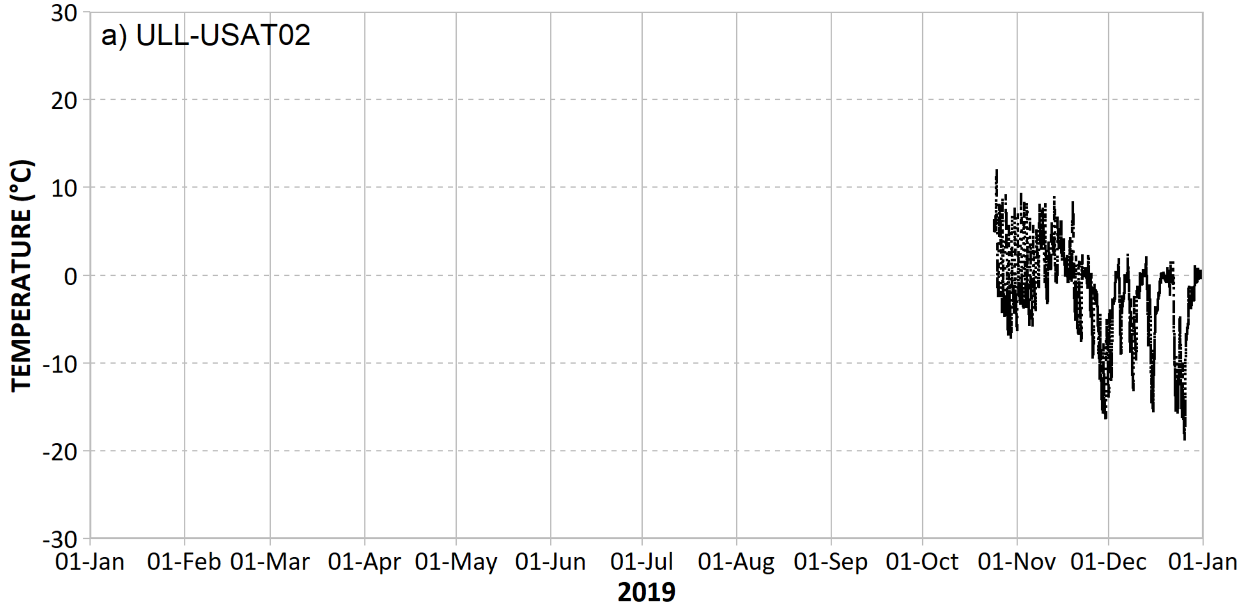


Figure 21. **Operational air temperature at ULL-USAT02 from 2019 to 2021. Black dots show air temperature at intervals of 15 minutes.**



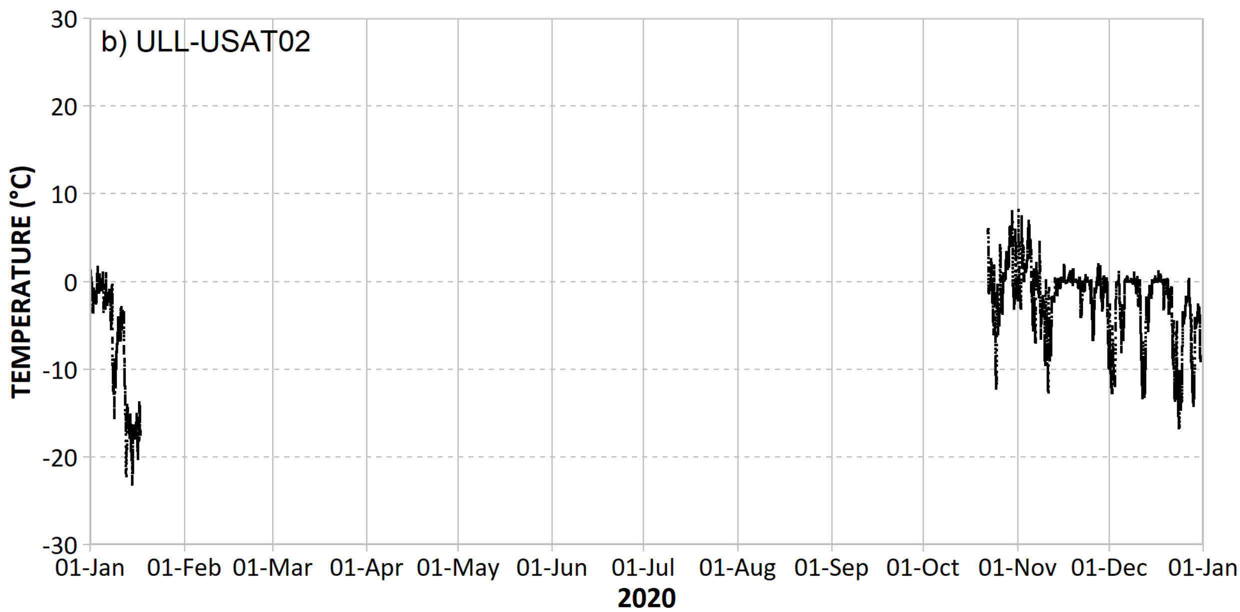


Figure 21. Continued.

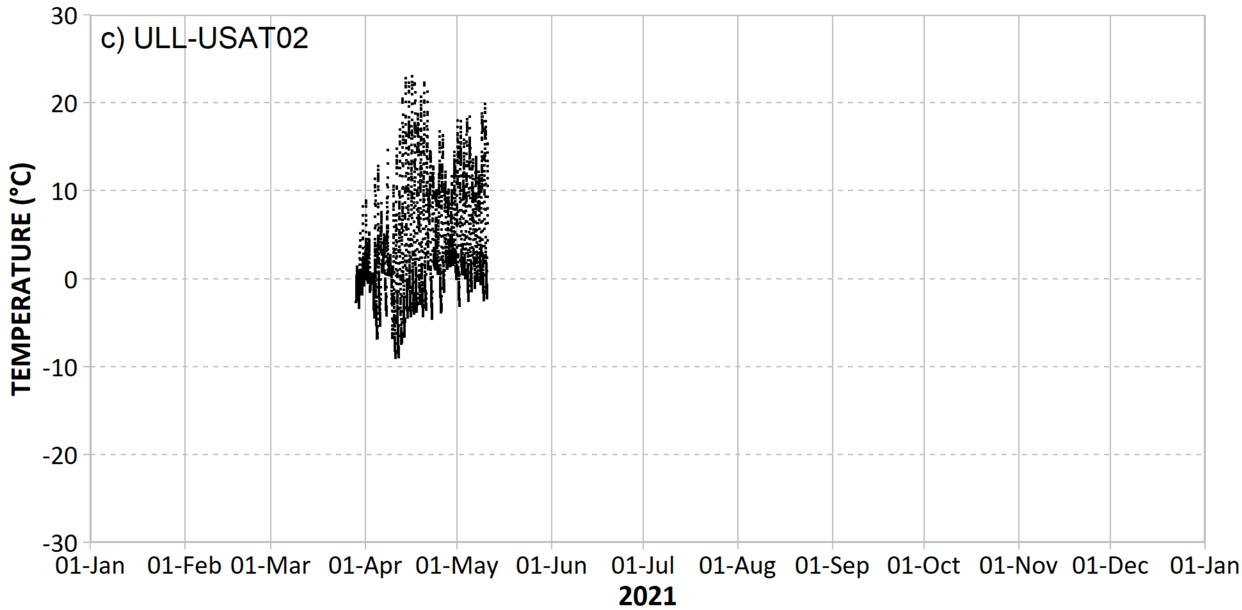
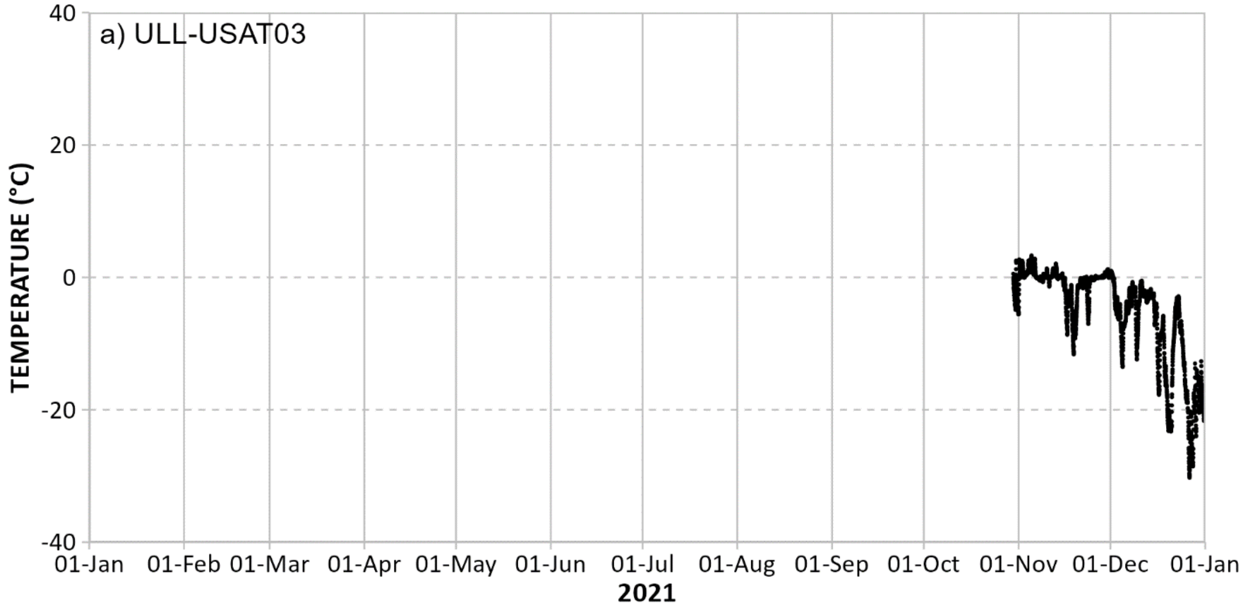


Figure 22. Operational air temperature at ULL-USAT03 from 2021 to 2023. Black dots show air temperature at intervals of 15 minutes.



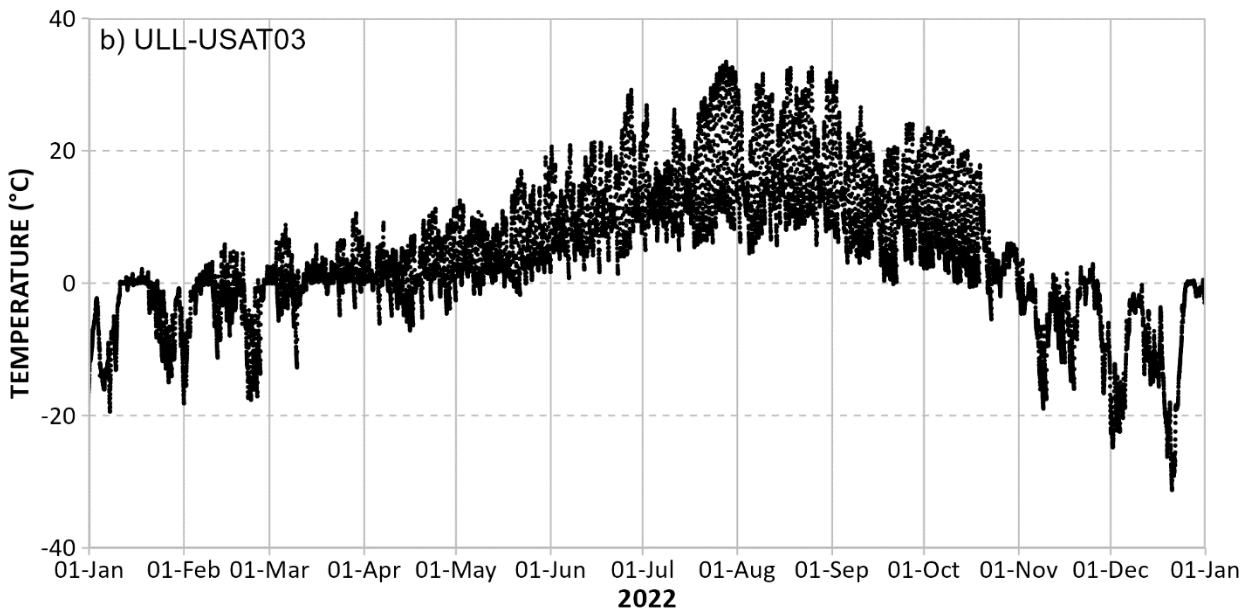


Figure 22. Continued.

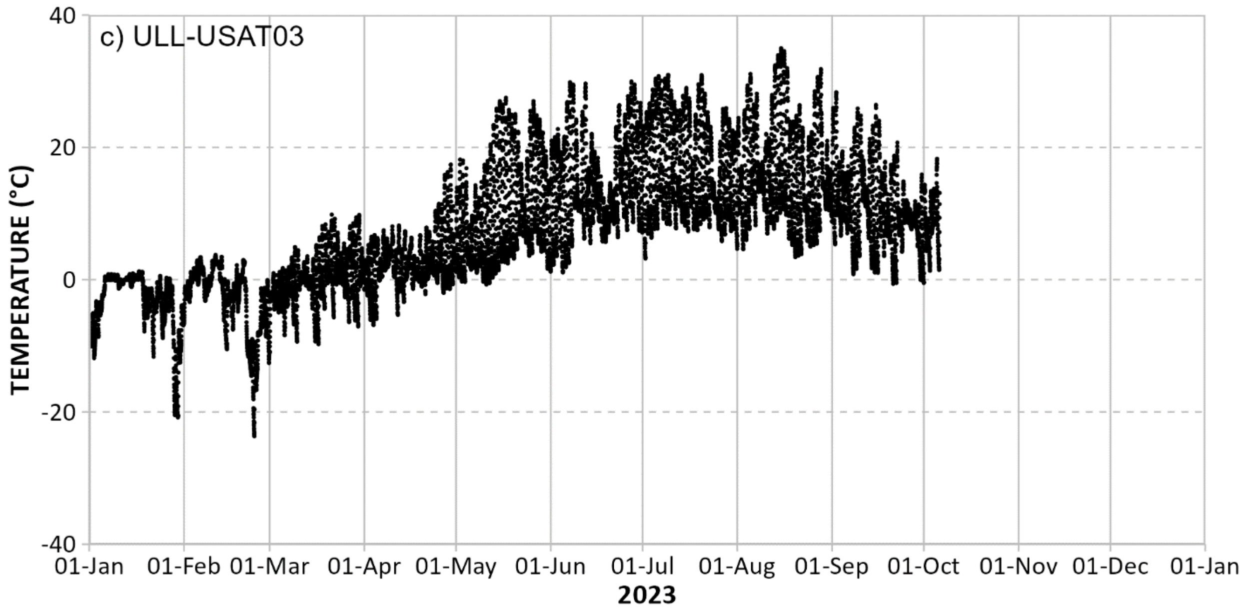
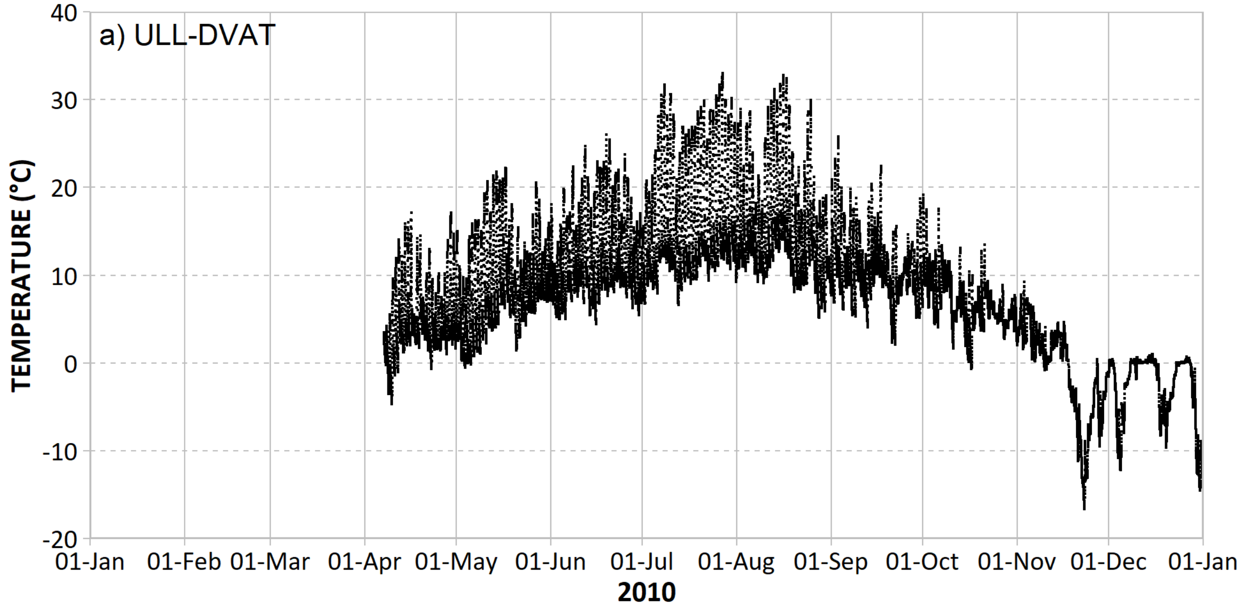


Figure 23. Baseline air temperature at ULL-DVAT from 2010 to 2013. Black dots show air temperature at intervals of 15 minutes.



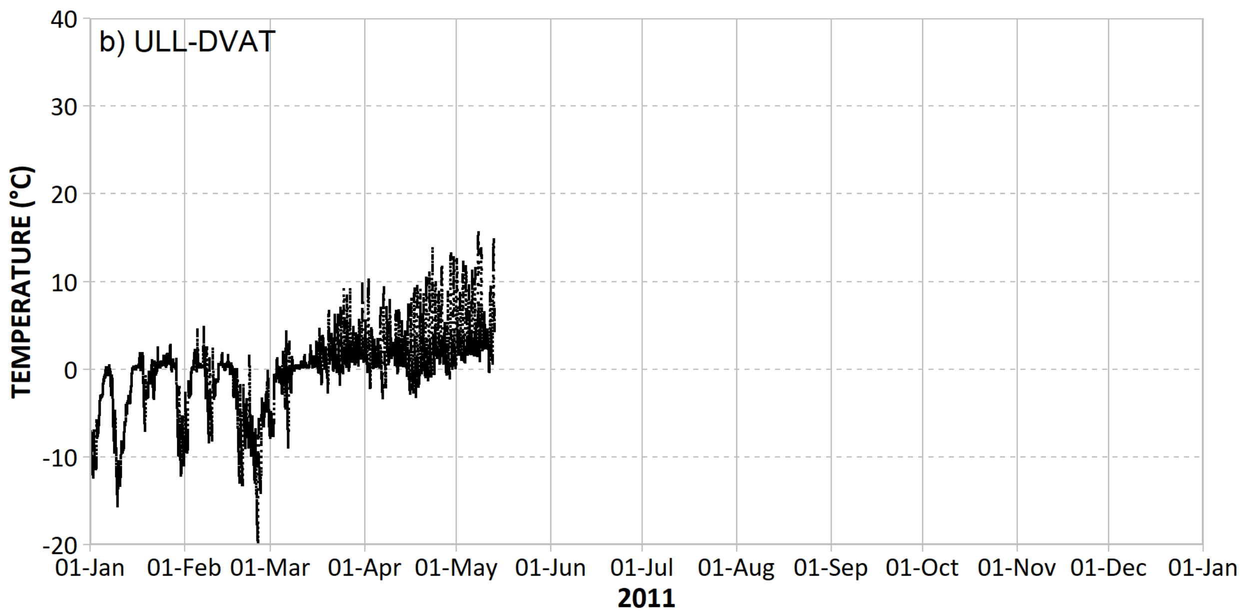
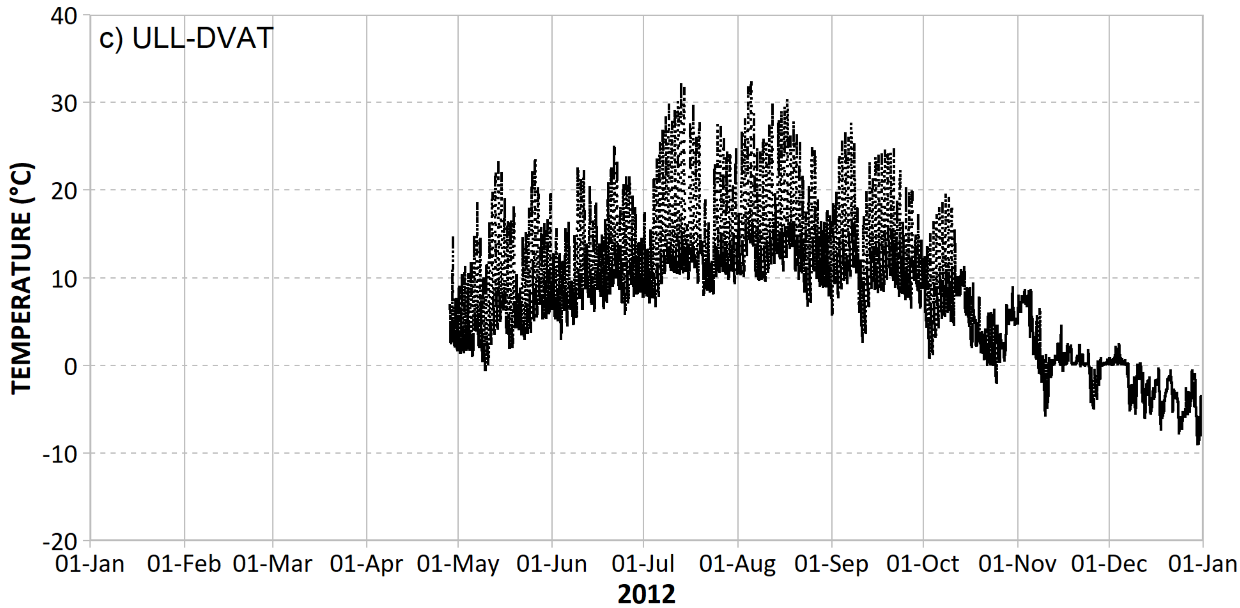


Figure 23. Continued.



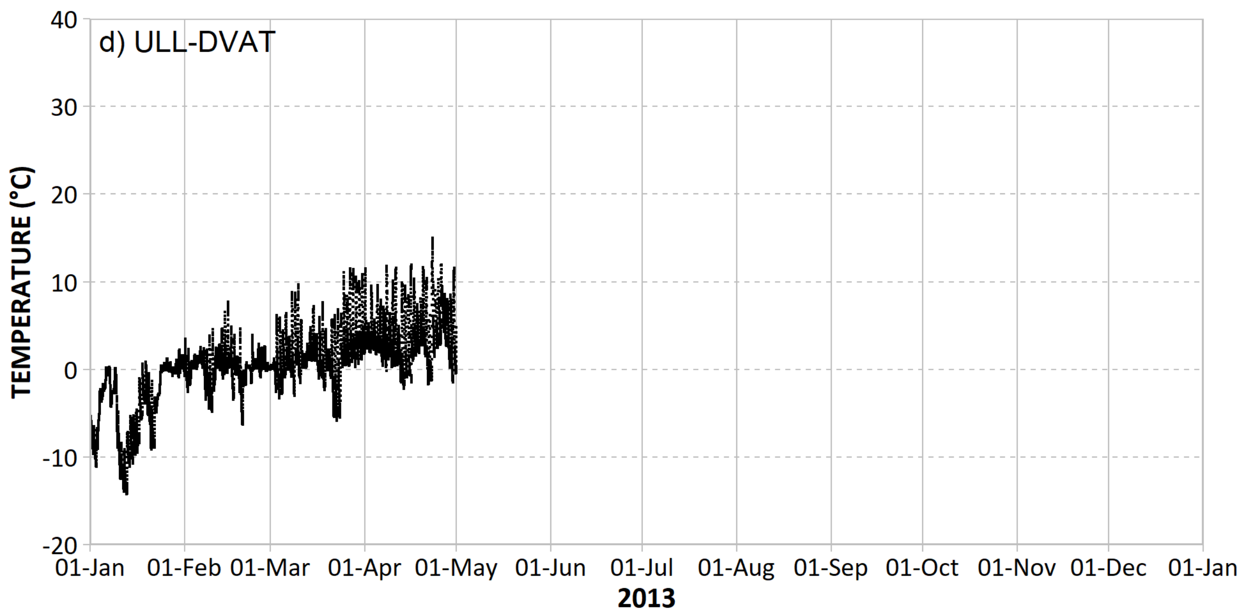


Figure 24. Operational air temperature at ULL-DSAT from 2018 to 2023. Black dots show air temperature at intervals of 15 minutes.

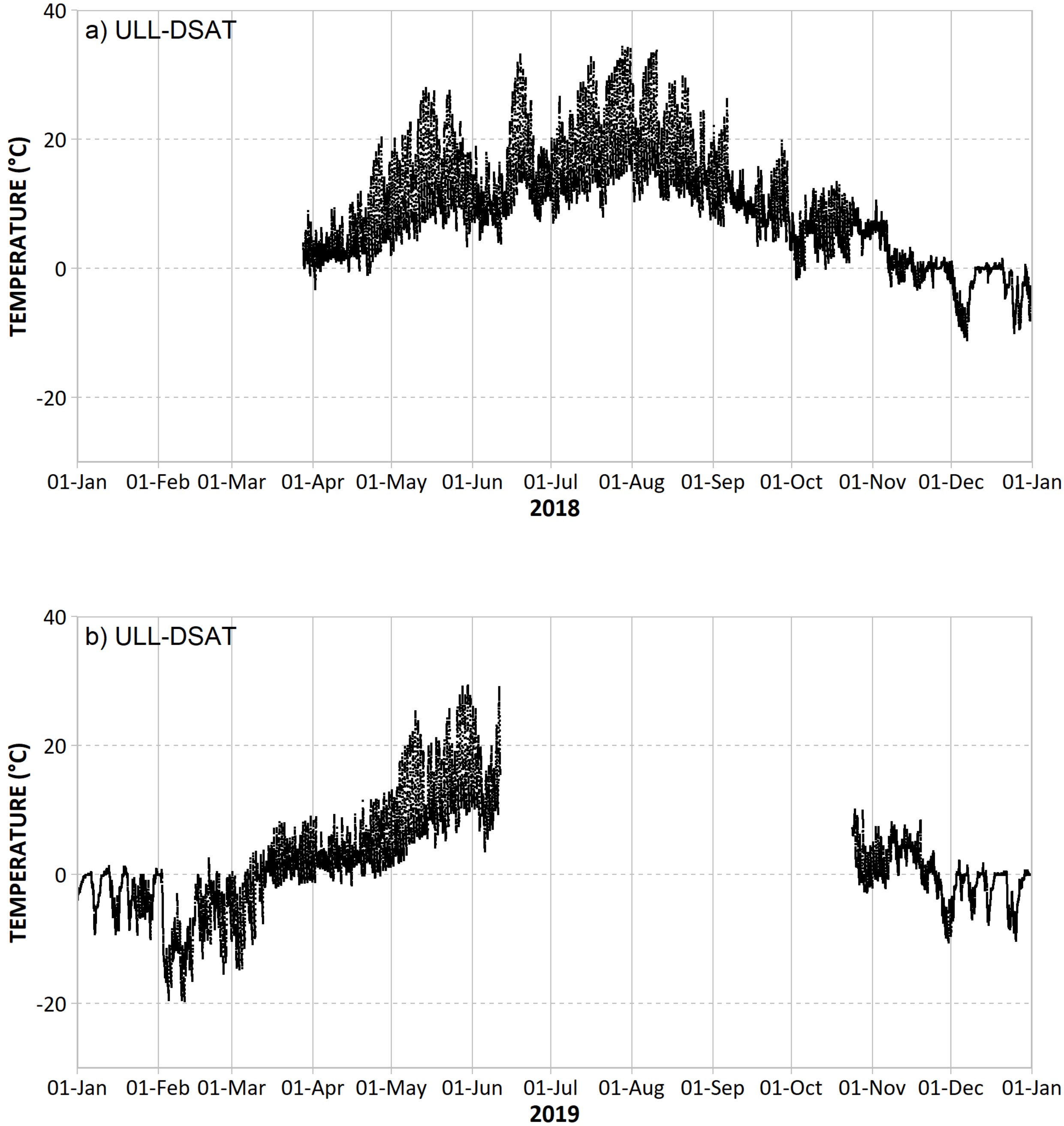
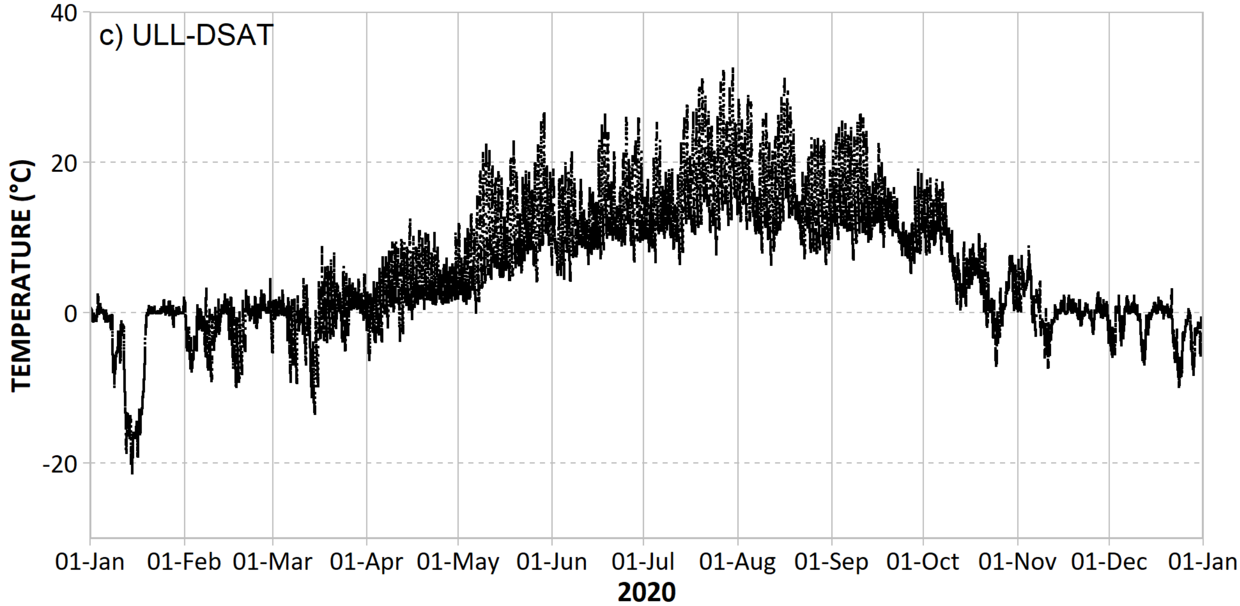


Figure 24. Continued.



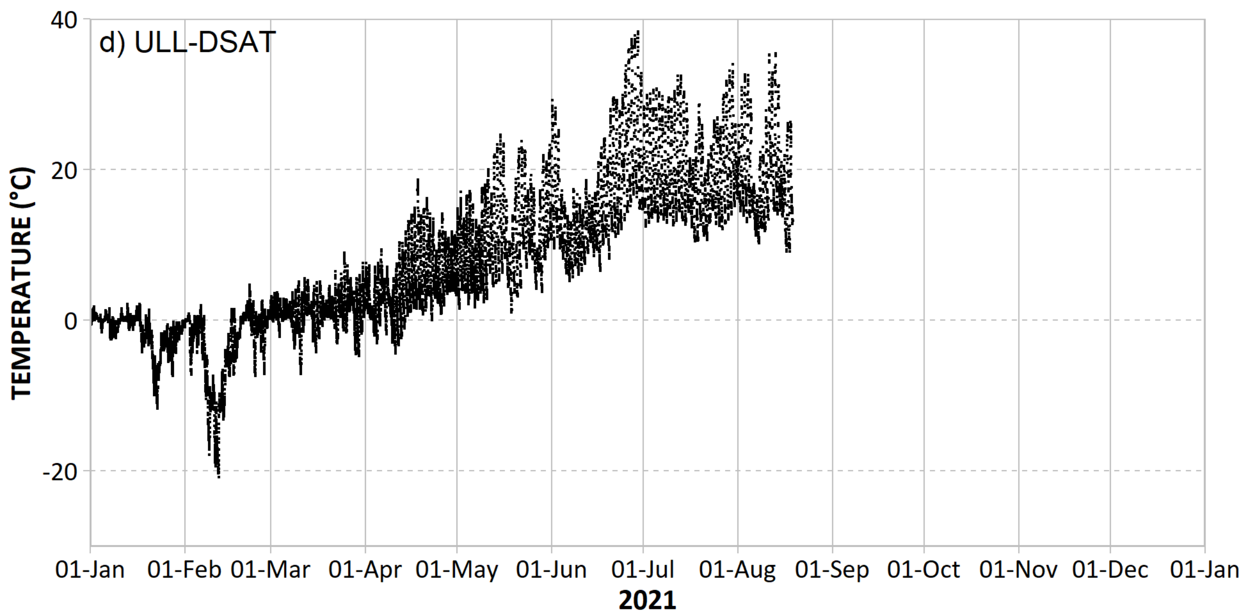
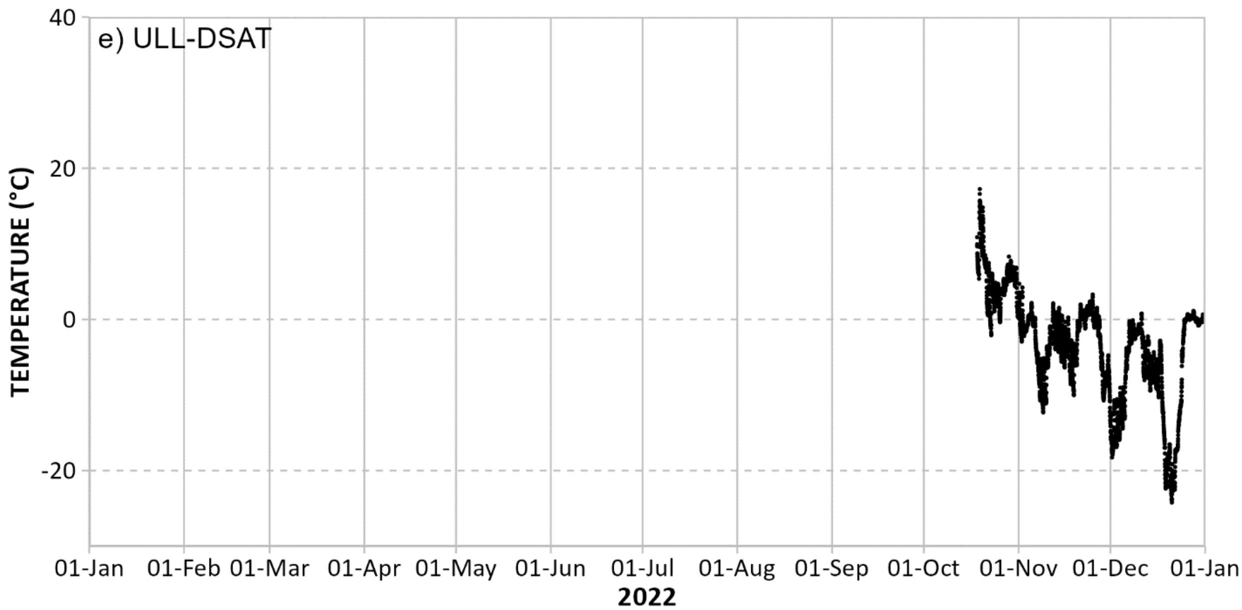
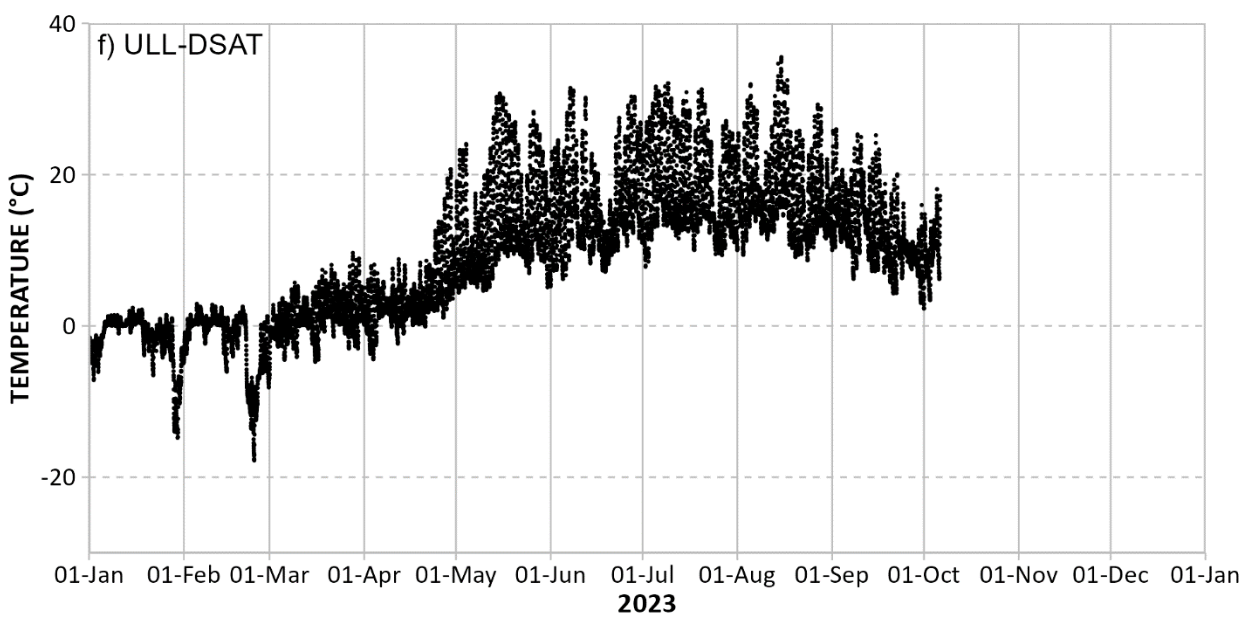


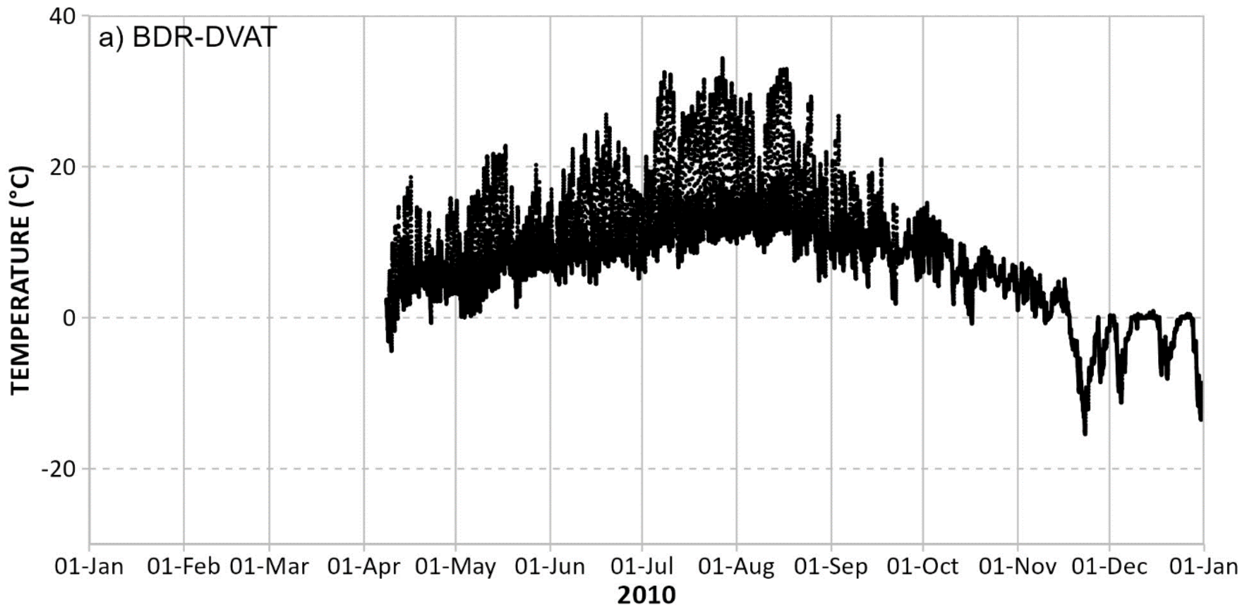
Figure 24. Continued.





3.2. Boulder Creek

Figure 25. Baseline air temperature at BDR-DVAT from 2010 to 2013. Black dots show air temperature at intervals of 15 minutes.



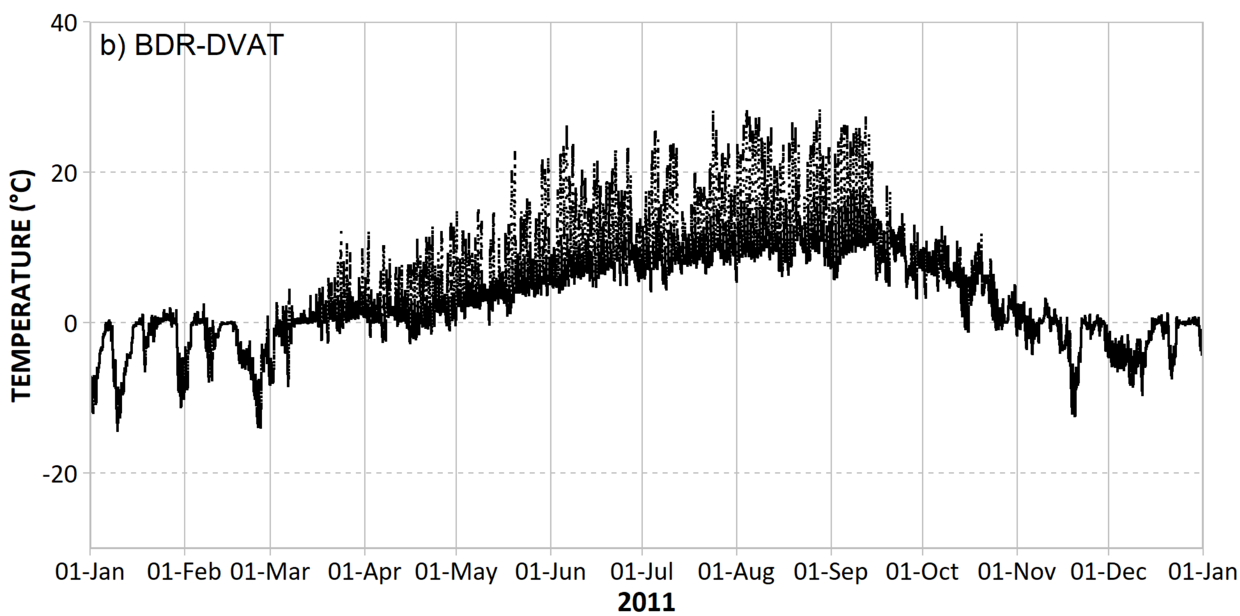
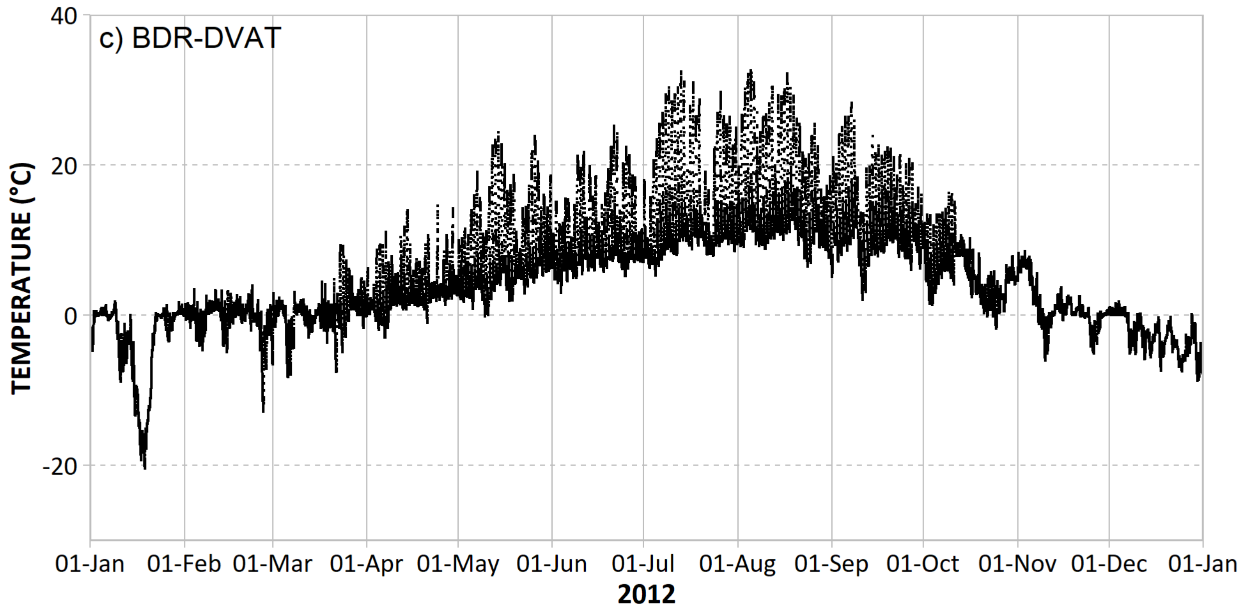


Figure 25. Continued.



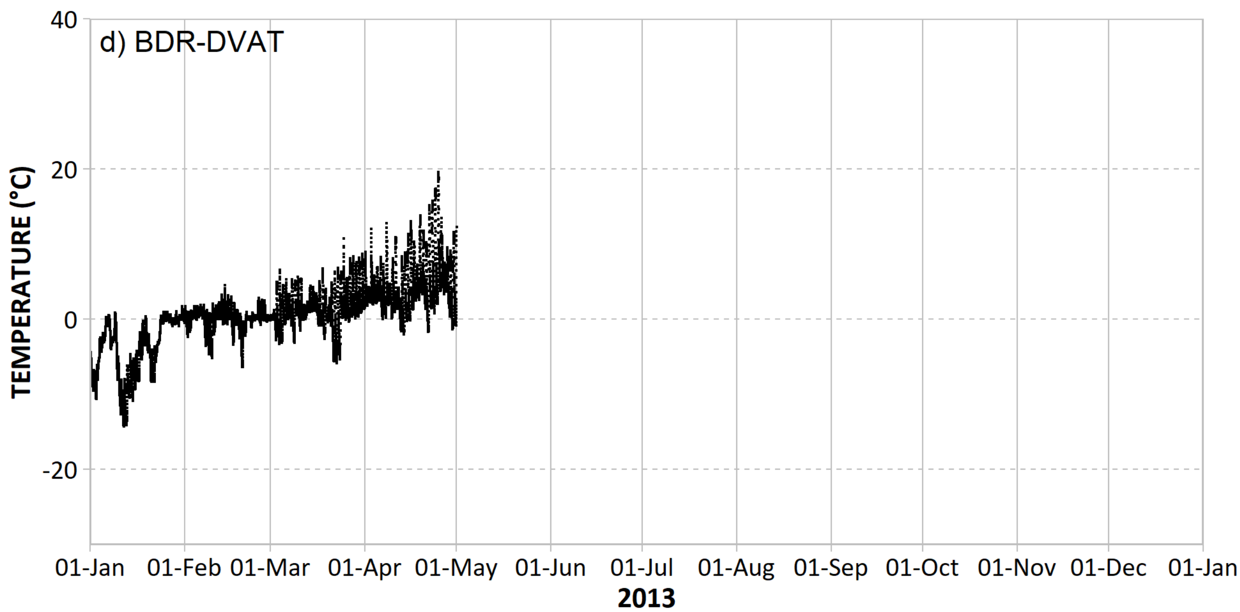
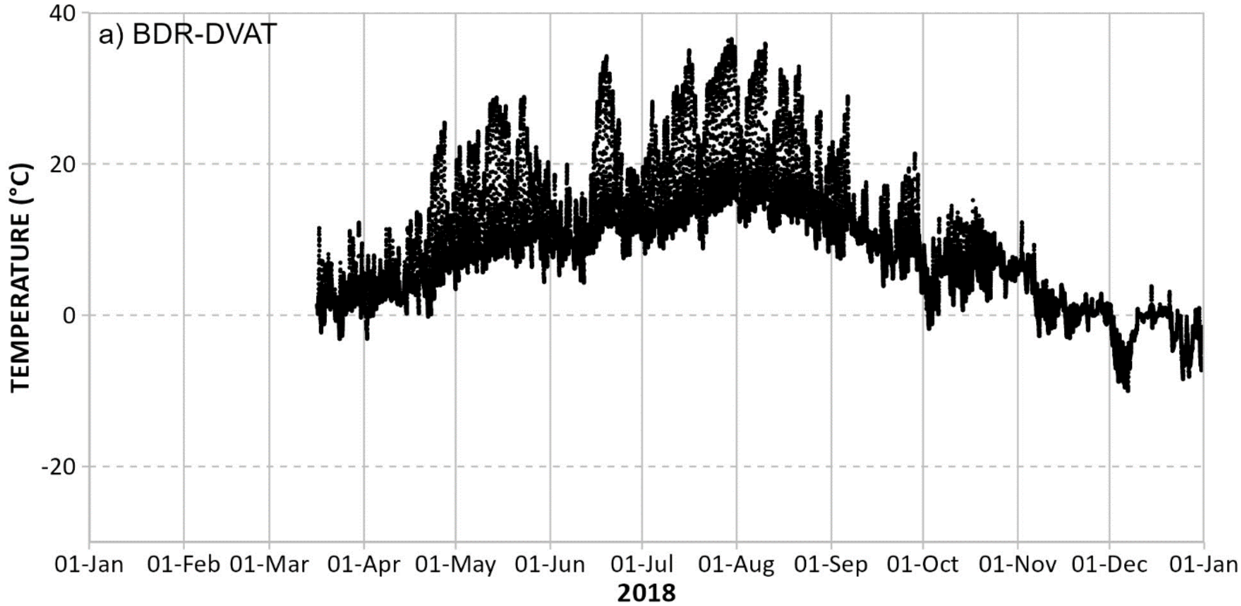


Figure 26. Operational air temperature at BDR-DVAT from 2018 to 2023. Black dots show air temperature at intervals of 15 minutes.



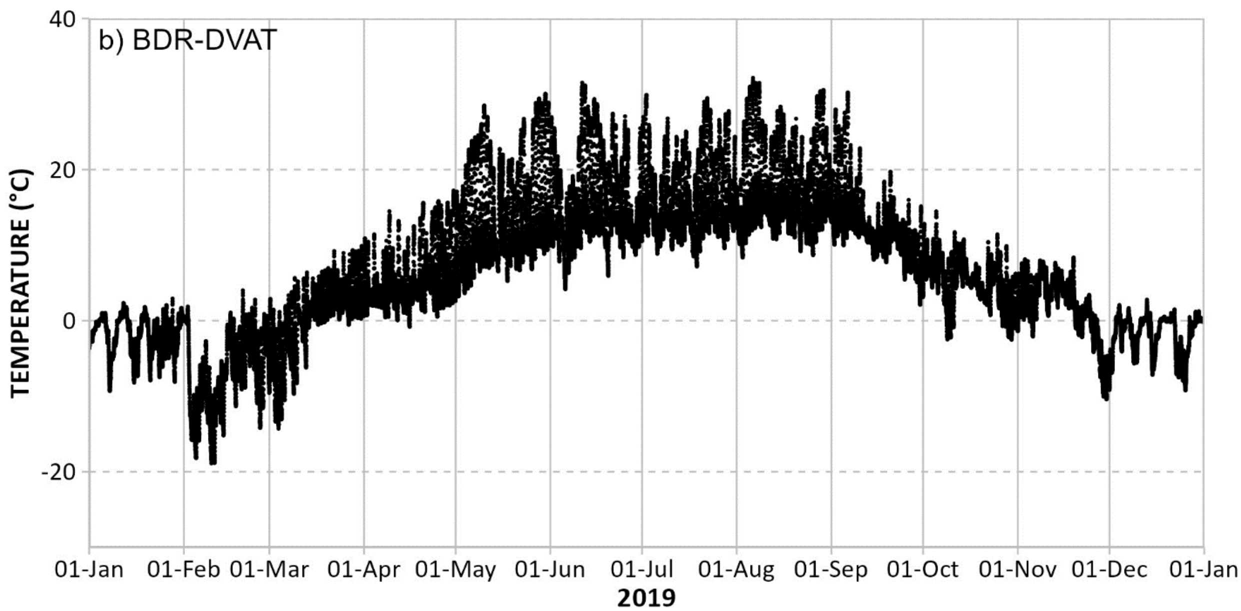
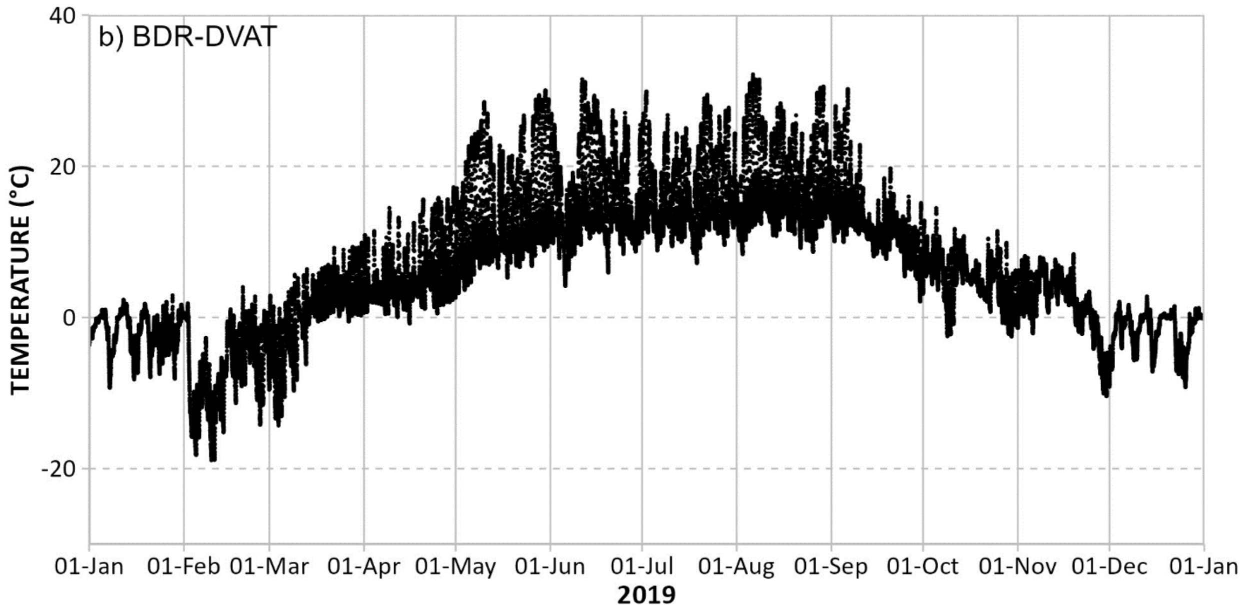


Figure 26. Continued.



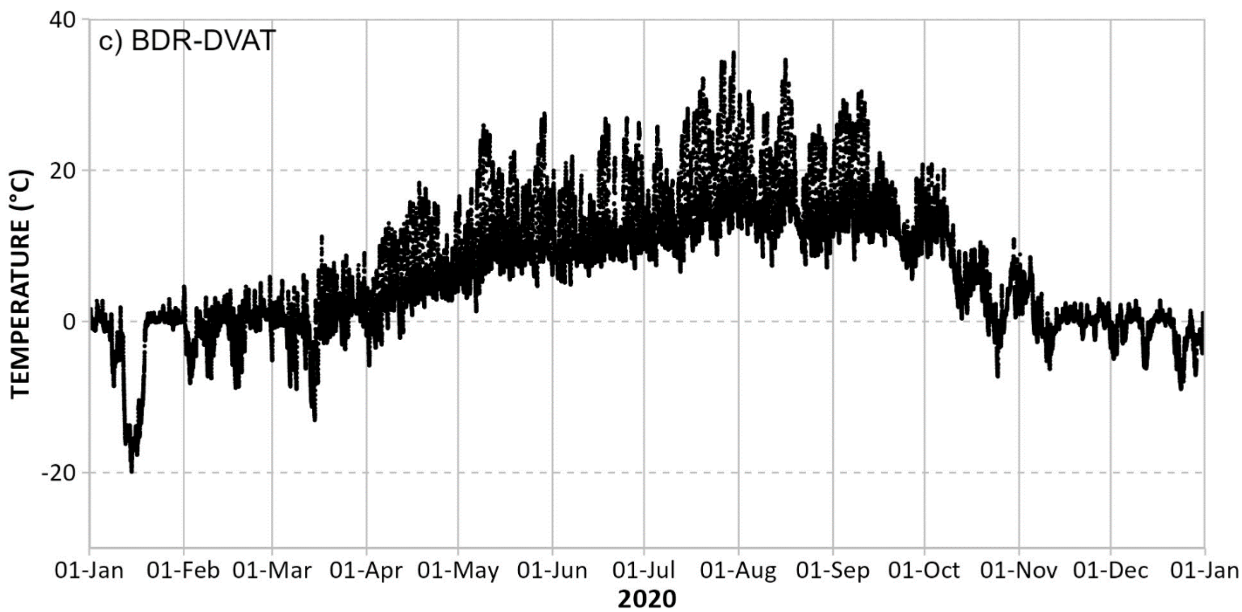
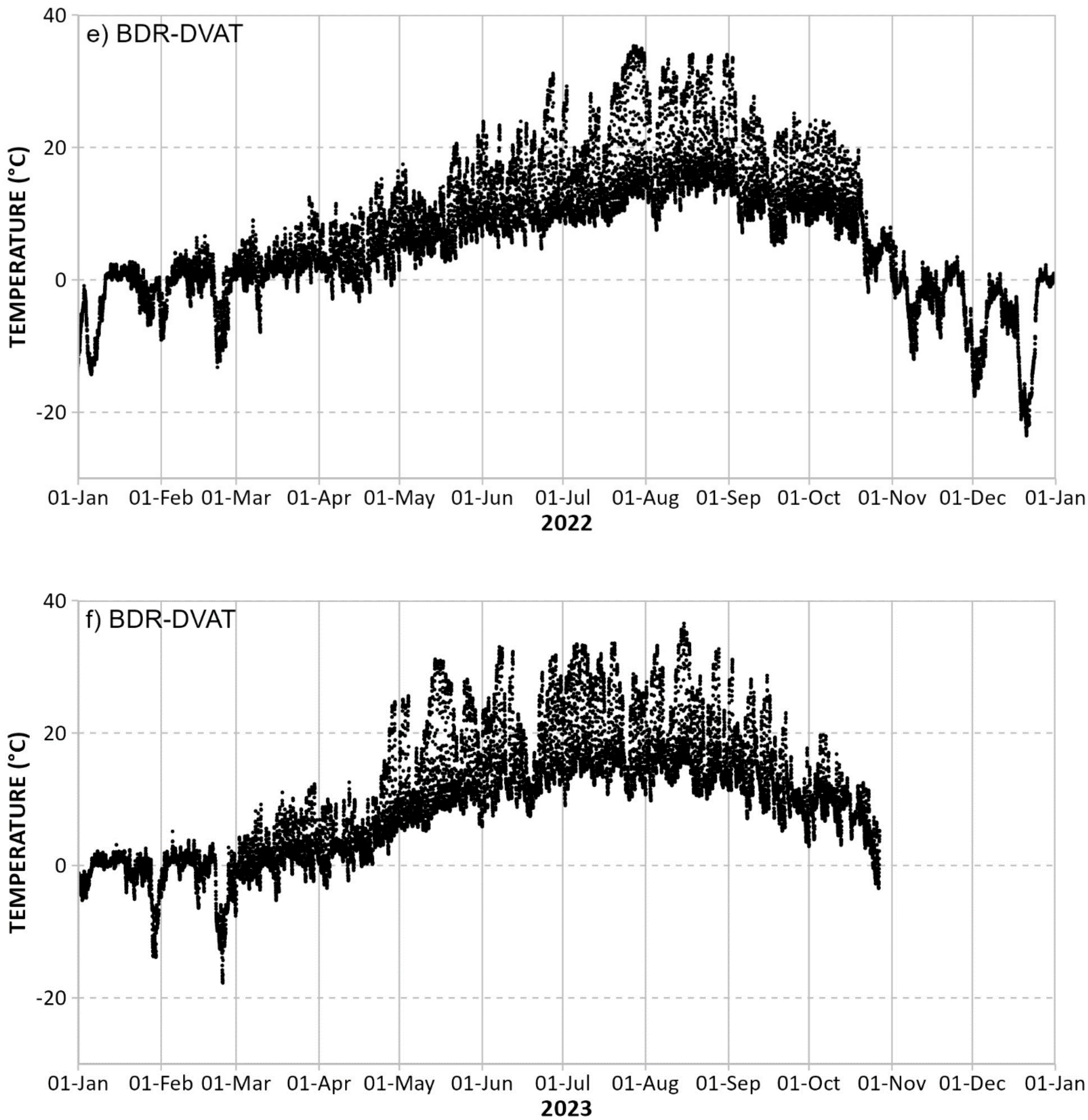


Figure 26. Continued.



4. WATER TEMPERATURE MONTHLY STATISTICS – BASELINE CONDITIONS

4.1. Upper Lillooet River

Table 2. Baseline monthly summary statistics at the upstream (ULL-USWQ1) and diversion (ULL-DVWQ) sites in the Upper Lillooet River from 2008 to 2013.

Year	Month	Water Temperature[1] (°C)							
		ULL-USWQ1				ULL-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2008	Dec	0.7	0.0	2.8	0.6	-	-	-	-
2009	Jan	0.7	0.0	1.6	0.3	-	-	-	-
	Feb	0.9	0.0	3.0	0.6	-	-	-	-
	Mar	1.6	0.0	6.2	1.2	-	-	-	-
	Apr	3.4	0.5	8.1	1.8	-	-	-	-
	May	4.7	1.1	10.1	2.0	-	-	-	-
	Jun	6.2	3.6	10.5	1.7	-	-	-	-
	Jul	7.3	4.1	11.8	1.8	-	-	-	-
	Aug	6.4	3.9	9.9	1.5	-	-	-	-
	Sep	5.6	2.4	9.4	1.3	-	-	-	-
	Oct	3.6	0.6	6.9	1.4	-	-	-	-
	Nov	1.2	0.0	4.0	1.0	-	-	-	-
	Dec	0.4	0.0	1.2	0.3	-	-	-	-
2010	Jan	1.0	0.0	2.8	0.5	-	-	-	-
	Feb	1.8	0.0	4.1	0.7	-	-	-	-
	Mar	2.4	0.0	6.5	1.2	-	-	-	-
	Apr	3.2	0.3	8.0	1.6	-	-	-	-
	May	4.0	0.9	8.5	1.6	-	-	-	-
	Jun	4.9	2.8	8.9	1.4	-	-	-	-
	Jul	6.4	3.7	10.1	1.7	-	-	-	-
	Aug	6.4	3.7	10.1	1.5	-	-	-	-
	Sep	5.7	2.8	9.9	1.2	-	-	-	-
	Oct	4.5	1.7	7.4	1.0	-	-	-	-
	Nov	1.6	0.0	4.6	1.3	-	-	-	-
	Dec	0.7	0.0	1.8	0.4	1.2	0.0	2.4	0.6

[1] Statistics based on continuous data logged at 60 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

Table 2. Continued.

Year	Month	Water Temperature[1] (°C)							
		ULL-USWQ1				ULL-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2011	Jan	0.9	0.0	2.5	0.6	1.3	0.0	3.1	0.9
	Feb	0.8	0.0	2.7	0.6	1.2	0.0	3.3	0.8
	Mar	1.9	0.0	5.7	1.2	-	-	-	-
	Apr	3.2	0.8	7.4	1.6	-	-	-	-
	May	3.1	1.1	7.3	1.2	-	-	-	-
	Jun	4.4	2.2	8.5	1.3	-	-	-	-
	Jul	5.8	3.3	10.0	1.4	-	-	-	-
	Aug	6.8	4.0	10.4	1.6	-	-	-	-
	Sep	6.4	3.9	10.1	1.4	-	-	-	-
	Oct	4.6	0.0	8.5	1.5	-	-	-	-
	Nov	0.9	0.0	3.5	0.7	-	-	-	-
	Dec	0.7	0.0	1.7	0.4	1.1	0.1	2.2	0.5
2012	Jan	0.6	0.0	2.2	0.5	1.1	0.0	2.8	0.7
	Feb	1.4	0.0	3.7	0.7	2.1	0.0	4.0	0.8
	Mar	1.8	0.0	5.7	1.2	2.5	0.1	5.1	1.1
	Apr	2.8	0.5	6.9	1.4	3.4	1.3	7.0	1.3
	May	3.7	1.5	7.7	1.5	4.3	1.9	8.5	1.7
	Jun	4.8	2.6	9.0	1.4	5.4	2.9	9.9	1.5
	Jul	6.2	3.5	10.0	1.6	6.6	3.9	10.4	1.6
	Aug	6.7	4.0	10.7	1.6	6.9	4.2	10.7	1.5
	Sep	6.0	2.7	9.9	1.6	6.2	3.1	9.9	1.5
	Oct	3.9	0.8	7.4	1.3	4.3	1.4	7.7	1.2
	Nov	1.8	0.0	5.6	1.4	2.3	0.0	5.9	1.4
	Dec	0.6	0.0	1.9	0.4	1.1	0.1	2.5	0.5
2013	Jan	0.6	0.0	1.7	0.5	1.0	0.0	2.5	0.7
	Feb	1.4	0.0	3.3	0.8	2.1	0.3	3.6	0.6
	Mar	2.1	0.0	7.0	1.5	2.8	0.4	6.2	1.2
	Apr	3.4	0.0	8.2	1.8	3.9	1.0	8.0	1.5
	May	4.4	1.1	9.5	1.8	-	-	-	-

[1] Statistics based on continuous data logged at 60 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

4.2. Boulder Creek

Table 3. Baseline monthly summary statistics at the upstream (NTH-USWQ1) site in North Creek and upstream (BDR-USWQ) and diversion (BDR-DVWQ) sites in Boulder Creek from 2008 to 2013.

Year	Month	Water Temperature[1] (°C)											
		NTH-USWQ1				BDR-USWQ				BDR-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2008	Nov	-	-	-	-	-	-	-	-	-	-	-	-
	Dec	-	-	-	-	-	-	-	-	0.8	0.0	3.5	0.9
2009	Jan	-	-	-	-	-	-	-	-	1.1	0.0	2.0	0.6
	Feb	-	-	-	-	-	-	-	-	1.2	0.0	2.2	0.6
	Mar	-	-	-	-	-	-	-	-	1.1	0.0	2.3	0.6
	Apr	-	-	-	-	-	-	-	-	2.6	1.4	4.8	0.6
	May	-	-	-	-	-	-	-	-	4.1	2.4	8.5	1.1
	Jun	-	-	-	-	-	-	-	-	6.2	3.6	10.0	1.4
	Jul	-	-	-	-	-	-	-	-	7.9	4.6	11.4	1.6
	Aug	-	-	-	-	-	-	-	-	7.5	5.2	10.7	1.2
	Sep	-	-	-	-	-	-	-	-	6.7	3.3	10.0	1.2
	Oct	-	-	-	-	-	-	-	-	3.7	0.6	6.4	1.4
	Nov	-	-	-	-	-	-	-	-	1.6	0.0	4.0	0.9
	Dec	-	-	-	-	-	-	-	-	0.5	0.0	1.8	0.5
2010	Jan	-	-	-	-	-	-	-	-	1.4	0.0	2.7	0.6
	Feb	-	-	-	-	-	-	-	-	2.1	0.9	3.2	0.4
	Mar	-	-	-	-	-	-	-	-	2.3	0.0	4.2	0.8
	Apr	-	-	-	-	-	-	-	-	3.2	0.5	5.9	0.9
	May	-	-	-	-	2.8	0.8	5.6	0.9	4.2	1.8	7.1	1.0
	Jun	-	-	-	-	3.6	2.1	7.4	1.1	5.1	3.4	8.9	1.1
	Jul	-	-	-	-	5.5	2.9	9.4	1.6	7.0	4.3	11.0	1.6
	Aug	-	-	-	-	6.0	3.1	9.7	1.4	7.5	4.6	11.1	1.4
	Sep	-	-	-	-	5.2	2.2	9.2	1.2	6.7	3.5	10.7	1.2
	Oct	4.9	3.3	7.7	0.9	4.7	2.8	6.8	0.6	4.7	2.1	7.2	1.0
	Nov	1.7	0.0	4.7	1.3	2.0	0.0	4.3	1.4	1.8	0.0	4.8	1.5
	Dec	1.4	0.0	2.3	0.5	1.4	0.0	2.3	0.5	1.1	0.0	2.0	0.6

[1] Statistics based on continuous data logged at 15 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

Table 3. Continued.

Year	Month	Water Temperature[1] (°C)											
		NTH-USWQ1				BDR-USWQ				BDR-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2011	Jan	1.4	0.0	2.7	0.7	1.4	0.0	2.7	0.7	0.8	0.0	2.4	0.8
	Feb	1.2	0.0	2.5	0.6	1.2	0.0	2.5	0.6	0.7	0.0	2.3	0.7
	Mar	2.0	0.1	3.7	0.5	2.0	0.1	3.7	0.5	1.7	0.0	3.2	0.6
	Apr	2.5	1.2	4.9	0.7	2.5	1.2	4.9	0.7	2.6	1.5	4.5	0.5
	May	2.8	1.8	4.8	0.5	2.7	1.3	5.2	0.7	3.3	2.4	6.1	0.6
	Jun	2.8	1.6	4.8	0.5	2.9	1.2	3.9	0.5	4.1	2.3	6.9	0.7
	Jul	3.7	2.5	6.2	0.7	4.1	2.2	7.6	1.0	5.5	3.3	9.0	1.1
	Aug	5.0	2.9	8.2	1.1	5.4	3.0	8.8	1.2	6.8	4.1	10.0	1.3
	Sep	5.6	3.3	8.5	1.1	5.2	3.0	8.4	1.1	6.6	3.9	10.1	1.3
	Oct	3.3	0.2	5.9	1.2	3.6	0.2	6.0	1.2	4.2	0.7	7.1	1.5
	Nov	0.9	0.0	2.5	0.6	0.9	0.0	2.5	0.6	0.8	0.0	2.5	0.7
	Dec	1.2	0.0	2.3	0.5	1.2	0.0	2.3	0.5	0.9	0.0	2.0	0.5
2012	Jan	1.0	0.0	2.4	0.7	1.0	0.0	2.3	0.7	0.6	0.0	1.7	0.5
	Feb	1.7	0.0	2.9	0.6	1.7	0.0	2.9	0.6	1.5	0.0	2.3	0.5
	Mar	1.7	0.0	3.4	0.7	1.7	0.0	3.4	0.7	1.5	0.0	2.6	0.5
	Apr	2.5	0.9	5.0	0.7	2.7	0.9	5.0	0.7	2.6	1.4	4.4	0.5
	May	2.8	1.8	4.9	0.6	3.0	0.7	4.7	0.9	3.7	2.3	6.2	0.7
	Jun	3.2	2.1	5.7	0.6	2.9	0.4	5.1	0.7	4.3	2.2	6.7	0.8
	Jul	4.4	2.8	7.4	1.0	4.7	1.2	8.4	1.3	6.3	3.2	9.8	1.4
	Aug	6.2	4.1	9.5	1.3	6.0	3.8	9.5	1.4	7.6	5.3	10.7	1.3
	Sep	6.1	2.6	9.6	1.3	5.9	2.6	9.2	1.3	7.0	3.6	10.2	1.3
	Oct	3.5	0.6	6.7	1.4	3.5	0.6	6.7	1.4	4.4	1.3	8.1	1.6
	Nov	1.8	0.1	4.7	1.1	1.8	0.1	4.4	1.1	2.3	0.5	5.4	1.3
	Dec	0.9	0.1	2.2	0.4	0.9	0.1	2.2	0.4	0.8	0.1	2.2	0.5
2013	Jan	1.0	0.0	2.2	0.6	1.0	0.0	2.2	0.6	0.7	0.0	1.9	0.5
	Feb	1.5	0.1	2.6	0.5	1.5	0.1	2.6	0.5	1.4	0.3	2.1	0.4
	Mar	1.6	0.1	3.4	0.6	1.6	0.1	3.4	0.6	1.7	0.2	3.5	0.7
	Apr	2.6	0.9	5.4	0.7	2.6	0.9	5.4	0.7	3.2	1.7	5.4	0.6
	May	-	-	-	-	-	-	-	-	4.5	1.8	7.3	1.1

[1] Statistics based on continuous data logged at 15 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

5. AIR TEMPERATURE MONTHLY STATISTICS

5.1. Baseline Conditions

Table 4. Upper Lillooet River baseline (2010 to 2013) air temperature monthly data summary statistics.

Year	Month	Air Temperature[1] (°C)							
		ULL-USAT				ULL-DVAT			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2010	Apr	2.6	-7.6	13.4	4.0	4.8	-4.7	17.1	4.0
	May	5.2	-3.3	17.0	4.8	8.9	-0.5	22.3	5.1
	Jun	10.4	0.5	24.4	5.5	12.2	4.4	26.0	4.8
	Jul	15.3	3.1	30.8	7.7	16.7	6.6	33.0	6.6
	Aug	13.9	0.8	31.2	7.0	15.3	5.1	32.8	5.8
	Sep	9.2	-1.4	24.2	4.4	10.6	2.1	25.8	3.7
	Oct	5.1	-3.6	16.0	3.3	6.8	-0.7	19.1	2.9
	Nov	-3.3	-19.9	5.6	6.0	-1.3	-16.7	9.3	5.3
	Dec	-4.9	-22.1	0.6	5.9	-2.7	-14.5	1.0	3.8
2011	Jan	-5.9	-23.8	2.0	6.4	-3.5	-15.6	2.8	4.4
	Feb	-5.8	-20.6	1.6	5.1	-3.7	-19.7	4.8	4.6
	Mar	-	-	-	-	0.5	-8.9	9.8	2.7
	Apr	1.3	-6.0	15.5	3.7	2.7	-3.3	13.8	3.2
	May	3.7	-3.5	15.1	3.8	-	-	-	-
	Jun	7.7	-0.5	21.2	5.4	-	-	-	-
	Jul	11.8	0.8	27.5	5.3	-	-	-	-
	Aug	13.1	1.9	26.5	6.5	-	-	-	-
	Sep	10.1	-0.2	27.7	5.7	-	-	-	-
	Oct	3.4	-4.5	12.6	3.5	-	-	-	-
	Nov	-3.5	-19.5	3.6	4.1	-	-	-	-
	Dec	-6.2	-17.6	0.1	4.9	-	-	-	-
2012	Jan	-5.6	-25.0	1.3	6.5	-	-	-	-
	Feb	-2.2	-10.3	0.6	2.5	-	-	-	-
	Mar	-1.4	-13.2	9.8	3.3	-	-	-	-
	Apr	2.3	-6.5	12.3	3.2	-	-	-	-
	May	5.0	-2.8	17.7	4.8	8.2	-0.5	23.4	5.2
	Jun	9.4	-0.2	24.1	5.2	11.3	3.0	24.9	4.3
	Jul	14.4	2.6	30.5	6.8	14.8	6.8	32.1	5.8
	Aug	14.5	2.3	32.3	7.2	15.6	6.8	32.3	5.4
	Sep	10.3	-1.1	27.8	6.4	12.8	2.7	27.6	4.7
	Oct	4.0	-4.6	17.8	4.1	6.0	-2.0	19.4	3.9
	Nov	-0.4	-10.7	7.6	3.9	1.2	-5.7	8.6	3.1
	Dec	-5.4	-16.4	1.5	3.9	-2.9	-9.0	2.4	2.5
2013	Jan	-7.8	-21.5	1.0	6.2	-4.4	-14.2	2.3	4.2
	Feb	-2.1	-13.0	2.6	2.9	0.1	-6.3	7.7	1.8
	Mar	-0.2	-10.4	11.2	3.7	1.6	-5.9	11.5	3.0
	Apr	2.9	-5.2	12.6	3.6	4.0	-2.2	15.0	3.2

[1] Statistics based on data logged at 30-minute intervals and were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

Table 5. Boulder Creek baseline (2010 to 2013) air temperature monthly data summary statistics.

Year	Month	Air Temperature[1] (°C)			
		BDR-DVAT			
		Avg	Min	Max	SD
2010	May	8.8	0.1	22.8	5.0
	Jun	11.7	4.4	26.9	5.0
	Jul	16.5	6.1	34.4	7.1
	Aug	15.4	4.9	32.9	6.1
	Sep	10.2	1.9	26.7	3.6
	Oct	6.5	-0.8	15.2	2.5
	Nov	-1.1	-15.4	7.2	5.0
	Dec	-2.6	-13.5	0.9	3.5
2011	Jan	-3.5	-14.4	1.9	4.1
	Feb	-3.3	-14.0	2.4	3.5
	Mar	0.4	-8.4	12.1	2.8
	Apr	2.5	-2.7	13.1	3.1
	May	6.2	-0.3	22.7	4.3
	Jun	10.8	4.0	26.1	4.9
	Jul	11.9	4.2	28.0	4.8
	Aug	13.9	5.5	28.2	5.4
	Sep	11.4	3.3	27.3	4.6
	Oct	4.9	-1.2	12.7	3.0
	Nov	-1.4	-12.4	3.1	2.9
	Dec	-2.6	-9.6	1.2	2.5
2012	Jan	-3.8	-20.4	1.8	5.6
	Feb	-0.6	-12.8	3.9	2.3
	Mar	-0.1	-8.3	9.3	2.4
	Apr	3.1	-2.9	14.6	2.7
	May	8.5	-0.1	24.3	5.2
	Jun	10.5	3.0	25.2	4.5
	Jul	14.1	5.3	32.4	6.3
	Aug	15.4	6.5	32.6	5.9
	Sep	12.4	2.1	28.2	4.6
	Oct	5.7	-1.8	16.2	3.4
	Nov	1.0	-6.0	8.5	3.0
	Dec	-2.9	-8.8	1.8	2.4
2013	Jan	-4.2	-14.2	1.7	3.9
	Feb	-0.1	-6.4	4.5	1.5
	Mar	1.2	-5.9	10.8	2.5
	Apr	4.6	-2.0	19.6	3.7
	May	-	-	-	-

[1] Statistics based on data logged at 30-minute intervals and were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

5.2. Operational Monitoring

Table 6. Upper Lillooet River operational (2018 to 2023) air temperature monthly data summary statistics.

Year	Month	Air Temperature[1] (°C)															
		ULL-USAT01				ULL-USAT02				ULL-USAT03				ULL-DSAT			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2018	Mar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Apr	3.8	-6.5	20.0	4.7	-	-	-	-	-	-	-	-	4.5	-3.2	20.2	4.0
	May	9.8	-1.7	27.2	7.2	-	-	-	-	-	-	-	-	13.0	2.1	27.9	5.7
	Jun	12.0	0.2	32.1	6.3	-	-	-	-	-	-	-	-	13.4	3.9	33.1	5.6
	Jul	15.9	3.7	32.7	7.1	-	-	-	-	-	-	-	-	18.5	7.1	34.3	6.1
	Aug	14.7	3.0	31.6	6.8	-	-	-	-	-	-	-	-	17.5	7.6	33.7	5.4
	Sep	9.2	-0.1	27.0	4.9	-	-	-	-	-	-	-	-	10.5	2.9	26.3	3.7
	Oct	4.3	-4.3	19.5	4.9	-	-	-	-	-	-	-	-	5.5	-1.6	13.4	2.9
	Nov	-0.6	-8.8	11.5	3.7	-	-	-	-	-	-	-	-	1.1	-3.3	10.5	2.7
	Dec	-5.8	-18.5	1.6	5.7	-	-	-	-	-	-	-	-	-3.0	-11.1	1.5	3.2
2019	Jan	-	-	-	-	-	-	-	-	-	-	-	-	-2.8	-10.0	1.3	2.7
	Feb	-	-	-	-	-	-	-	-	-	-	-	-	-8.2	-19.7	2.5	5.2
	Mar	-	-	-	-	-	-	-	-	-	-	-	-	-0.9	-14.7	9.0	4.6
	Apr	-	-	-	-	-	-	-	-	-	-	-	-	3.4	-1.7	12.7	2.9
	May	-	-	-	-	-	-	-	-	-	-	-	-	12.3	1.2	29.3	6.1
	Jun	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nov	-	-	-	-	-0.9	-16.3	9.2	5.0	-	-	-	-	1.1	-10.5	8.4	3.8
	Dec	-	-	-	-	-4.3	-18.7	2.3	4.9	-	-	-	-	-2.2	-10.2	2.1	2.8
2020	Jan	-	-	-	-	-	-	-	-	-	-	-	-	-3.9	-21.3	2.4	6.1
	Feb	-	-	-	-	-	-	-	-	-	-	-	-	-1.8	-9.9	4.5	2.8
	Mar	-	-	-	-	-	-	-	-	-	-	-	-	-0.8	-13.4	8.7	3.6
	Apr	-	-	-	-	-	-	-	-	-	-	-	-	3.0	-6.3	12.4	3.2
	May	-	-	-	-	-	-	-	-	-	-	-	-	10.2	0.0	26.5	5.3
	Jun	-	-	-	-	-	-	-	-	-	-	-	-	12.9	4.2	26.3	4.4
	Jul	-	-	-	-	-	-	-	-	-	-	-	-	16.3	6.5	32.4	5.4
	Aug	-	-	-	-	-	-	-	-	-	-	-	-	15.6	6.4	31.1	5.0
	Sep	-	-	-	-	-	-	-	-	-	-	-	-	13.6	5.3	26.3	4.2
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	5.8	-7.0	17.8	4.9
	Nov	-	-	-	-	-0.9	-12.7	8.1	2.9	-	-	-	-	0.4	-7.3	8.8	2.3
	Dec	-	-	-	-	-4.2	-16.7	1.1	4.6	-	-	-	-	-1.8	-9.8	3.1	2.6

[1] Statistics based on data logged at 30-minute intervals and were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in red.

Table 6. Continued.

Year	Month	Air Temperature[1] (°C)															
		ULL-USAT01				ULL-USAT02				ULL-USAT03				ULL-DSAT			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2021	Jan	-	-	-	-	-	-	-	-	-	-	-	-	-1.6	-11.7	2.2	2.4
	Feb	-	-	-	-	-	-	-	-	-	-	-	-	-3.9	-20.8	4.7	5.2
	Mar	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-7.1	8.9	2.2
	Apr	-	-	-	-	3.3	-9.0	23.0	6.3	-	-	-	-	4.6	-4.4	18.7	4.2
	May	-	-	-	-	-	-	-	-	-	-	-	-	10.0	1.0	24.6	5.2
	Jun	-	-	-	-	-	-	-	-	-	-	-	-	16.3	5.2	38.3	7.1
	Jul	-	-	-	-	-	-	-	-	-	-	-	-	19.5	10.5	34.0	5.4
	Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nov	-	-	-	-	-	-	-	-	-0.8	-11.6	3.3	2.4	-	-	-	-
	Dec	-	-	-	-	-	-	-	-	-9.5	-30.3	1.0	7.6	-	-	-	-
2022	Jan	-	-	-	-	-	-	-	-	-5.5	-19.9	2.1	5.4	-	-	-	-
	Feb	-	-	-	-	-	-	-	-	-3.7	-18.2	5.8	5.1	-	-	-	-
	Mar	-	-	-	-	-	-	-	-	0.7	-12.8	10.5	3.0	-	-	-	-
	Apr	-	-	-	-	-	-	-	-	1.7	-7.2	11.2	3.5	-	-	-	-
	May	-	-	-	-	-	-	-	-	5.3	-2.6	19.0	4.4	-	-	-	-
	Jun	-	-	-	-	-	-	-	-	11.4	0.8	29.2	5.8	-	-	-	-
	Jul	-	-	-	-	-	-	-	-	15.9	5.0	33.4	7.0	-	-	-	-
	Aug	-	-	-	-	-	-	-	-	17.2	4.5	32.6	7.0	-	-	-	-
	Sep	-	-	-	-	-	-	-	-	11.7	-0.1	30.4	6.2	-	-	-	-
	Oct	-	-	-	-	-	-	-	-	6.5	-5.4	23.4	5.9	-	-	-	-
	Nov	-	-	-	-	-	-	-	-	-5.2	-19.0	3.5	5.0	-2.8	-12.3	4.7	3.5
	Dec	-	-	-	-	-	-	-	-	-10.4	-31.3	0.5	8.4	-7.7	-24.2	1.1	7.0
2023	Jan	-	-	-	-	-	-	-	-	-3.4	-20.8	1.3	4.5	-1.8	-14.8	2.4	3.2
	Feb	-	-	-	-	-	-	-	-	-3.1	-23.7	3.7	5.1	-2.1	-17.8	2.9	4.0
	Mar	-	-	-	-	-	-	-	-	-0.3	-12.6	9.8	3.8	1.0	-8.1	9.7	2.6
	Apr	-	-	-	-	-	-	-	-	2.4	-6.8	17.4	3.6	3.6	-4.4	20.7	3.8
	May	-	-	-	-	-	-	-	-	10.1	-0.7	27.5	7.3	14.0	4.4	30.7	6.2
	Jun	-	-	-	-	-	-	-	-	14.6	1.1	30.0	6.7	15.9	5.2	31.5	5.7
	Jul	-	-	-	-	-	-	-	-	17.0	3.2	31.0	6.9	18.5	7.8	32.1	5.6
	Aug	-	-	-	-	-	-	-	-	16.3	3.4	35.0	7.2	17.7	8.7	35.5	5.3
	Sep	-	-	-	-	-	-	-	-	11.0	-0.6	28.3	5.6	12.5	3.0	26.0	4.4
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Statistics based on data logged at 30-minute intervals and were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in red.

Table 7. Boulder Creek operational (2018 to 2023) air temperature data summary statistics.

Year	Month	Air Temperature[1] (°C)			
		BDR-DVAT			
		Avg	Min	Max	SD
2018	Apr	5.6	-3.1	25.5	4.7
	May	13.7	3.5	28.8	6.1
	Jun	13.6	4.3	34.2	5.8
	Jul	18.8	8.1	36.5	7.1
	Aug	18.3	8.4	35.9	6.1
	Sep	11.1	3.0	28.9	4.1
	Oct	6.0	-1.8	15.2	2.8
	Nov	1.6	-3.0	12.3	2.6
	Dec	-2.5	-10.0	3.8	2.9
2019	Jan	-2.0	-9.3	2.9	2.4
	Feb	-7.2	-18.9	4.0	5.1
	Mar	0.1	-14.3	9.9	4.5
	Apr	5.3	-0.8	17.2	3.8
	May	13.8	2.6	30.0	6.4
	Jun	15.6	4.2	31.5	5.7
	Jul	16.2	7.2	29.9	5.0
	Aug	17.1	8.4	32.2	5.4
	Sep	12.3	2.1	30.2	4.3
	Oct	4.8	-2.5	14.5	3.0
	Nov	1.5	-10.4	8.4	3.9
	Dec	-1.9	-9.2	2.8	2.5
2020	Jan	-3.6	-19.9	3.0	6.1
	Feb	-1.1	-8.8	5.9	2.8
	Mar	-0.1	-13.1	11.2	3.7
	Apr	5.1	-5.8	18.3	4.4
	May	11.8	1.3	27.5	5.4
	Jun	12.5	4.9	26.9	4.9
	Jul	16.4	6.6	35.6	6.1
	Aug	16.5	7.1	34.6	5.6
	Sep	14.3	5.6	30.4	4.8
	Oct	6.2	-7.3	20.8	5.1
	Nov	0.6	-6.3	8.9	2.3
	Dec	-1.4	-8.9	2.8	2.4

[1] Statistics based on continuous data logged at 15 minute intervals until 2021-10-05 9:15 PST, then at 30 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site are shaded in red.

Table 7. Continued.

Year	Month	Air Temperature[1] (°C)			
		BDR-DVAT			
		Avg	Min	Max	SD
2021	Jan	-1.2	-10.7	5.2	2.3
	Feb	-3.4	-19.8	6.3	5.0
	Mar	1.6	-7.4	11.2	2.6
	Apr	6.3	-4.0	21.2	5.1
	May	11.6	1.3	25.6	5.5
	Jun	15.6	4.8	38.8	7.4
	Jul	20.2	10.5	36.1	6.3
	Aug	17.3	8.5	36.3	5.9
	Sep	11.5	0.4	27.6	4.1
	Oct	-	-	-	-
	Nov	-	-	-	-
	Dec	-	-	-	-
2022	Jan	-	-	-	-
	Feb	-	-	-	-
	Mar	-	-	-	-
	Apr	-	-	-	-
	May	-	-	-	-
	Jun	-	-	-	-
	Jul	-	-	-	-
	Aug	-	-	-	-
	Sep	-	-	-	-
	Oct	-	-	-	-
	Nov	-2.4	-12.0	5.8	3.6
	Dec	-7.3	-23.5	2.3	6.8
2023	Jan	-1.5	-13.9	3.1	3.0
	Feb	-1.8	-17.7	5.2	4.0
	Mar	1.6	-7.6	12.3	3.1
	Apr	4.7	-3.4	24.7	4.5
	May	14.3	5.2	31.2	6.7
	Jun	16.7	5.9	33.0	6.2
	Jul	19.8	9.1	33.6	6.2
	Aug	18.6	9.8	36.6	6.0
	Sep	13.5	3.6	31.1	5.0
	Oct	8.0	-3.5	19.7	3.9

[1] Statistics based on continuous data logged at 15 minute intervals until 2021-10-05 9:15 PST, then at 30 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site are shaded in red.

6. DAILY WATER TEMPERATURE SUMMARY FIGURES - BASELINE

Figure 27. Daily mean water temperature collected during baseline monitoring in the Upper Lillooet River (2008 to 2013).

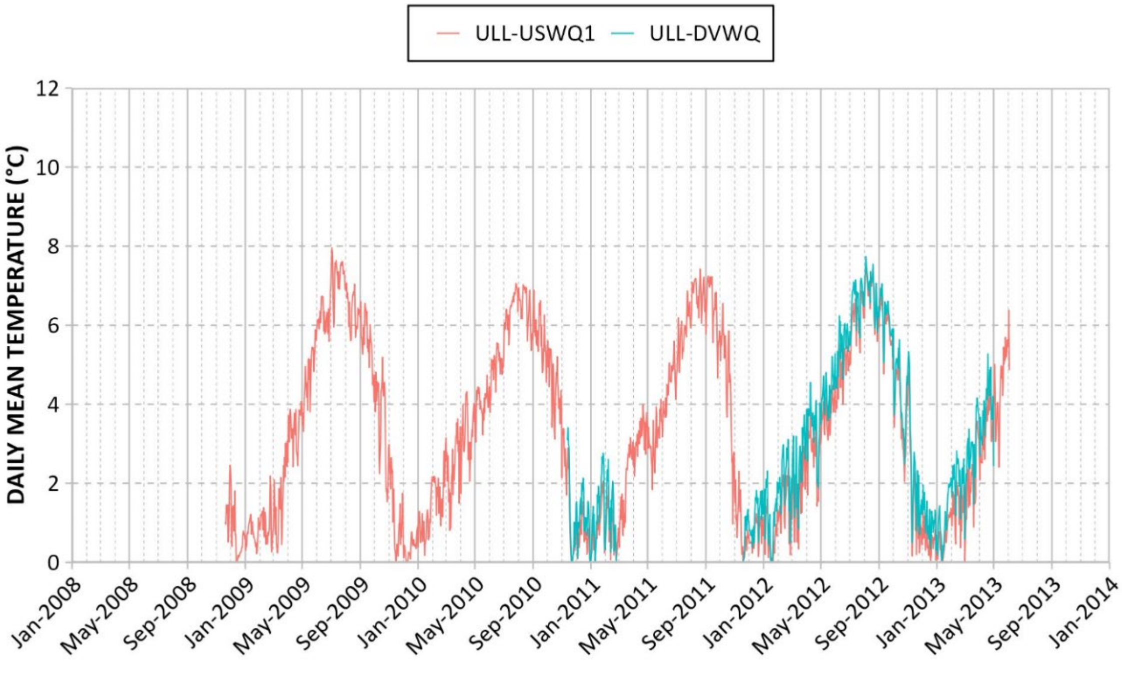
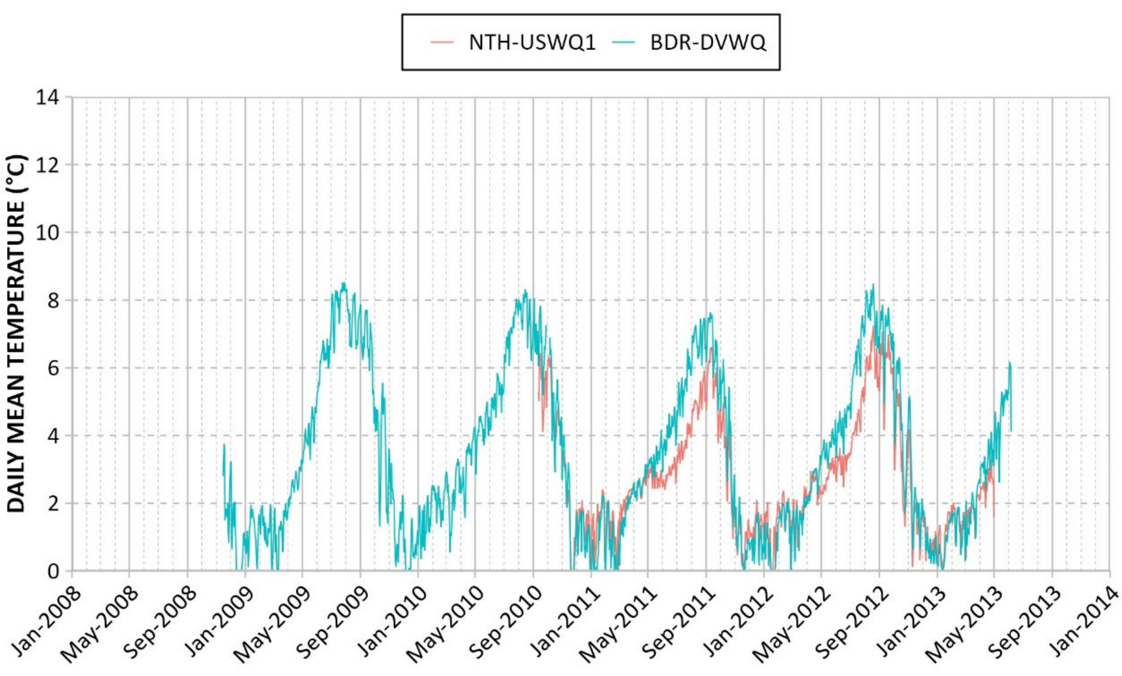


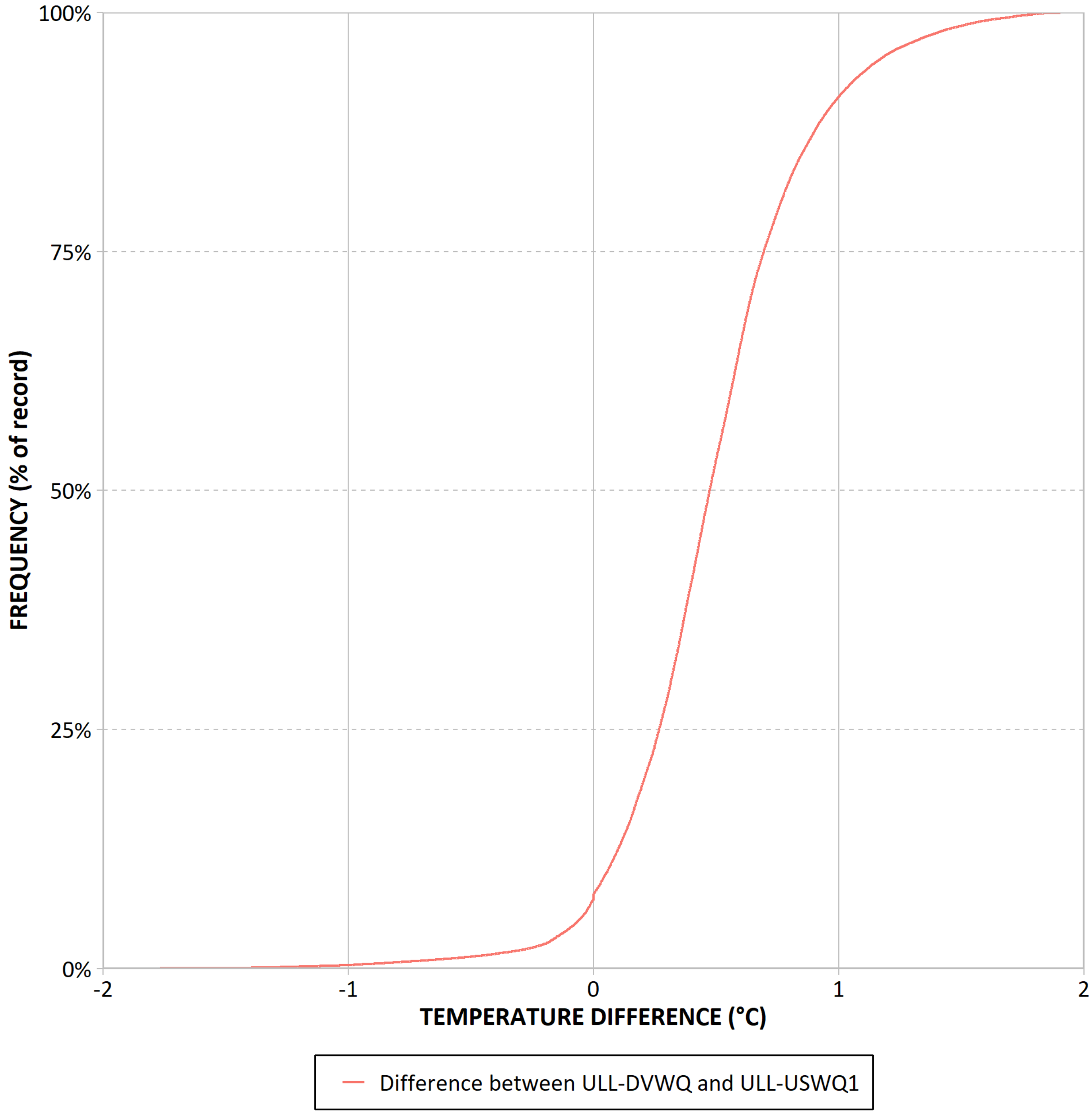
Figure 28. Daily mean water temperature collected during baseline monitoring in Boulder Creek and North Creek (2008 to 2013).



7. INTER-SITE COMPARISON – BASELINE CONDITIONS

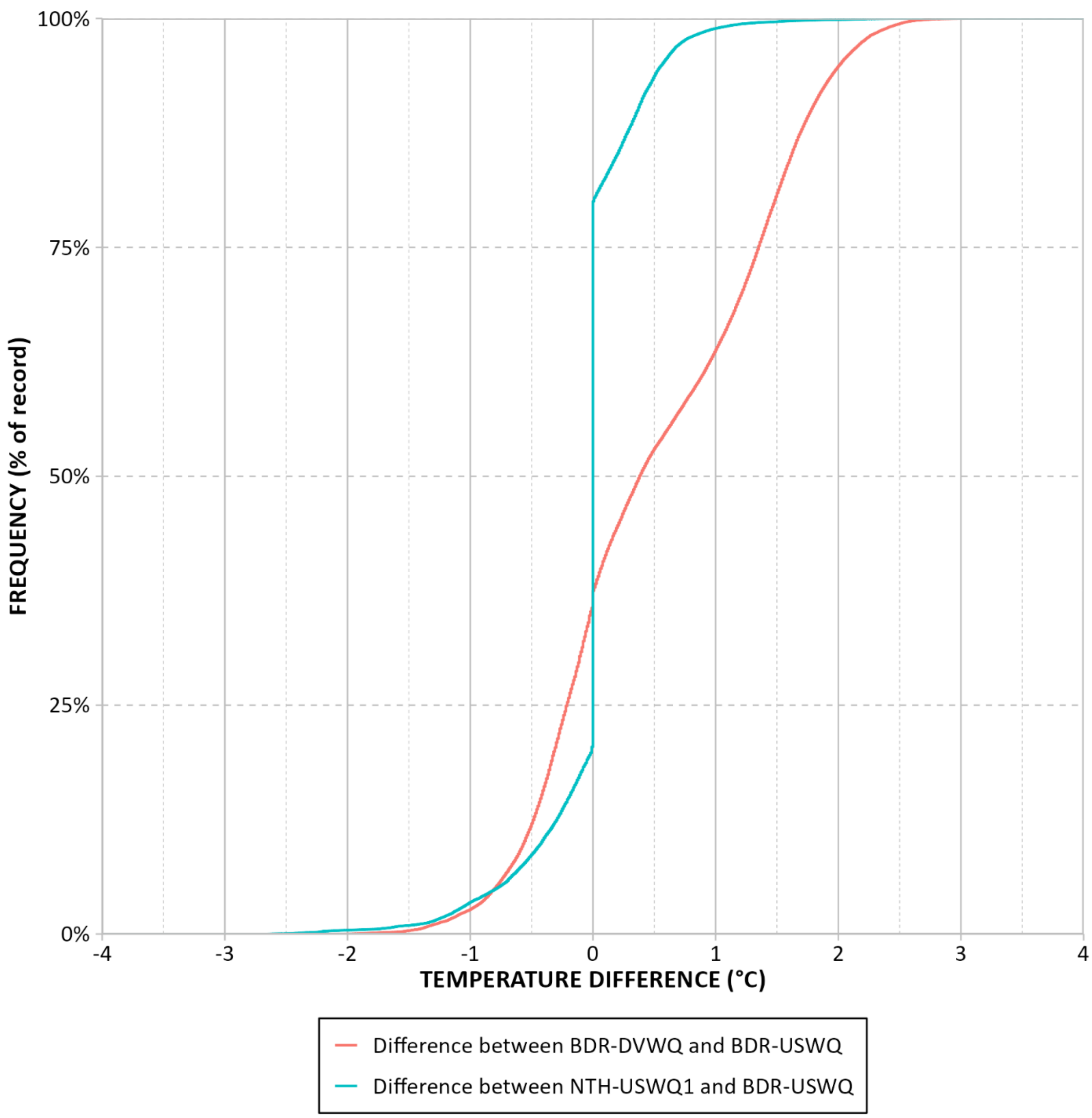
7.1. Upper Lillooet River

Figure 29. Cumulative frequency distribution of differences in baseline instantaneous water temperature between the diversion (ULL-DVWQ) and upstream control (ULL-USWQ1) site in the Upper Lillooet River. Positive values denote that impact sites were warmer than upstream sites and vice versa.



7.2. Boulder Creek

Figure 30. Cumulative frequency distribution of differences in baseline instantaneous water temperature between the upstream control site on Boulder Creek (BDR-USWQ) and the North Creek upstream site (NTH-USWQ1) and the Boulder Creek diversion site (BDR-DVWQ). Positive values denote that impact sites were warmer than upstream sites and vice versa.



8. INTER-SITE COMPARISON – OPERATIONAL MONITORING

Figure 31. Cumulative frequency distribution of instantaneous water temperature differences between control and impact Upper Lillooet River sites and ULL-USWQ04 (the upstream control site established in Year 4) during operations (2021 to 2023). Positive values denote that water temperature at the site of interest was warmer than the upstream control site (ULL-USWQ04).

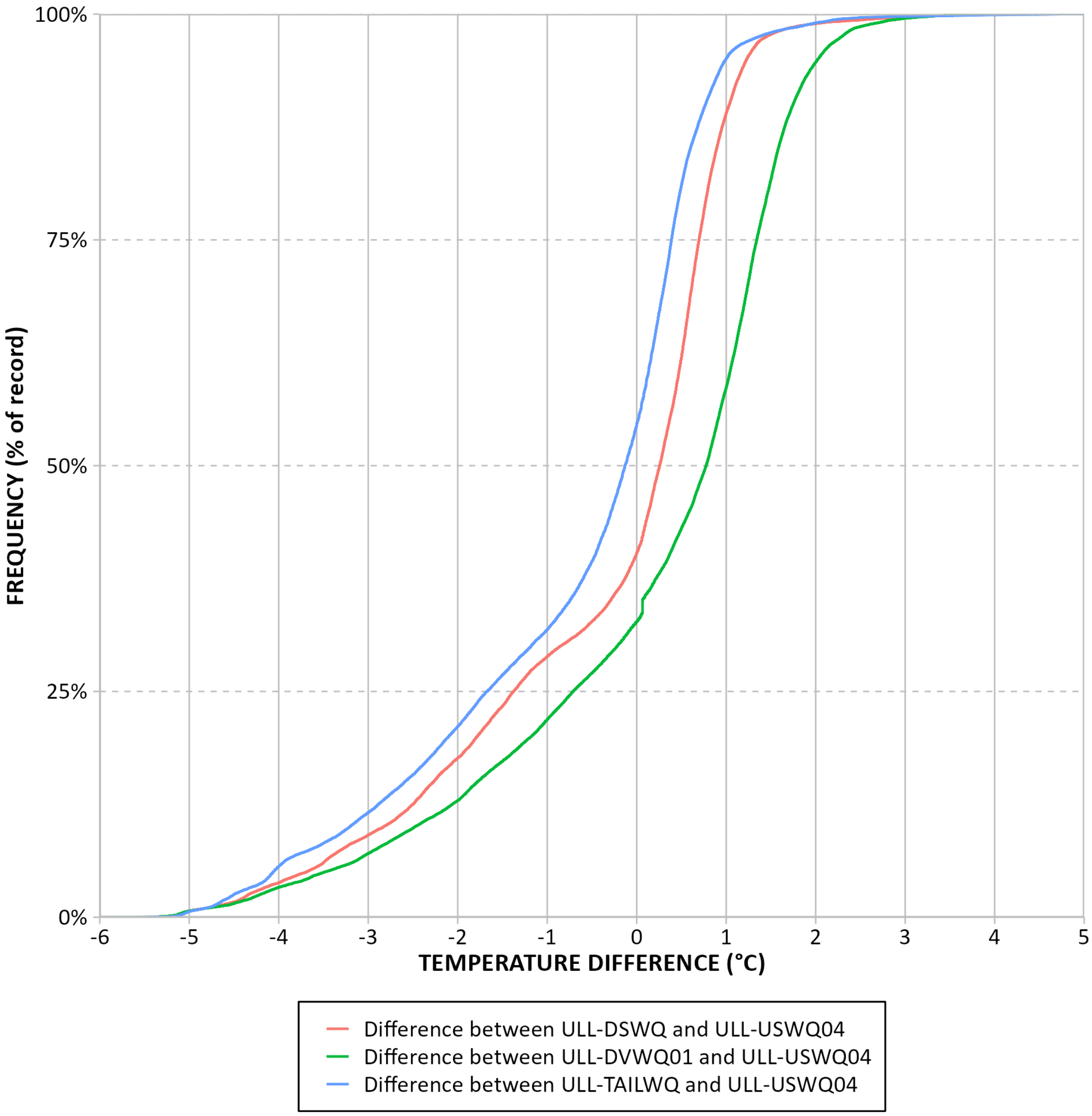
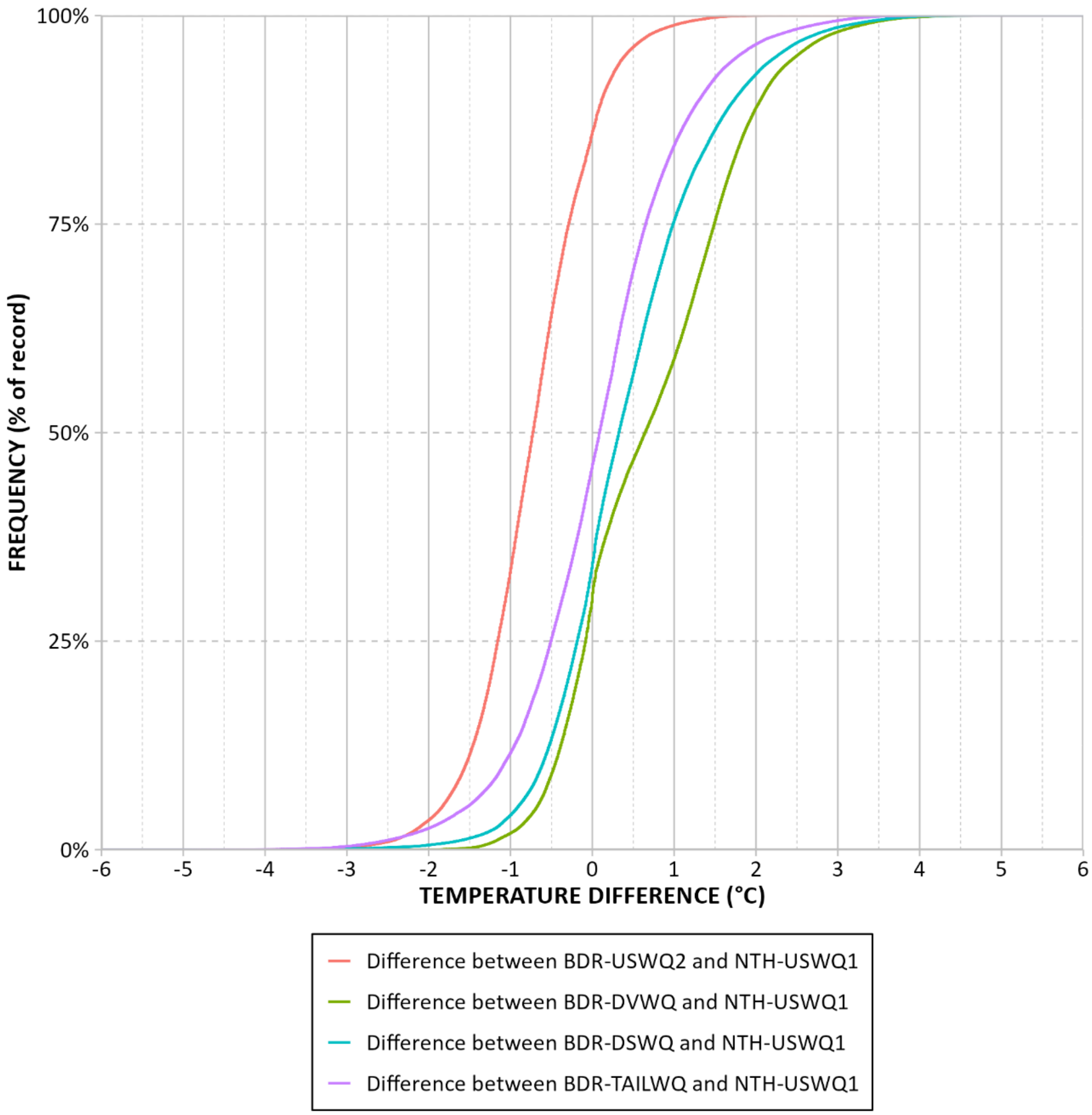


Figure 32. Cumulative frequency distribution of instantaneous water temperature differences between the control and impact Boulder Creek monitoring sites and NTH-USWQ1 during operations (2019 to 2023). Positive values denote that the site of interest was warmer than the upstream control site (NTH-USWQ1).

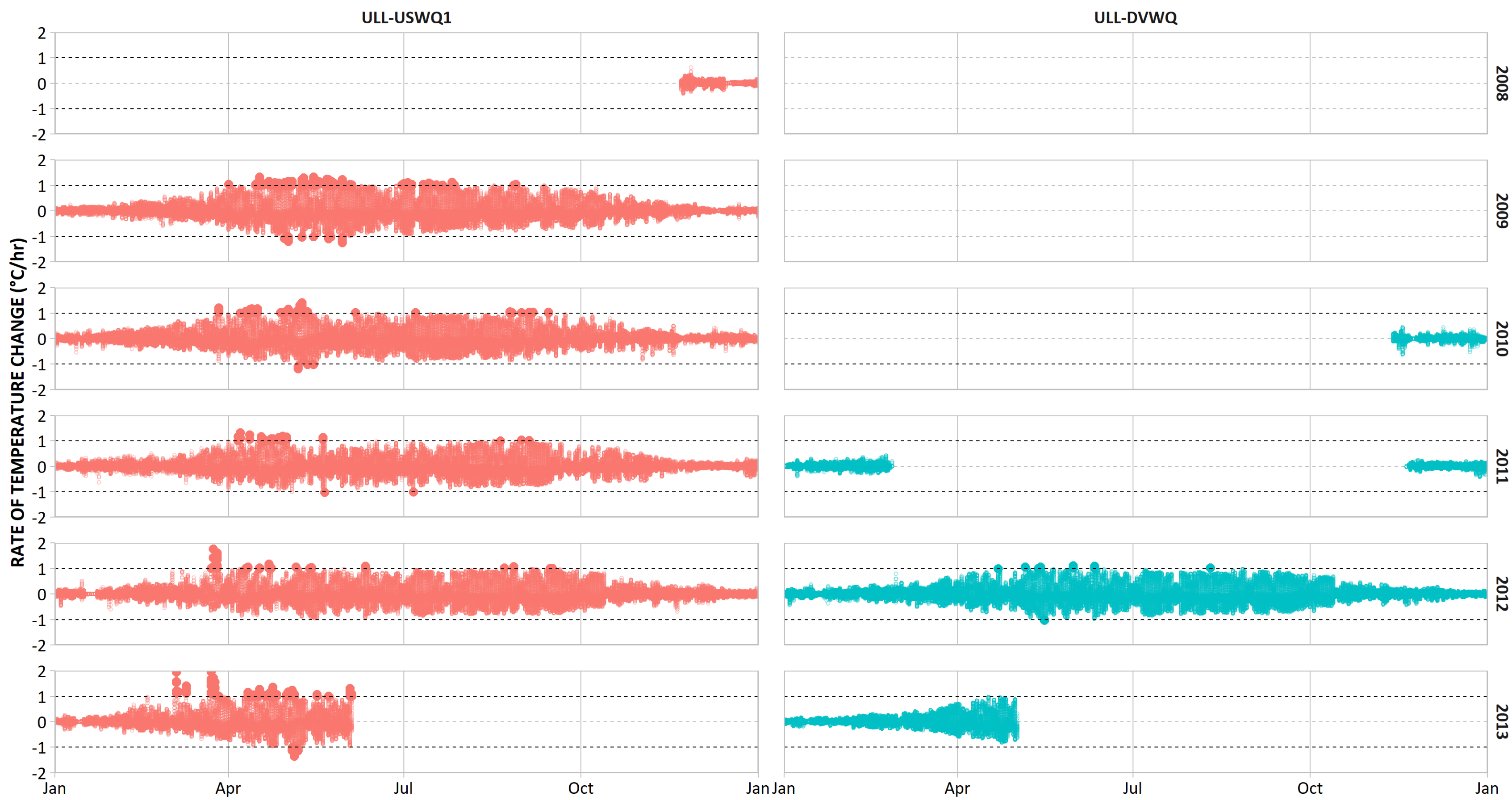


9. HOURLY RATE OF WATER TEMPERATURE CHANGE

9.1. Upper Lillooet River

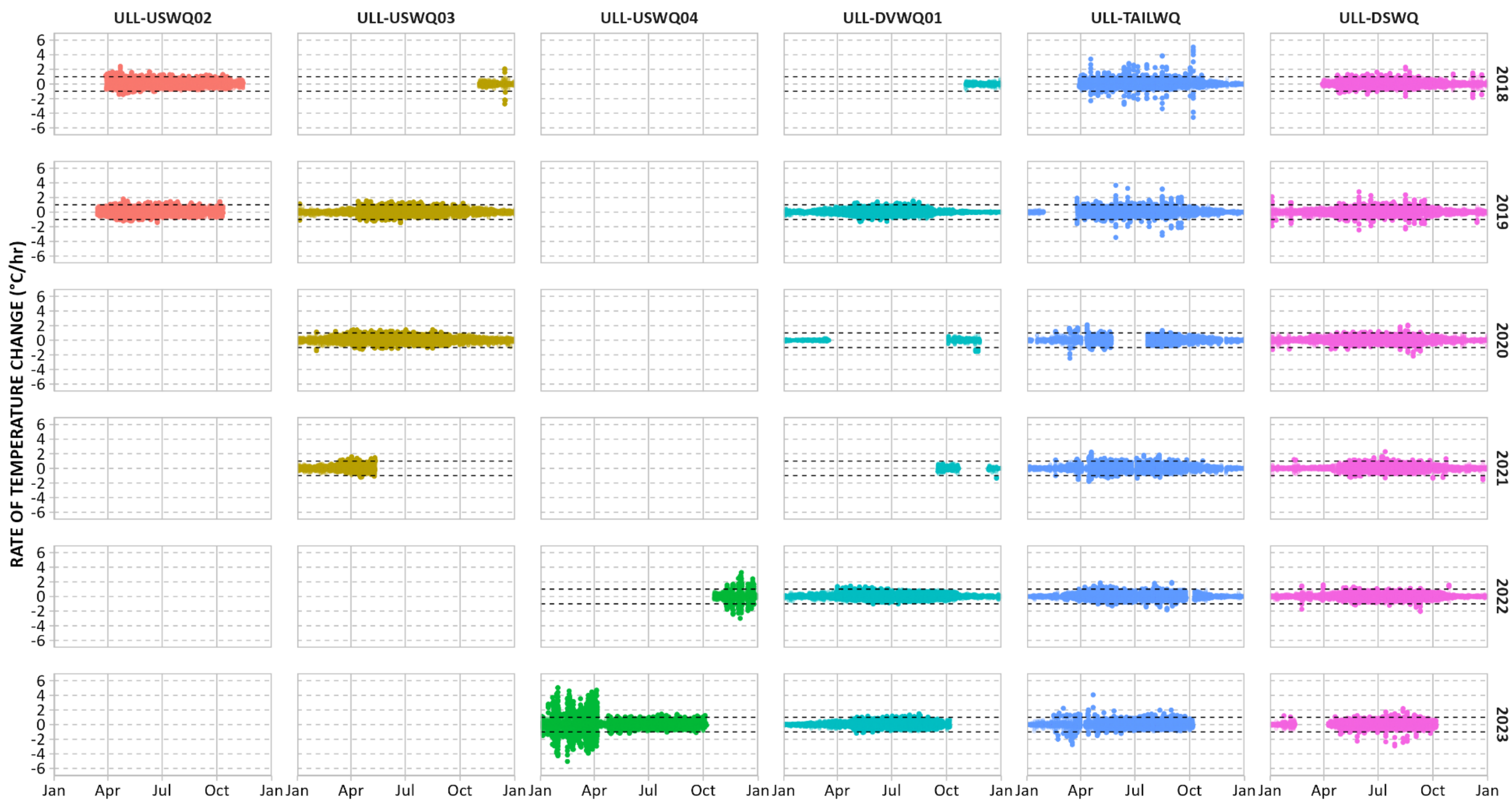
9.1.1. Baseline Conditions

Figure 33. Baseline hourly rate of change in water temperature at the upstream (ULL-USWQ1) and diversion (ULL-DVWQ) water temperature monitoring sites from 2008 to 2013.



9.1.2. Operational Monitoring

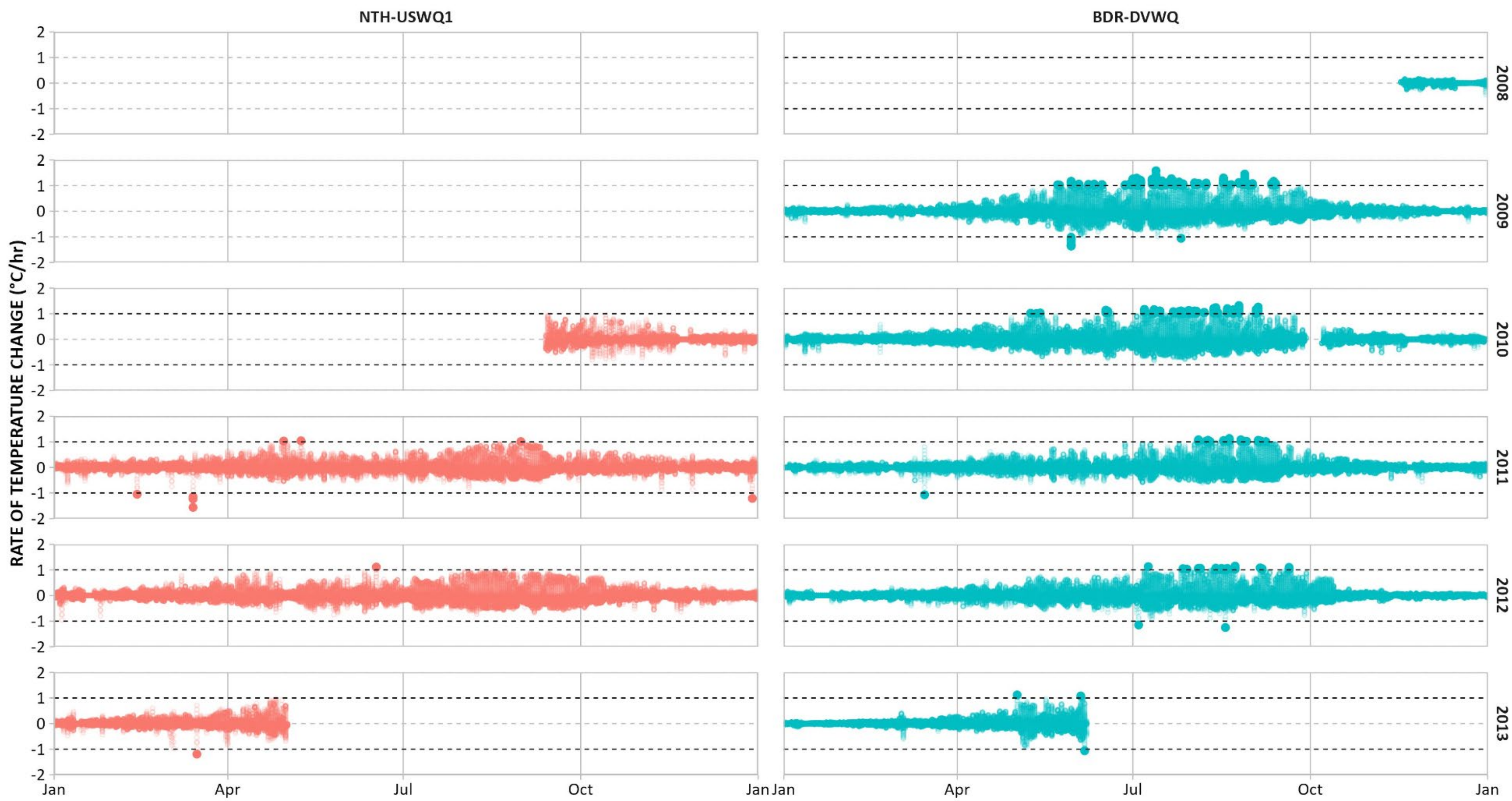
Figure 34. Upper Lillooet River summary of the hourly rate of change (°C/hr) during operations.



9.2. Boulder Creek

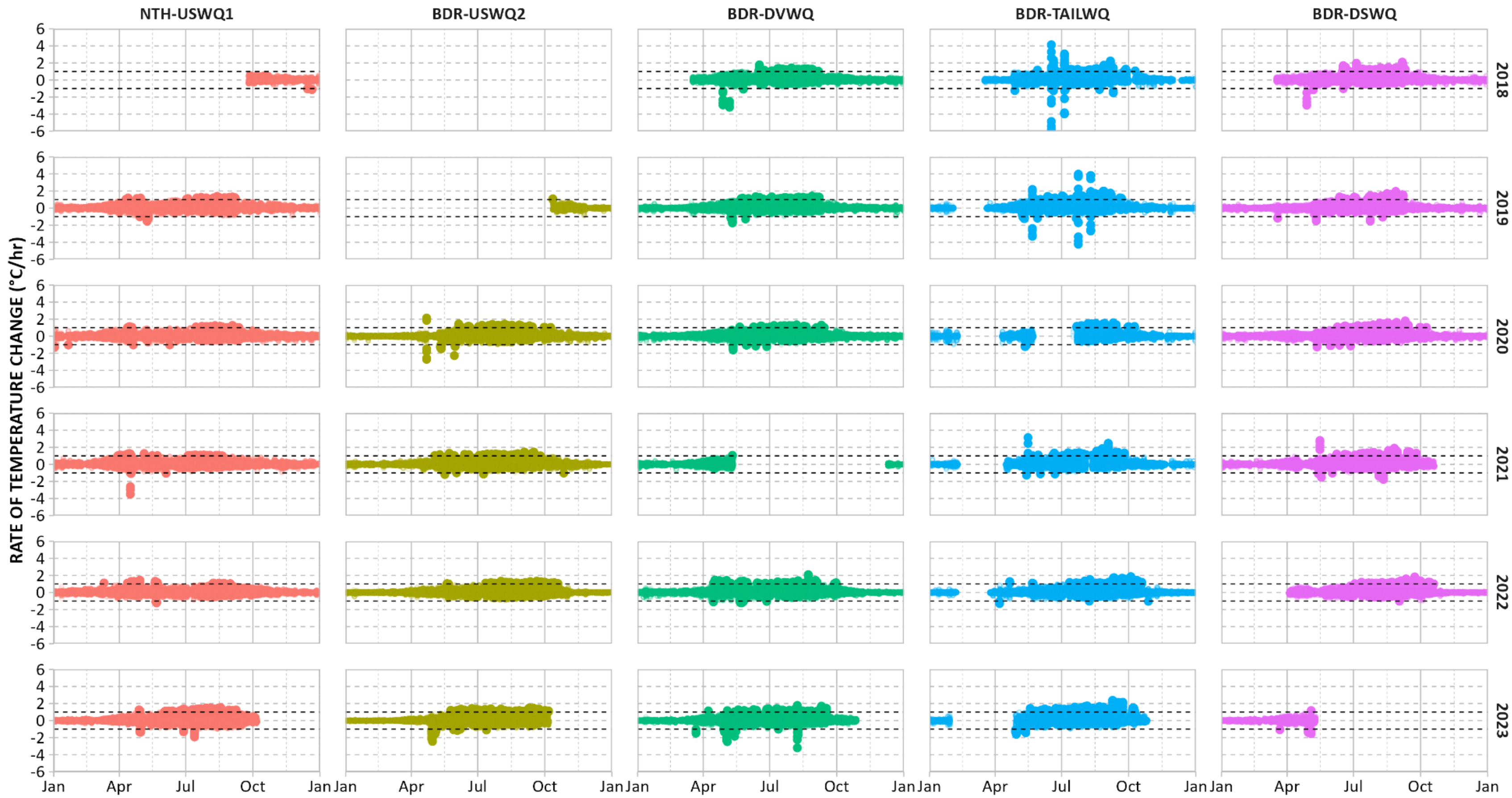
9.2.1. Baseline Conditions

Figure 35. Baseline hourly rate of change in water temperature at the upstream site in nearby North Creek (NTH-USWQ1), and diversion (BDR-DVWQ) water temperature monitoring sites in Boulder Creek from 2008 to 2013.



9.2.2. Operational Monitoring

Figure 36. Boulder Creek summary of hourly rate of change (°C/hr) for each year during operations.



10. MEAN WEEKLY MAXIMUM TEMPERATURE (MWMXT)

10.1. Upper Lillooet River

Table 8. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout life history stages in the Upper Lillooet River upstream reach (ULL-USWQ1) during baseline monitoring (2008 to 2013).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2008	0.0	-	-	-	-	-
			92	2009	100	4.7	9.5	64.1	17.4	0.0
			92	2010	100	4.1	8.1	96.7	0.0	0.0
			92	2011	100	3.8	7.0	100.0	0.0	0.0
			92	2012	100	3.1	7.6	100.0	0.0	0.0
			92	2013	69.6	4.4	7.8	100.0	0.0	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2008	0.0	-	-	-	-	-
			124	2009	100	6.5	10.8	26.6	46.0	0.0
			124	2010	100	5.7	9.9	52.4	25.0	0.0
			124	2011	100	3.8	10.1	67.7	17.7	0.0
			124	2012	99.2	4.0	10.0	57.7	22.8	0.0
			124	2013	27.4	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	366	2008	9.8	-	-	-	-	-
			366	2009	100	0.1	10.8	52.3	40.3	0.0
			366	2010	100	0.3	9.9	57.0	30.4	0.0
			366	2011	100	0.4	10.1	61.4	24.1	0.0
			366	2012	99.5	0.1	10.0	58.2	26.9	0.0
			366	2013	42.2	-	-	-	-	-

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 9. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout life history stages in the Upper Lillooet River upstream reach (ULL-USWQ02) during operational monitoring (2018 to 2019).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2018	97.8	4.6	9.9	84.4	6.7	0.0
			92	2019	100	4.0	9.8	60.9	12.0	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2018	100	5.4	9.9	46.8	19.4	0.0
			124	2019	100	6.5	9.8	33.1	8.9	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2018	61.6	2.8	9.9	22.7	58.2	0.0
			365	2019	58.4	2.6	9.8	23.0	59.6	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 10. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout life history stages in the Upper Lillooet River upstream reach (ULL-USWQ03) during operational monitoring (2018 to 2021).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2018	0.0	-	-	-	-	-
			92	2019	100	4.7	10.1	57.6	19.6	0.0
			92	2020	100	4.3	9.1	77.2	1.1	0.0
			92	2021	43.5	-	-	-	-	-
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2018	0.0	-	-	-	-	-
			124	2019	100	6.3	10.1	21.8	21.0	0.0
			124	2020	100	4.3	9.5	41.9	18.5	0.0
			124	2021	8.1	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2018	15.1	-	-	-	-	-
			365	2019	99.7	0.7	10.1	54.7	35.2	0.0
			365	2020	100	0.9	9.5	54.4	34.4	0.0
			365	2021	35.6	-	-	-	-	-

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 11. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout life history stages in the Upper Lillooet River upstream reach (ULL-USWQ04) during operational monitoring (2022 to 2023).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)			2023	100	3.8	10.0	62.0	17.4	0.0
	Incubation (May. 01 to Sep. 01)			2023	100	4.1	10.0	25.0	29.8	0.0
	Rearing (Jan. 01 to Dec. 31)			2023	75.3	3.3	10.0	38.5	56.0	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 12. Mean weekly maximum temperatures (MWMxTs) measured during Coho Salmon life history stages in the Upper Lillooet River diversion reach (ULL-DVWQ01) during baseline (2012) and operational (2018 to 2023) monitoring.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2012	100	1.1	9.5	63.1	25.4	0.0
				2018	47.5	-	-	-	-	-
				2019	100.0	0.8	9.0	71.3	18.9	0.0
				2020	39.3	-	-	-	-	-
				2021	47.5	-	-	-	-	-
				2022	100	0.3	9.6	59.0	39.3	0.0
				2023	27.0	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2012	100	1.1	6.3	65.8	22.8	0.0
				2018	74.7	0.7	5.5	83.1	6.8	0.0
				2019	100	0.8	6.2	57.0	26.6	0.0
				2020	50.6	2.2	5.9	37.5	35.0	0.0
				2021	38.0	-	-	-	-	-
				2022	100	0.3	7.6	74.7	21.5	0.0
				2023	0.0	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	169	2012	100	0.5	6.3	66.3	18.9	0.0
				2018	88.2	0.4	5.5	77.9	14.1	0.0
				2019	90.0	0.2	6.2	69.3	18.3	0.0
				2020	23.7	-	-	-	-	-
				2021	71.0	0.3	5.6	50.8	24.2	0.0
				2022	100	0.3	7.6	65.7	20.1	0.0
				2023	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	365	2012	100	0.4	10.1	74.6	12.6	0.0
				2018	15.9	-	-	-	-	-
				2019	100	0.4	10.7	68.8	23.8	0.0
				2020	33.6	-	-	-	-	-
				2021	15.9	-	-	-	-	-
				2022	100	0.3	10.5	66.6	14.2	0.0
				2023	75.6	1.2	10.9	52.5	34.4	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.
2012 data were collected at ULL-DVWQ; 2018 and 2019 data were collected at ULL-DVWQ01.

Table 13. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout life history stages in the Upper Lillooet River diversion reach (ULL-DVWQ01) during baseline (2012) and operational (2018 to 2023) monitoring.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2012	100	3.6	8.5	90.2	0.0	0.0
				2018	0.0	-	-	-	-	-
				2019	100	4.7	10.7	52.2	31.5	0.0
				2020	0.0	-	-	-	-	-
				2021	0.0	-	-	-	-	-
				2022	100	5.0	9.0	70.7	0.0	0.0
				2023	100	5.1	10.8	48.9	33.7	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2012	100.0	4.5	10.1	46.0	31.5	0.0
				2018	0.0	-	-	-	-	-
				2019	100	7.3	10.7	14.5	68.5	0.0
				2020	0.0	-	-	-	-	-
				2021	0.0	-	-	-	-	-
				2022	100	6.7	10.5	33.9	36.3	0.0
				2023	100	5.9	10.9	12.1	73.4	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2012	100	0.4	10.1	54.9	35.8	0.0
				2018	15.9	-	-	-	-	-
				2019	100	0.4	10.7	52.6	41.1	0.0
				2020	33.6	-	-	-	-	-
				2021	15.9	-	-	-	-	-
				2022	100	0.3	10.5	48.8	45.2	0.0
				2023	75.6	1.2	10.9	40.2	53.6	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.
2012 data were collected at ULL-DVWQ; 2018 and 2019 data were collected at ULL-DVWQ01.

Table 14. Mean weekly maximum temperatures (MWMxTs) measured during Bull Trout life history stages in the Upper Lillooet River diversion reach (ULL-DVWQ01) during baseline (2012) and operational (2018 to 2023) monitoring.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2012	100	1.6	10.1	23.1	42.3	0.8
				2018	26.9	-	-	-	-	-
				2019	100	0.8	9.9	21.5	43.1	0.0
				2020	36.9	-	-	-	-	-
				2021	26.9	-	-	-	-	-
				2022	100	0.4	10.4	28.5	35.4	6.2
				2023	49.2	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2012	100	0.5	10.1	5.6	34.3	30.0
				2018	55.4	0.4	5.5	11.0	35.6	0.0
				2019	100	0.2	9.9	6.5	32.2	26.2
				2020	22.5	-	-	-	-	-
				2021	55.4	0.3	8.3	13.6	52.5	8.5
				2022	100	0.3	10.4	7.0	34.3	37.1
				2023	29.9	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2012	100	0.4	10.1	46.7	45.1	0.0
				2018	15.9	-	-	-	-	-
				2019	100	0.4	10.7	44.9	47.4	0.0
				2020	33.6	-	-	-	-	-
				2021	15.9	-	-	-	-	-
				2022	100	0.3	10.5	41.6	51.2	0.0
				2023	75.6	1.2	10.9	31.9	59.8	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.
2012 data were collected at ULL-DVWQ; 2018 and 2019 data were collected at ULL-DVWQ01.

Table 15. Mean weekly maximum temperatures (MWMxTs) measured during Coho Salmon life history stages in the Upper Lillooet River downstream reach (ULL-DSWQ) during operational monitoring (2018 to 2023).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2018	100	1.6	8.5	62.3	18.9	0.0
				2019	100	1.1	8.9	71.3	14.8	0.0
				2020	92.6	2.0	9.2	66.4	24.8	0.0
				2021	92.6	0.5	8.1	69.9	15.9	0.0
				2022	99.2	0.4	9.4	61.2	33.9	0.0
				2023	27.0	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2018	100	1.6	6.7	67.1	29.1	0.0
				2019	100	1.1	6.1	51.9	22.8	0.0
				2020	88.6	2.0	5.3	75.7	8.6	0.0
				2021	87.3	0.5	5.6	63.8	21.7	0.0
				2022	98.7	0.4	6.9	76.9	16.7	0.0
				2023	0.0	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	169	2018	100	1.1	6.7	66.9	24.3	0.0
				2019	100	1.0	6.1	62.4	21.2	0.0
				2020	94.7	2.0	5.8	56.9	30.0	0.0
				2021	94.1	0.5	5.6	57.2	21.4	0.0
				2022	68.6	0.4	6.9	81.0	13.8	0.0
				2023	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	365	2018	75.6	1.6	10.7	67.4	19.6	0.0
				2019	100	1.1	10.5	69.0	19.7	0.0
				2020	97.5	1.0	10.3	71.7	15.1	0.0
				2021	95.3	0.5	10.5	73.6	15.5	0.0
				2022	99.5	0.4	10.3	72.2	12.7	0.0
				2023	59.7	1.6	10.7	47.7	29.8	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 16. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout history stages in the Upper Lillooet River downstream reach (ULL-DSWQ) during operational monitoring (2018 to 2023).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2018	100	4.8	10.4	75.0	8.7	0.0
				2019	100	4.6	10.5	53.3	27.2	0.0
				2020	100	4.3	9.4	69.6	5.4	0.0
				2021	91.3	5.7	10.4	64.3	16.7	0.0
				2022	100	4.5	8.6	85.9	0.0	0.0
				2023	92.4	3.7	10.5	52.9	27.1	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2018	100	6.0	10.7	31.5	43.5	0.0
				2019	100	7.0	10.5	15.3	58.1	0.0
				2020	100	5.5	10.3	28.2	37.9	0.0
				2021	100	6.3	10.5	26.6	43.5	0.0
				2022	100	6.3	10.3	46.0	35.5	0.0
				2023	100	4.7	10.7	17.7	52.4	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2018	75.6	1.6	10.7	34.4	51.8	0.0
				2019	100	1.1	10.5	51.0	41.1	0.0
				2020	97.5	1.0	10.3	55.5	39.5	0.0
				2021	95.3	0.5	10.5	49.7	39.1	0.0
				2022	99.5	0.4	10.3	50.4	38.3	0.0
				2023	59.7	1.6	10.7	28.9	65.6	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 17. Mean weekly maximum temperatures (MWMxTs) measured during Bull Trout life history stages in the Upper Lillooet River downstream reach (ULL-DSWQ) during operational monitoring (2018 to 2023).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2018	100	1.6	10.0	23.8	58.5	0.8
				2019	100	1.1	10.2	20.0	46.2	2.3
				2020	93.1	2.0	10.0	29.8	47.9	0.8
				2021	93.1	1.9	9.9	24.8	58.7	0.0
				2022	99.2	0.4	10.3	29.5	37.2	2.3
				2023	49.2	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2018	100	1.1	10.0	0.0	41.3	26.8
				2019	100	1.0	10.2	0.0	34.1	24.8
				2020	95.8	2.0	10.0	0.0	65.2	29.9
				2021	95.3	0.5	9.9	8.9	43.3	24.6
				2022	89.7	0.4	10.3	9.4	29.3	38.7
				2023	29.9	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2018	75.6	1.6	10.7	22.8	65.6	0.0
				2019	100	1.1	10.5	45.8	49.0	0.0
				2020	97.5	1.0	10.3	44.8	44.5	0.0
				2021	95.3	0.5	10.5	37.1	50.3	0.0
				2022	99.5	0.4	10.3	47.4	49.6	0.0
				2023	59.7	1.6	10.7	21.1	71.1	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

10.2. Boulder Creek

Table 18. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout life history stages in the Boulder Creek diversion reach (BDR-DVWQ) during baseline (2008 to 2013) and operational (2018 to 2023) monitoring.

Species	Life Stage Data: Periodicity	Optimum Temperature Range (°C)	Duration (days)	Year	% Complete[1]	MWMxT: Min. (°C)	MWMxT: Max. (°C)	% of MWMxT: Below Lower Bound by >1°C	Below Lower Bound	Between Bounds	Above Upper Bound	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2008	0.0	-	-	-	-	-	-	-
				2009	100	2.5	10.3	76.1	95.7	4.3	0.0	0.0
				2010	97.8	3.2	7.8	100	100	0.0	0.0	0.0
				2011	92.4	2.8	5.7	100	100	0.0	0.0	0.0
				2012	100	2.6	6.1	100	100	0.0	0.0	0.0
				2013	68.5	3.4	7.8	100	100	0.0	0.0	0.0
			92	2018	100	3.2	10.6	79.3	88.0	12.0	0.0	0.0
				2019	100	4.0	10.8	64.1	79.3	20.7	0.0	0.0
				2020	100	3.0	8.6	92.4	100.0	0.0	0.0	0.0
				2021	43	-	-	-	-	-	-	-
				2022[2]	100	3.8	8.1	97.8	100.0	0.0	0.0	0.0
				2023	100	3.2	12.4	58.7	65.2	30.4	4.3	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2008	0	-	-	-	-	-	-	-
				2009	100	4.5	11.0	32.3	54.8	45.2	0.0	0.0
				2010	99	5.1	10.8	50.4	57.7	42.3	0.0	0.0
				2011	93	3.6	9.4	72.2	92.2	7.8	0.0	0.0
				2012	100	4.0	10.5	57.3	77.4	22.6	0.0	0.0
				2013	27	-	-	-	-	-	-	-
			124	2018	100	6.3	12.1	34.7	41.1	57.3	1.6	0.0
				2019	100	6.4	11.9	21.0	32.3	67.7	0.0	0.0
				2020	100	5.4	11.8	44.4	60.5	39.5	0.0	0.0
				2021	8	-	-	-	-	-	-	-
				2022[2]	100	5.6	12.0	56.5	64.5	34.7	0.8	0.0
				2023	100	5.8	13.2	19.4	24.2	54.8	21.0	4.8
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	366	2008	11.7	-	-	-	-	-	-	-
				2009	100	0.1	11.0	63.8	66.8	33.2	0.0	0.0
				2010	96.7	0.0	10.8	64.0	73.1	26.9	0.0	0.0
				2011	97.5	0.1	9.9	72.8	82.0	18.0	0.0	0.0
				2012	100	0.0	10.5	69.9	74.6	25.4	0.0	0.0
				2013	41.9	-	-	-	-	-	-	-
			365	2018	78.9	0.3	12.1	42.7	51.4	48.6	0.0	0.0
				2019	100	0.1	11.9	57.0	62.5	37.5	0.0	0.0
				2020	100	0.0	11.8	55.2	62.0	38.0	0.0	0.0
				2021	41.9	-	-	-	-	-	-	-
				2022[2]	100	0.0	12.0	52.6	60.8	39.2	0.0	0.0
				2023	82.2	0.2	13.2	41.0	45.3	54.7	0.0	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

[2] Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01.

Table 19. Mean weekly maximum temperatures (MWMxTs) measured during Bull Trout life history stages in the Boulder Creek diversion reach (BDR-DVWQ) during baseline (2008 to 2013) and operational (2018 to 2023) monitoring.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT				
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Below Lower Bound	Between Bounds	Above Upper Bound	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2008	15	-	-	-	-	-	-	-
				2009	100	0.2	10.4	38.5	43.8	36.2	20.0	4.6
				2010	92	0.0	10.8	26.7	40.8	34.2	25.0	8.3
				2011	100	0.2	9.9	35.4	42.3	43.8	13.8	0.0
				2012	100	1.3	10.5	31.5	38.5	35.4	26.2	6.2
				2013	0	-	-	-	-	-	-	-
			130	2018	100	0.3	12.0	23.8	26.9	43.1	30.0	19.2
				2019	100	0.3	11.9	20.8	39.2	27.7	33.1	31.5
				2020	100	1.7	11.8	29.2	35.4	15.4	49.2	34.6
				2021	0.0	-	-	-	-	-	-	-
				2022[2]	100	0.0	12.0	32.3	33.8	12.3	53.8	36.9
				2023	67.7	4.2	12.2	0.0	1.1	39.8	59.1	54.5
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	214	2008	48.4	-	-	-	-	-	-	-
				2009	100	0.1	10.4	11.7	35.7	36.2	28.2	27.2
				2010	95.3	0.0	10.8	20.7	49.3	20.2	30.5	27.1
				2011	100	0.0	9.9	18.2	54.7	12.6	32.7	24.8
				2012	100	0.1	10.5	18.8	47.9	16.9	35.2	31.0
				2013	0.0	-	-	-	-	-	-	-
			213	2018	100	0.1	12.0	17.8	42.7	24.9	32.4	28.2
				2019	100	0.0	11.9	13.6	40.2	28.5	31.3	27.6
				2020	100	0.1	11.8	8.9	39.0	24.9	36.2	34.7
				2021	39.0	-	-	-	-	-	-	-
				2022[2]	100	0.0	12.0	20.2	54.0	6.1	39.9	39.0
				2023	41.1	-	-	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	366	2008	11.7	-	-	-	-	-	-	-
				2009	100	0.1	11.0	56.4	63.8	36.2	0.0	0.0
				2010	96.7	0.0	10.8	53.0	64.0	36.0	0.0	0.0
				2011	97.5	0.1	9.9	66.9	72.8	27.2	0.0	0.0
				2012	100	0.0	10.5	61.2	69.9	30.1	0.0	0.0
				2013	41.9	-	-	-	-	-	-	-
			365	2018	78.9	0.3	12.1	31.9	42.7	57.3	0.0	0.0
				2019	100	0.1	11.9	51.0	57.0	43.0	0.0	0.0
				2020	100	0.0	11.8	48.6	55.2	44.8	0.0	0.0
				2021	41.9	-	-	-	-	-	-	-
				2022[2]	100	0.0	12.0	48.8	52.6	47.4	0.0	0.0
				2023	82.2	0.2	13.2	39.0	41.0	59.0	0.0	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

[2] Data collected between Aug. 2, 2022 to Oct. 20, 2022 were synthesized using data from BDR-DVLG01.

Table 20. Mean weekly maximum temperatures (MWMxTs) measured during Cutthroat Trout life history stages in the Boulder Creek downstream reach (BDR-DSWQ) during operational monitoring (2018 to 2023).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT				
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Below Lower Bound	Between Bounds	Above Upper Bound	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2018	100	3.6	10.2	83.7	91.3	8.7	0.0	0.0
				2019	100	3.6	10.3	70.7	82.6	17.4	0.0	0.0
				2020	100	3.3	8.8	91.3	100	0.0	0.0	0.0
				2021	100	3.5	10.7	88.0	92.4	7.6	0.0	0.0
				2022	97.8	3.4	7.6	100	100	0.0	0.0	0.0
				2023	42.4	-	-	-	-	-	-	-
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2018	100	5.2	11.6	37.9	49.2	50.0	0.0	0.0
				2019	100	4.7	11.5	28.2	37.1	62.9	0.0	0.0
				2020	100	4.1	11.4	43.5	57.3	41.9	0.0	0.0
				2021	99.2	4.5	12.0	41.5	47.2	50.4	2.4	0.0
				2022	100	4.5	11.8	58.9	65.3	34.7	0.0	0.0
				2023	7.3	-	-	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2018	78.9	0.4	11.6	49.7	59.7	40.3	0.0	0.0
				2019	100	0.1	11.5	62.5	65.8	34.2	0.0	0.0
				2020	100	0.1	11.4	60.7	65.3	34.7	0.0	0.0
				2021	78.6	0.1	12.0	53.7	64.8	35.2	0.0	0.0
				2022	74.8	0.1	11.8	52.0	56.8	43.2	0.0	0.0
				2023	35.3	-	-	-	-	-	-	-

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 21. Mean weekly maximum temperatures (MWMxTs) measured during Bull Trout life history stages in the Boulder Creek downstream reach (BDR-DSWQ) during operational monitoring (2018 to 2023).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT				
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Below Lower Bound	Between Bounds	Above Upper Bound	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2018	100	0.4	11.6	24.6	31.5	45.4	22.3	16.2
				2019	100	0.6	11.5	30.0	43.1	24.6	32.3	20.8
				2020	100	1.4	11.4	30.8	36.2	22.3	41.5	21.5
				2021	57.7	3.7	11.3	5.3	10.7	50.7	37.3	21.3
				2022	100	0.1	11.8	33.1	33.8	16.9	49.2	31.5
				2023	0.0	-	-	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2018	100	0.1	11.6	14.1	43.7	27.2	29.1	28.2
				2019	100	0.1	11.5	12.6	38.8	30.8	30.4	27.6
				2020	100	0.1	11.4	8.5	44.1	21.1	34.7	34.3
				2021	35.2	-	-	-	-	-	-	-
				2022	100	0.1	11.8	20.7	53.1	7.5	39.4	39.0
				2023	0.0	-	-	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2018	78.9	0.4	11.6	34.7	49.7	50.3	0.0	0.0
				2019	100	0.1	11.5	55.9	62.5	37.5	0.0	0.0
				2020	100	0.1	11.4	54.4	60.7	39.3	0.0	0.0
				2021	78.6	0.1	12.0	47.4	53.7	46.3	0.0	0.0
				2022	74.8	0.1	11.8	39.9	52.0	48.0	0.0	0.0
				2023	35.3	-	-	-	-	-	-	-

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

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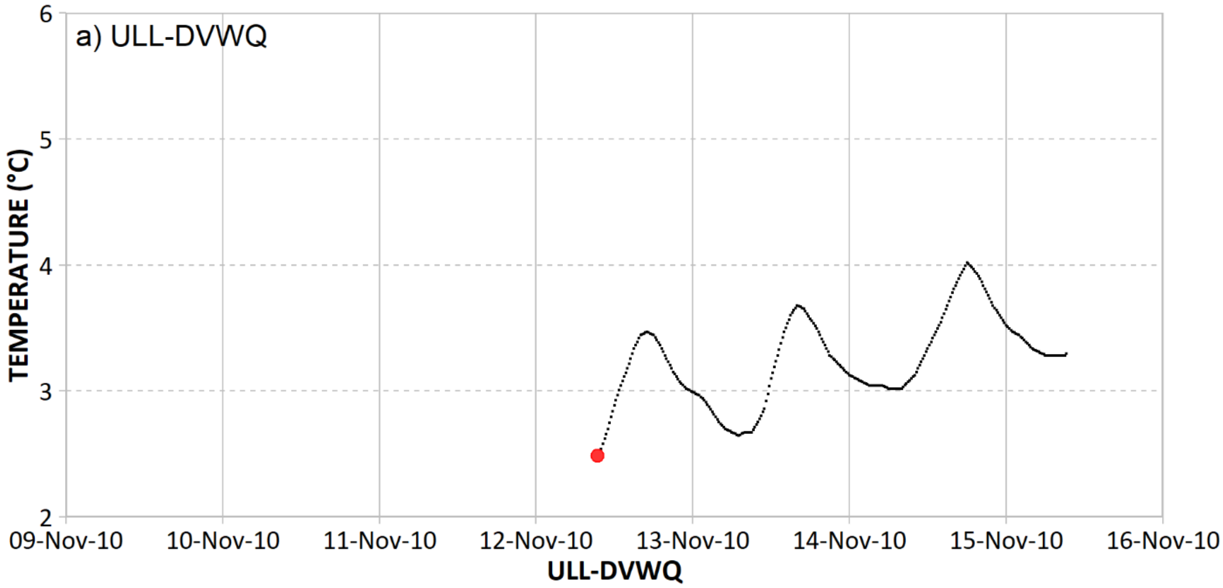
Appendix D. Water Temperature QA/QC Figures, 2023

LIST OF FIGURES

1. QA/QC SPOT TEMPERATURE MEASUREMENTS

1.1. Upper Lillooet River

Figure 1. Spot temperature QA/QC plots for ULL-DVWQ and ULL-DVWQ01.



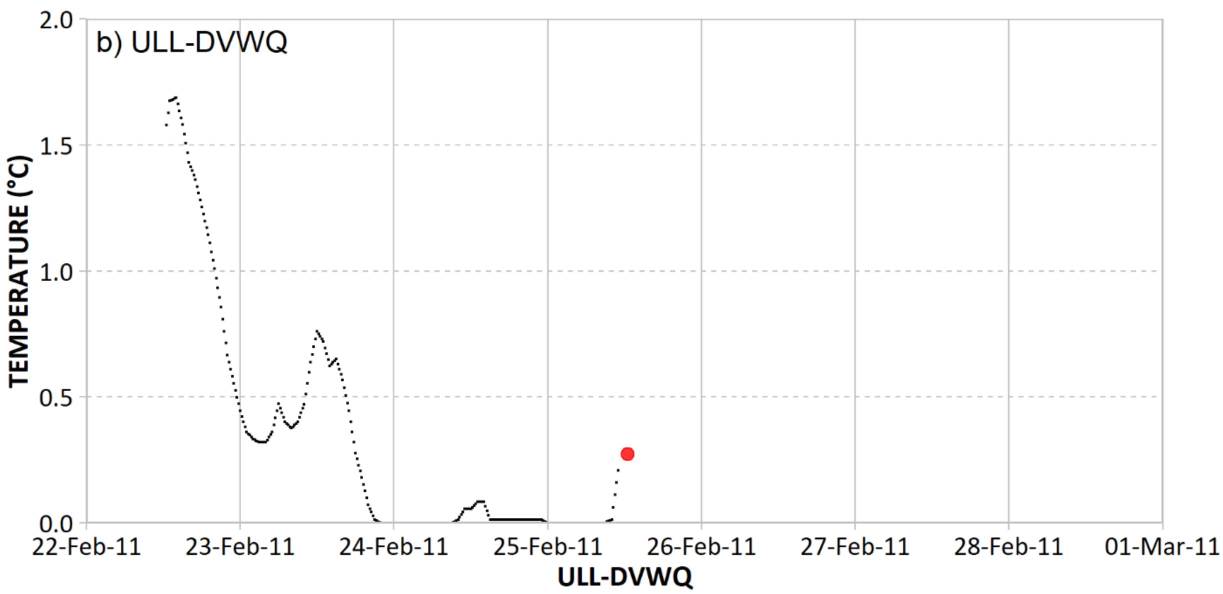
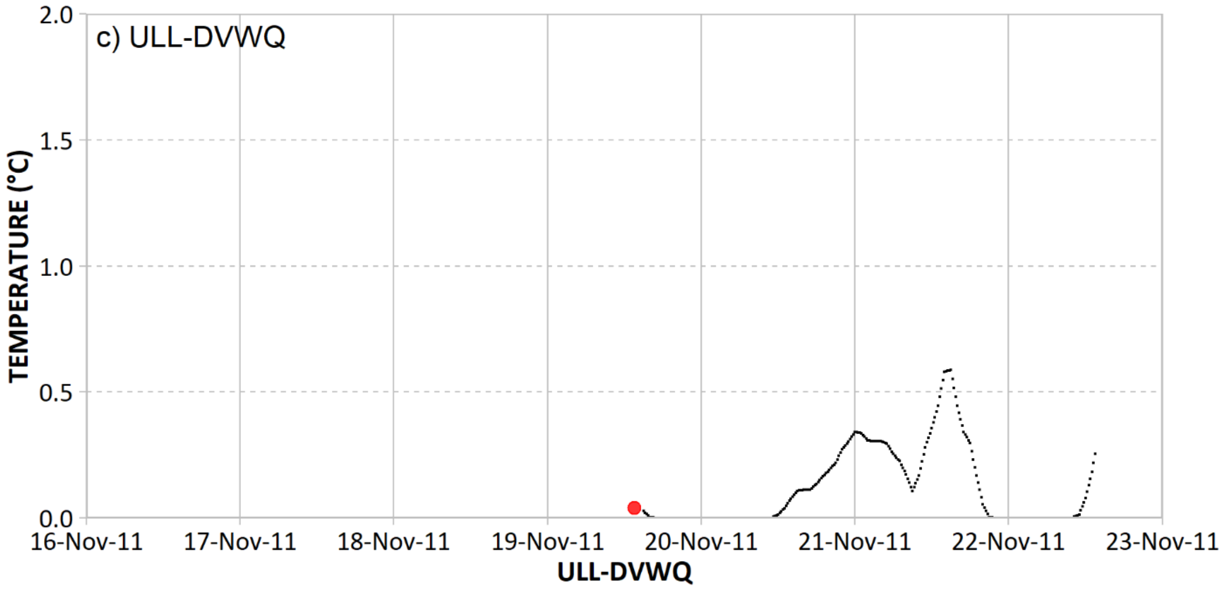
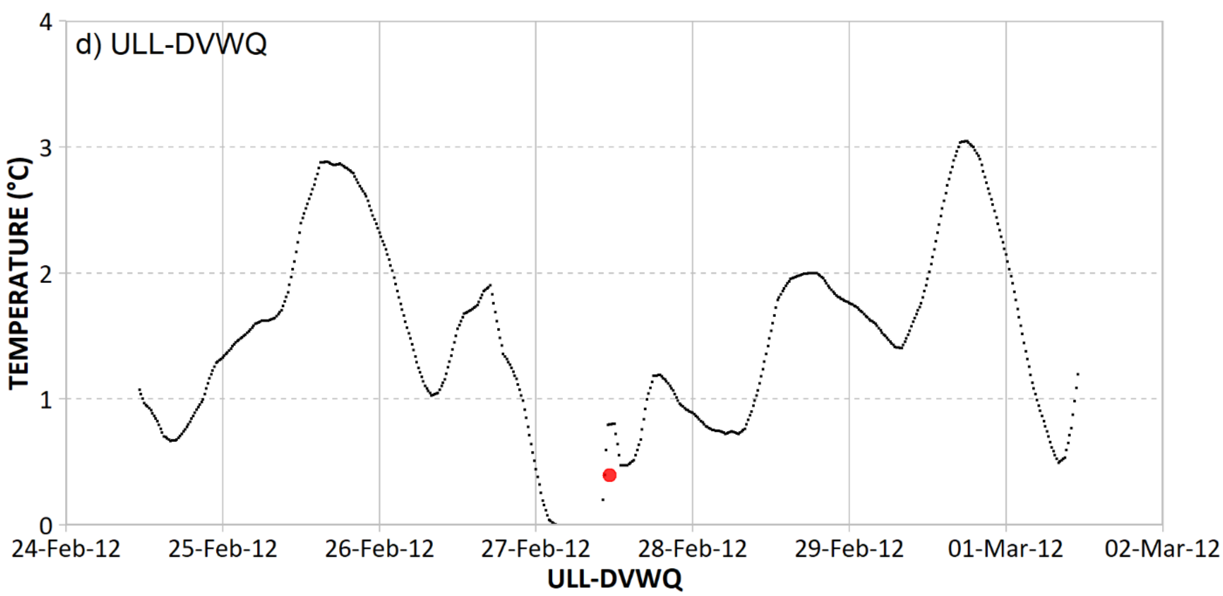


Figure 1. Continued.





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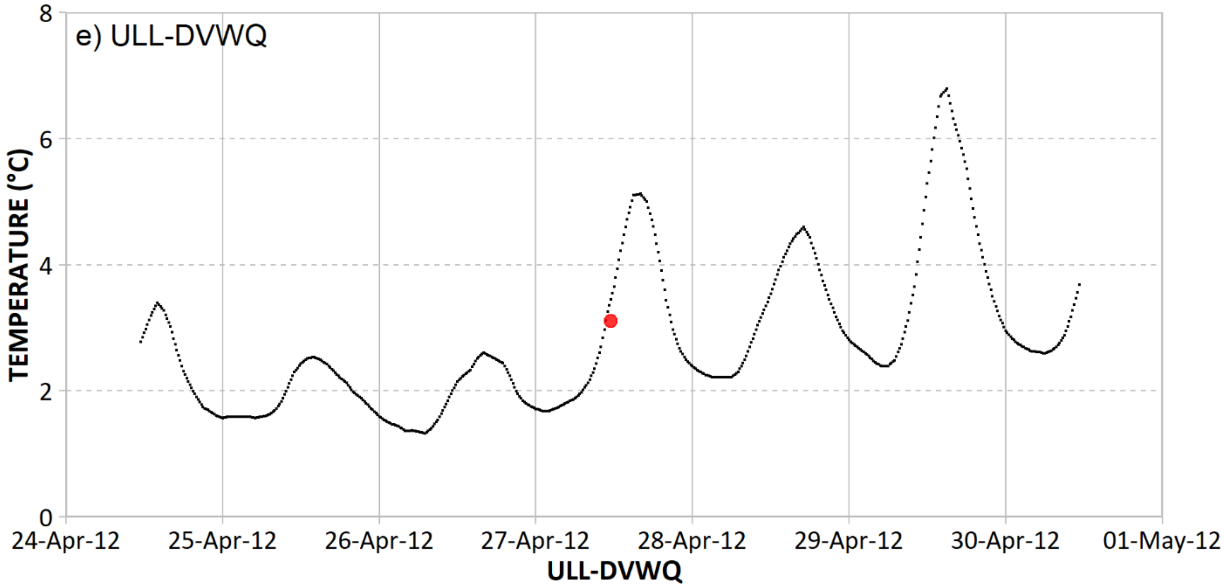


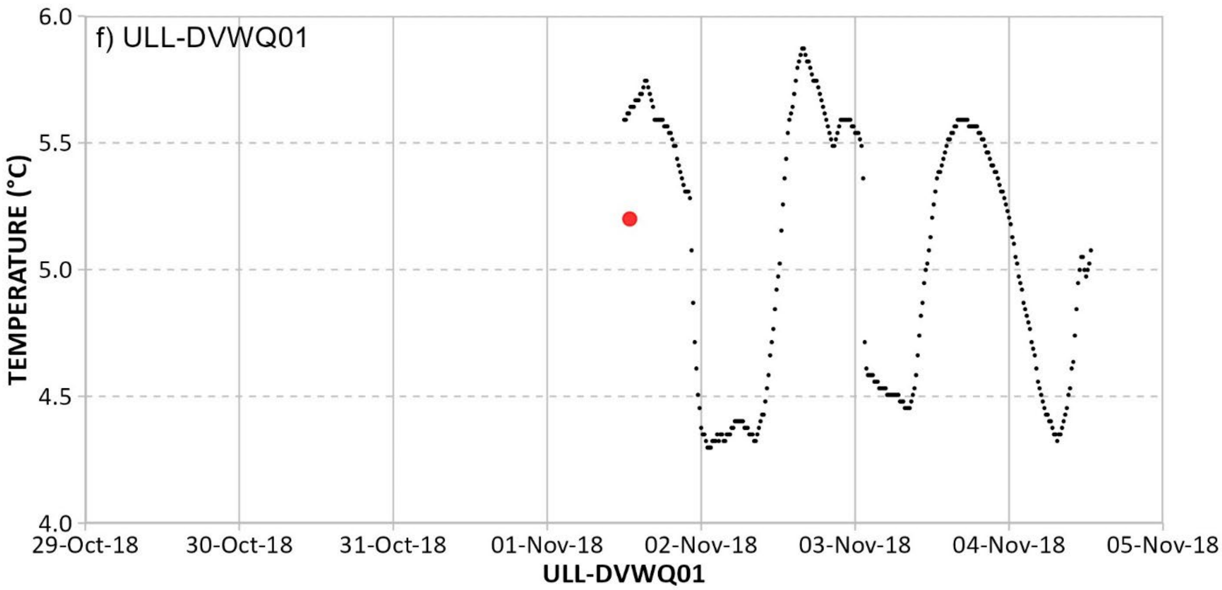
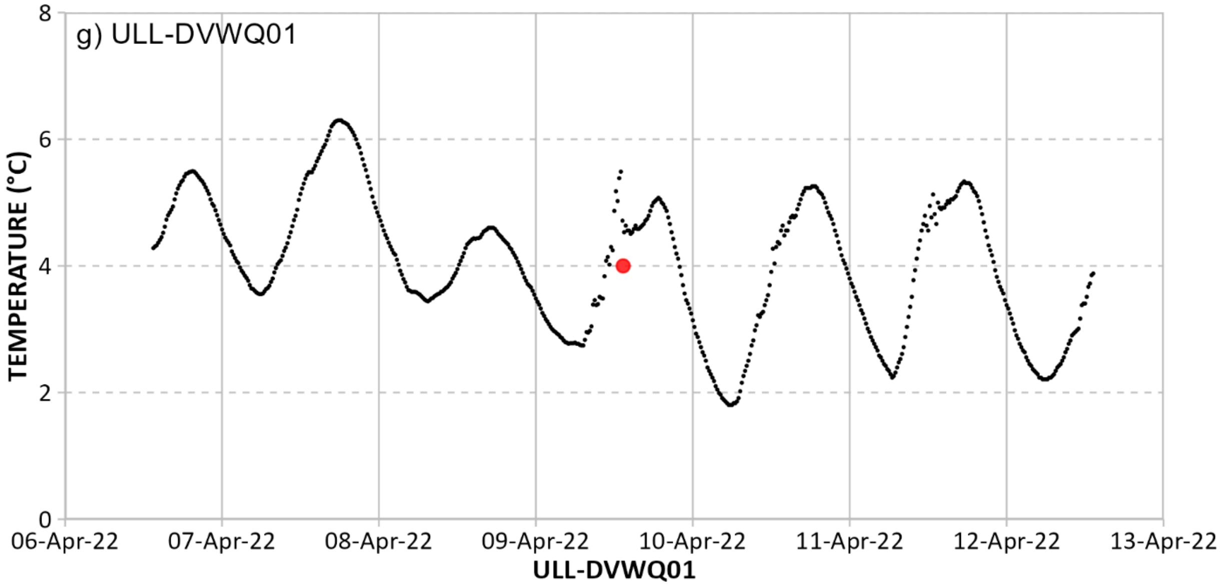


Figure 1. Continued.



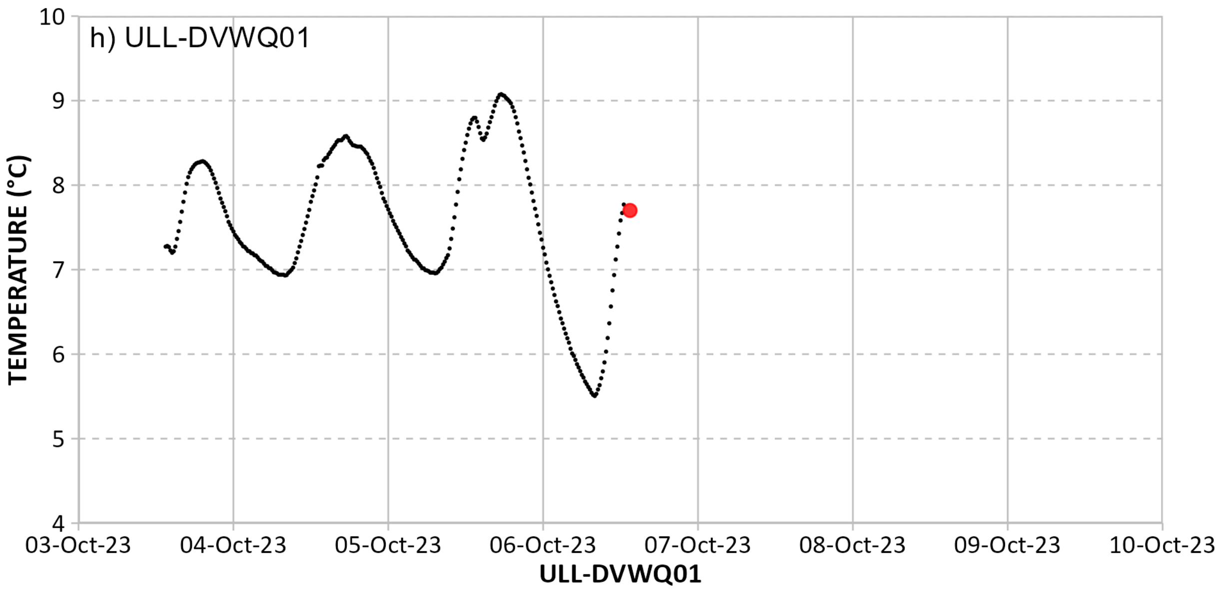
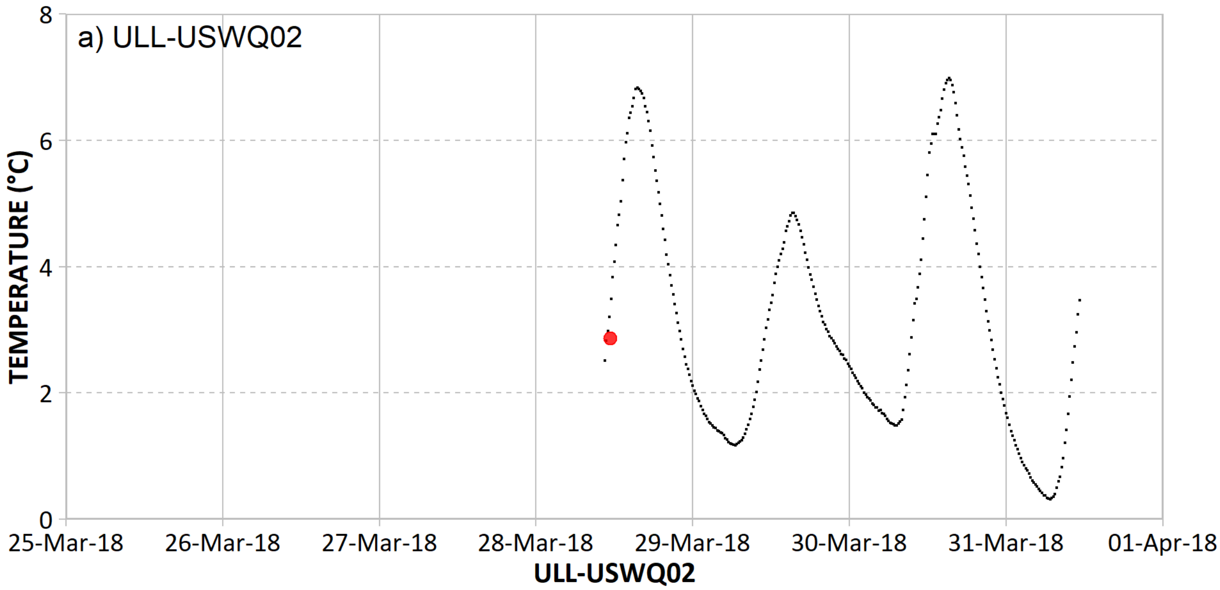
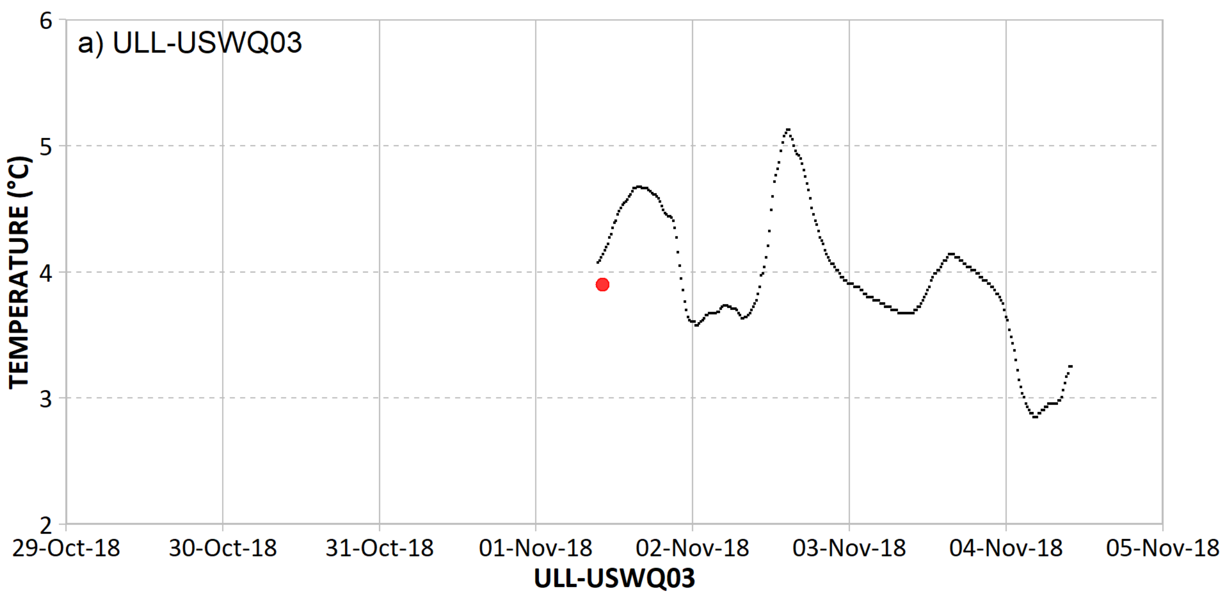


Figure 2. Spot temperature QA/QC plots for ULL-USWQ02, ULL-USWQ03, and ULL-USWQ04.





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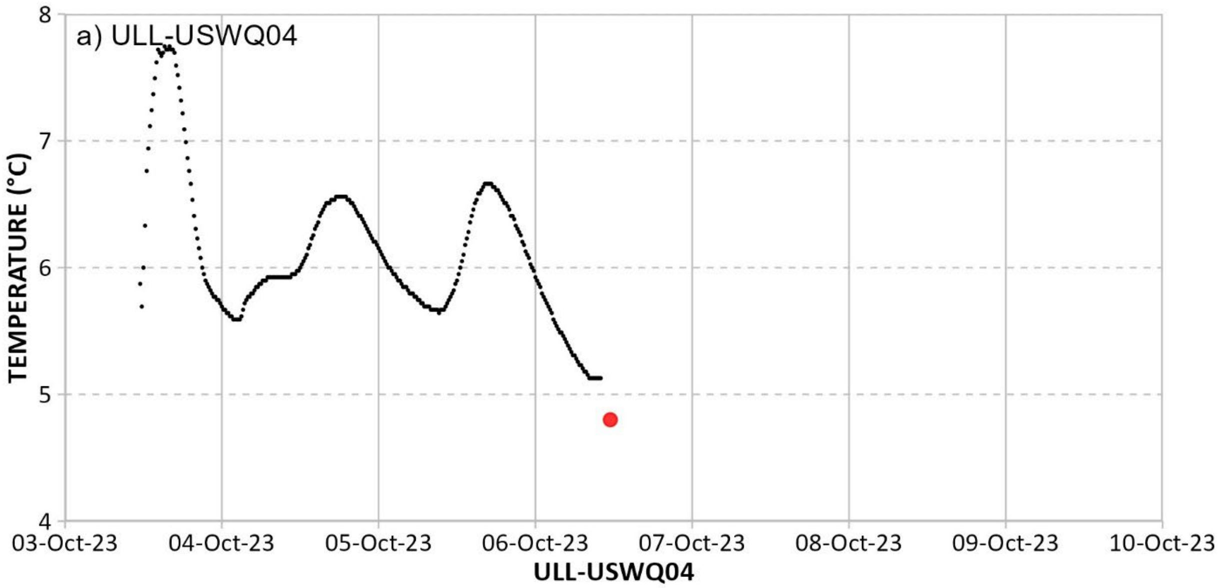
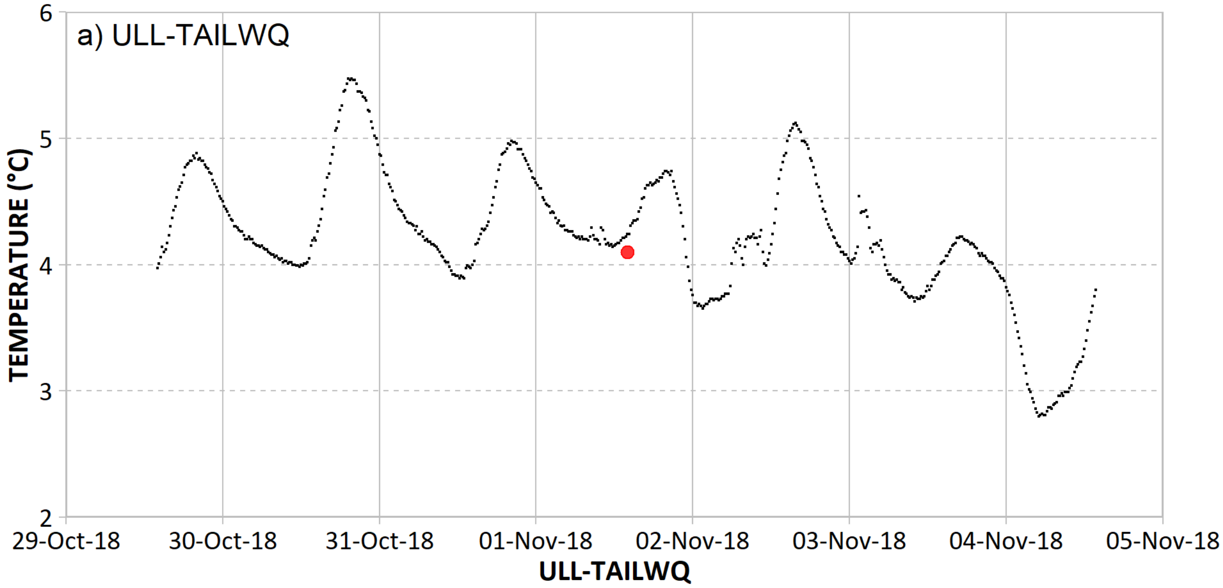
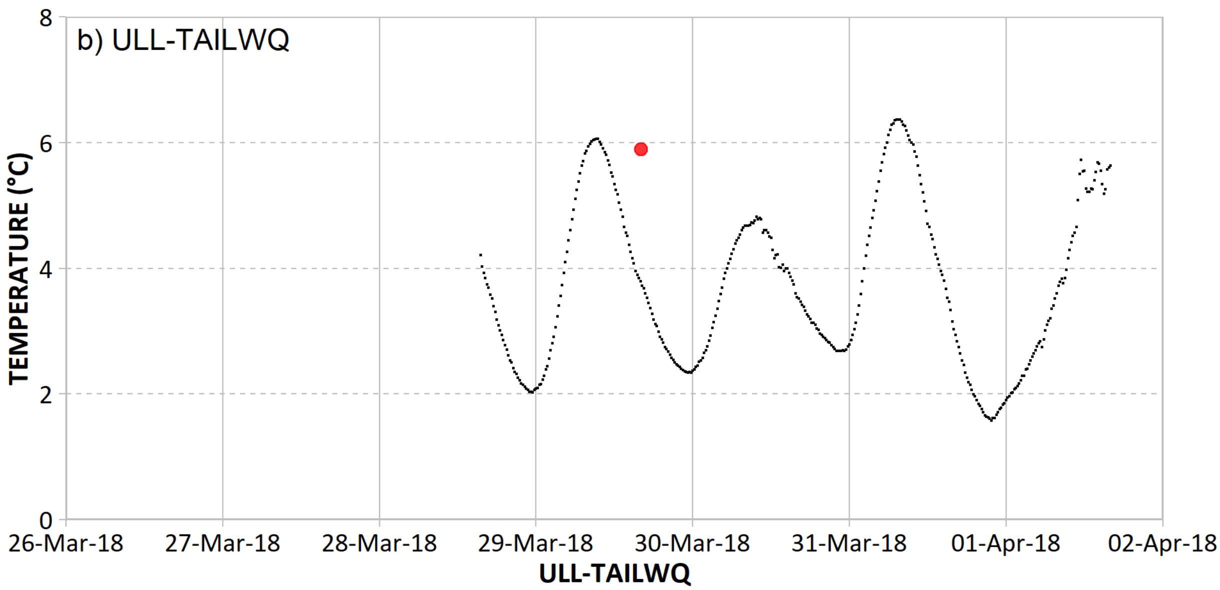


Figure 3. Spot temperature QA/QC plots for ULL-TAILWQ.





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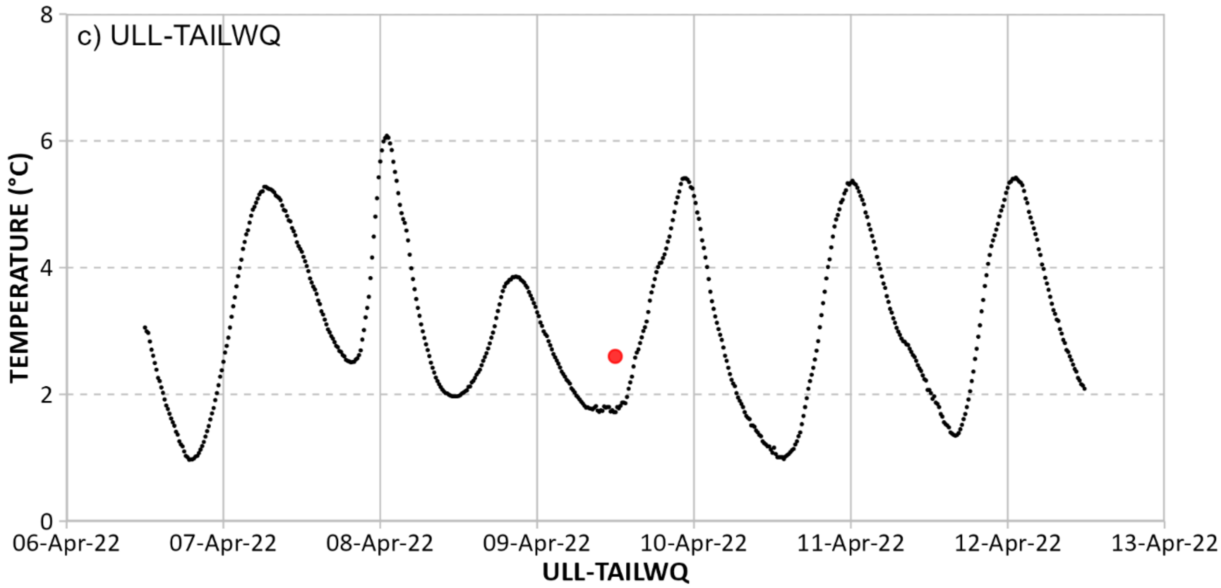


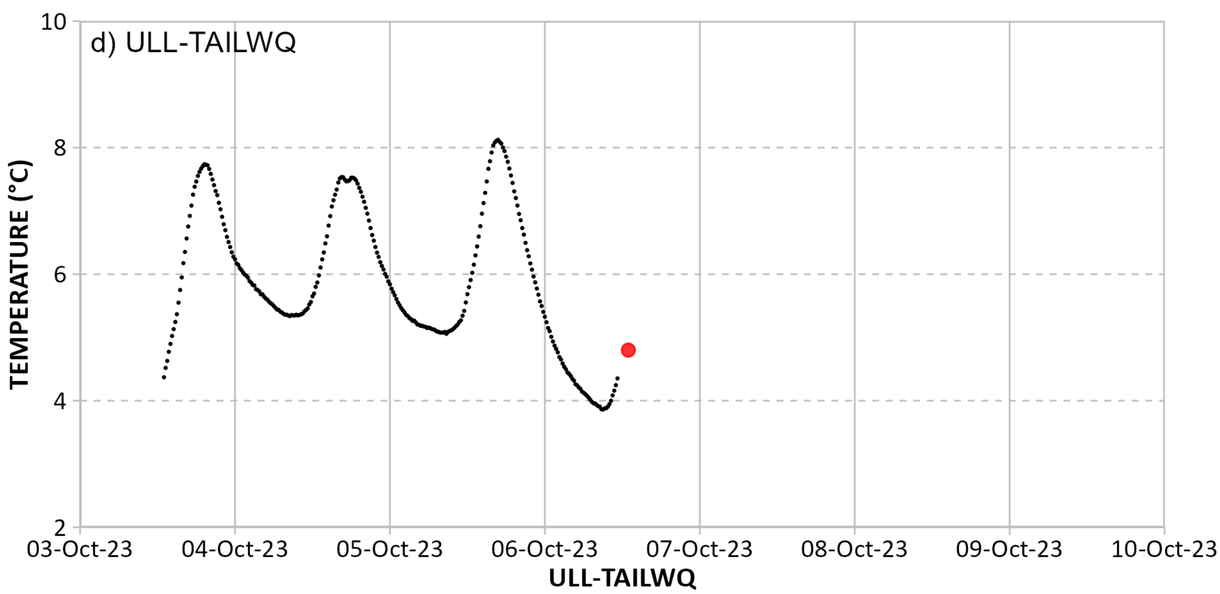
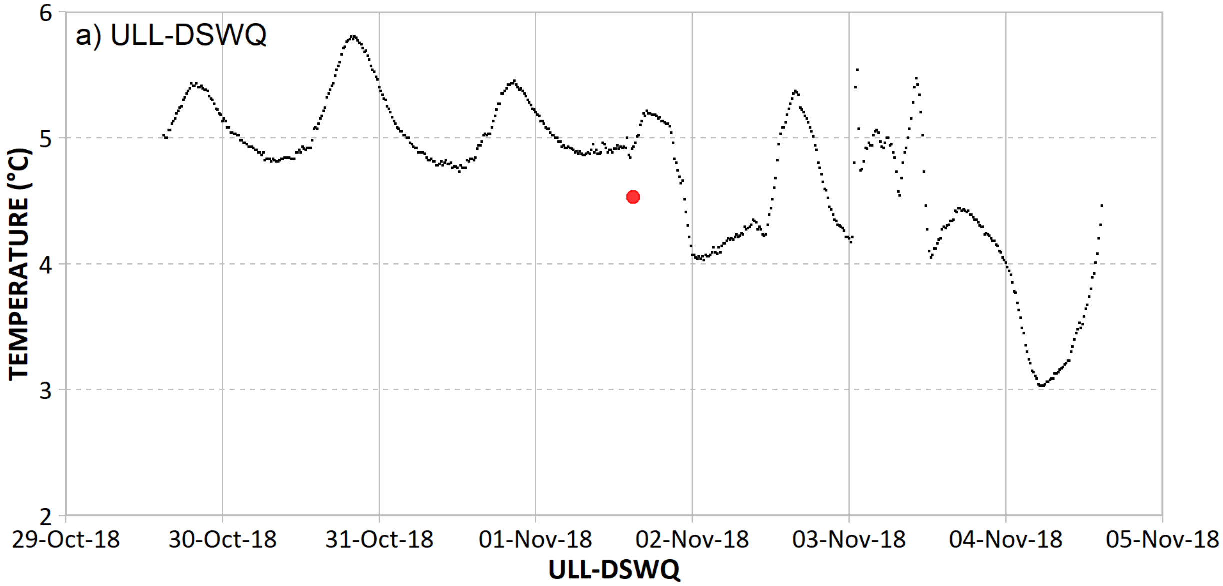
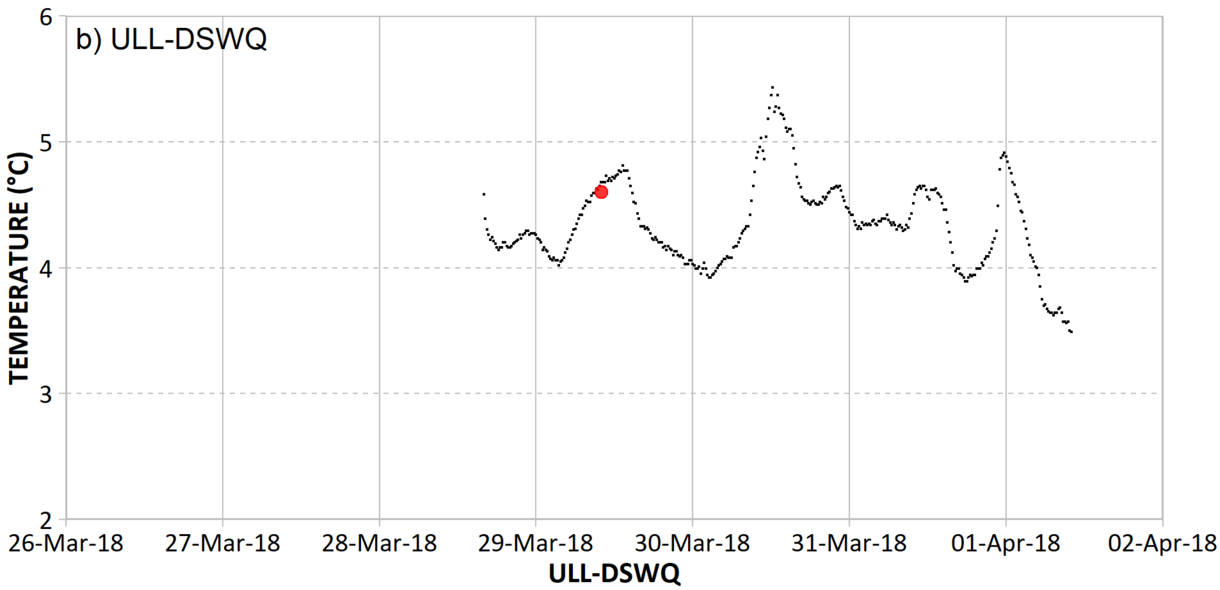


Figure 4. Spot temperature QA/QC plots for ULL-DSWQ.





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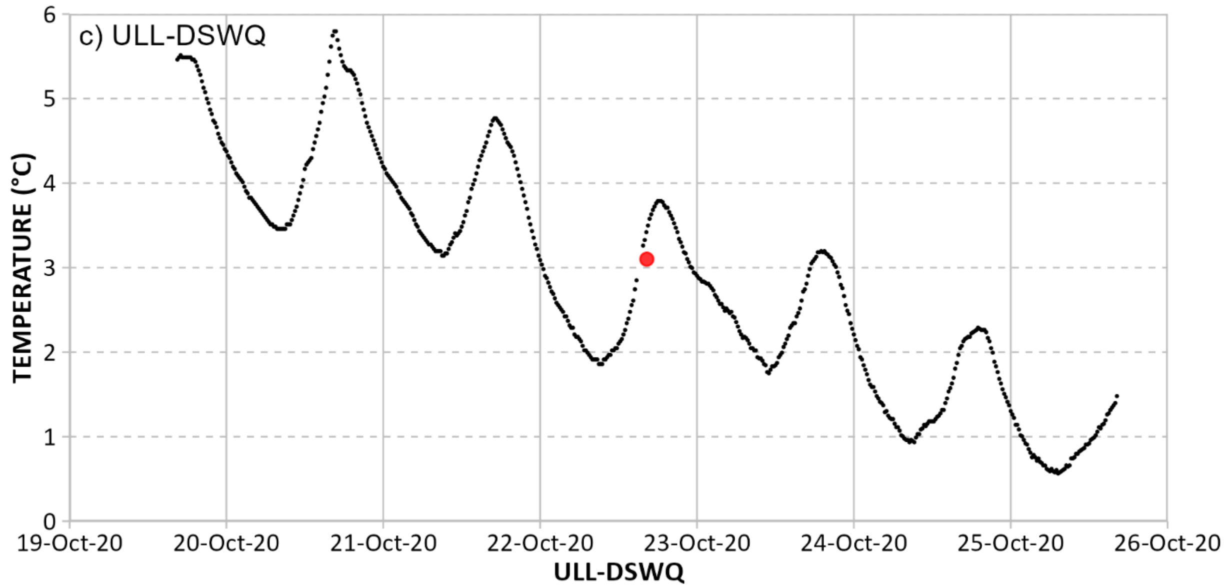

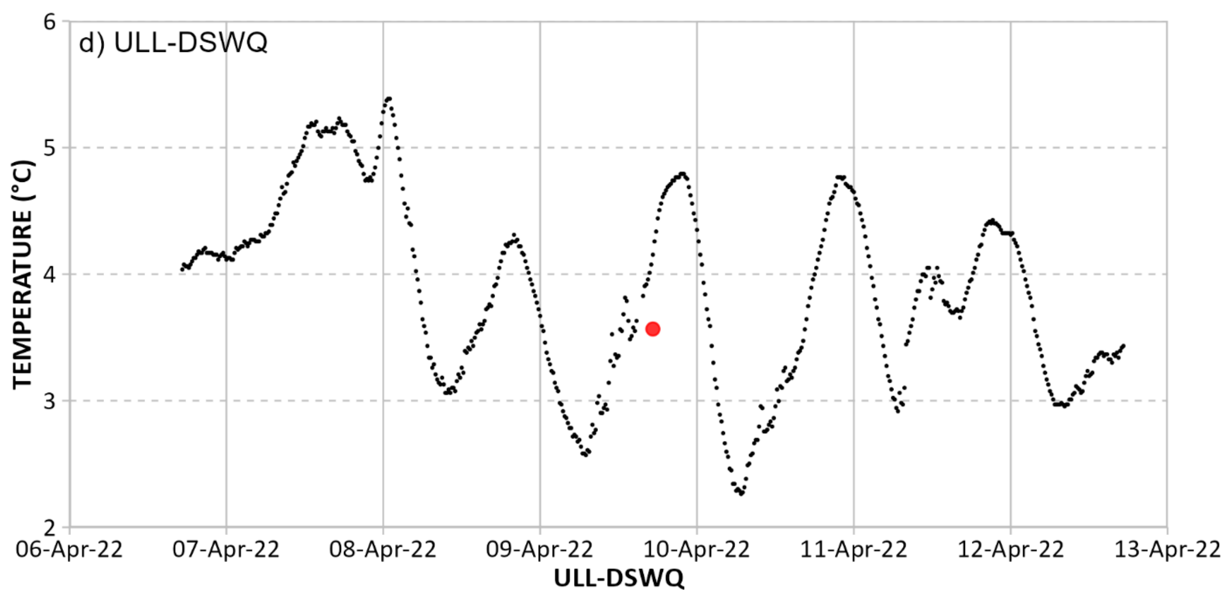

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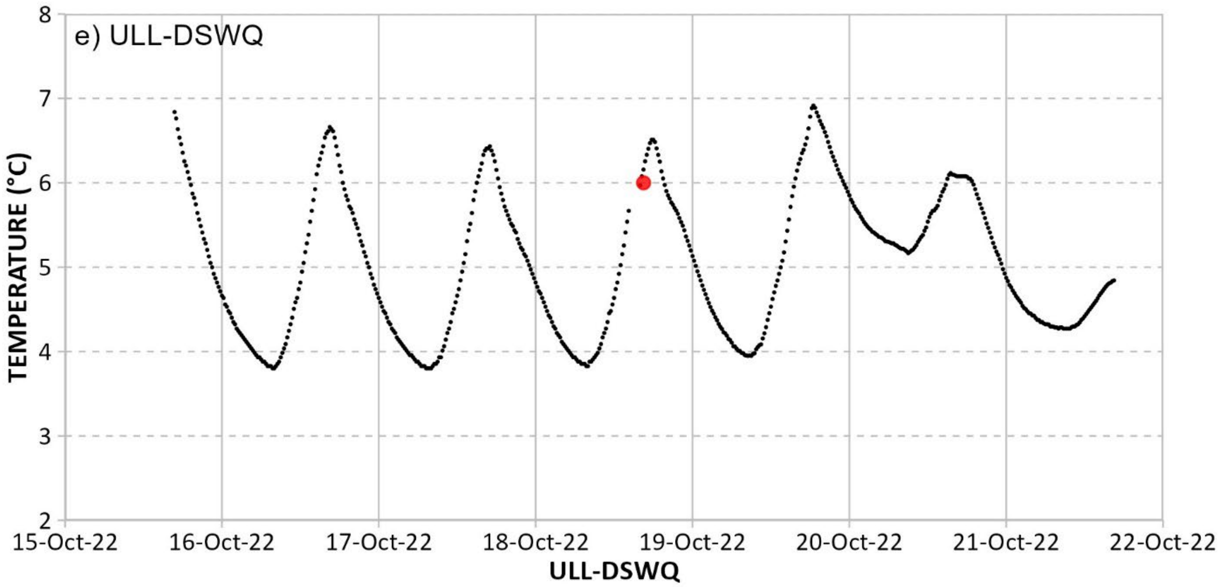
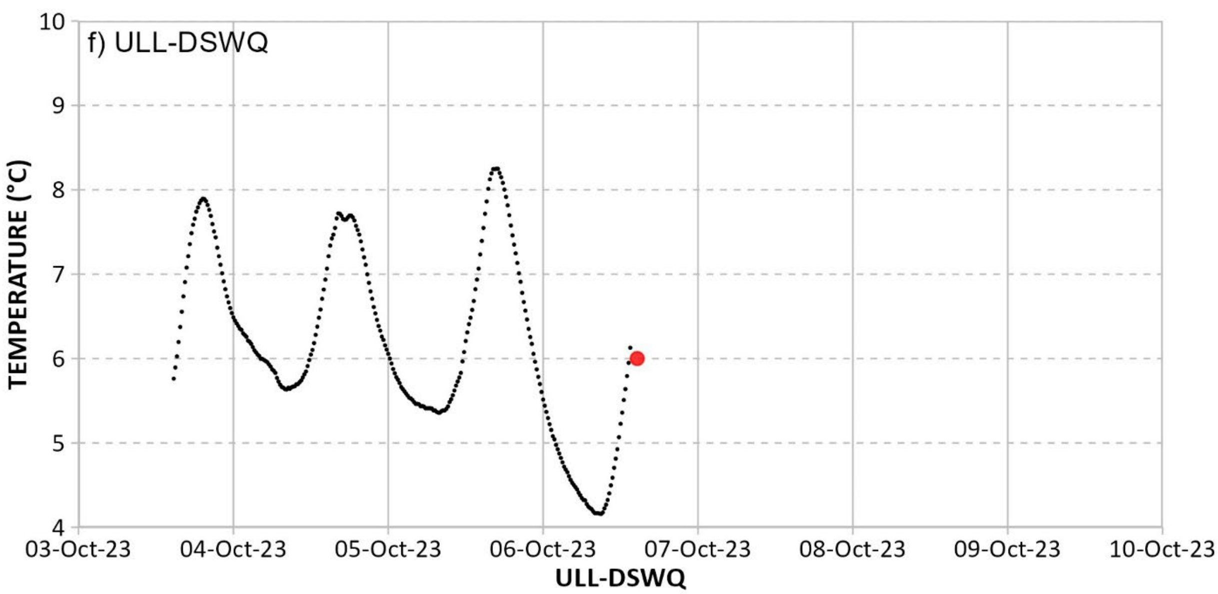
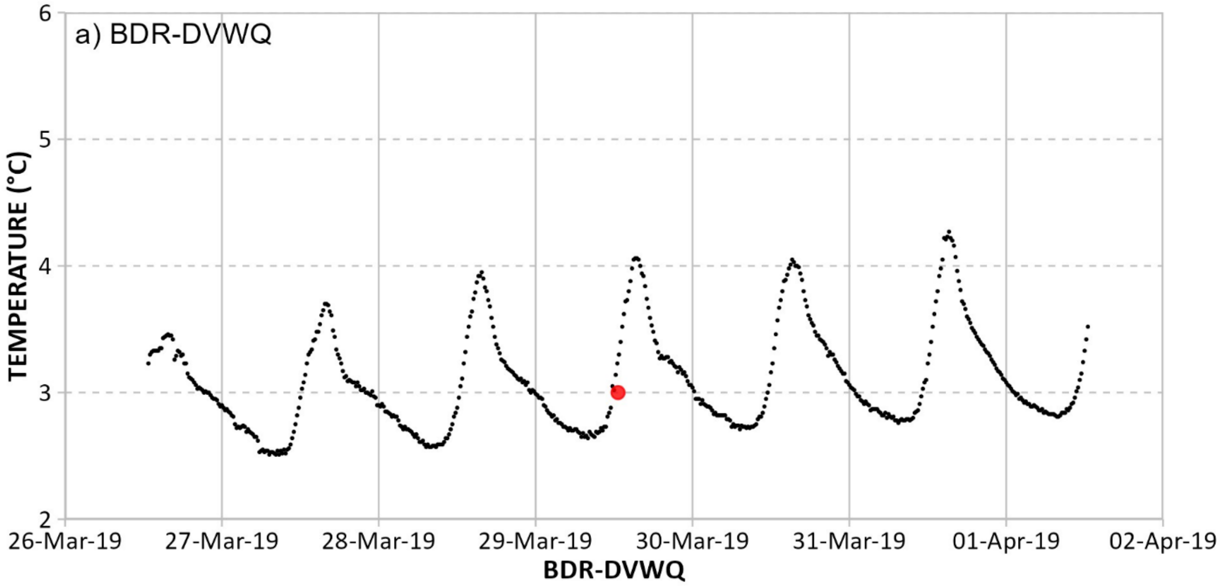
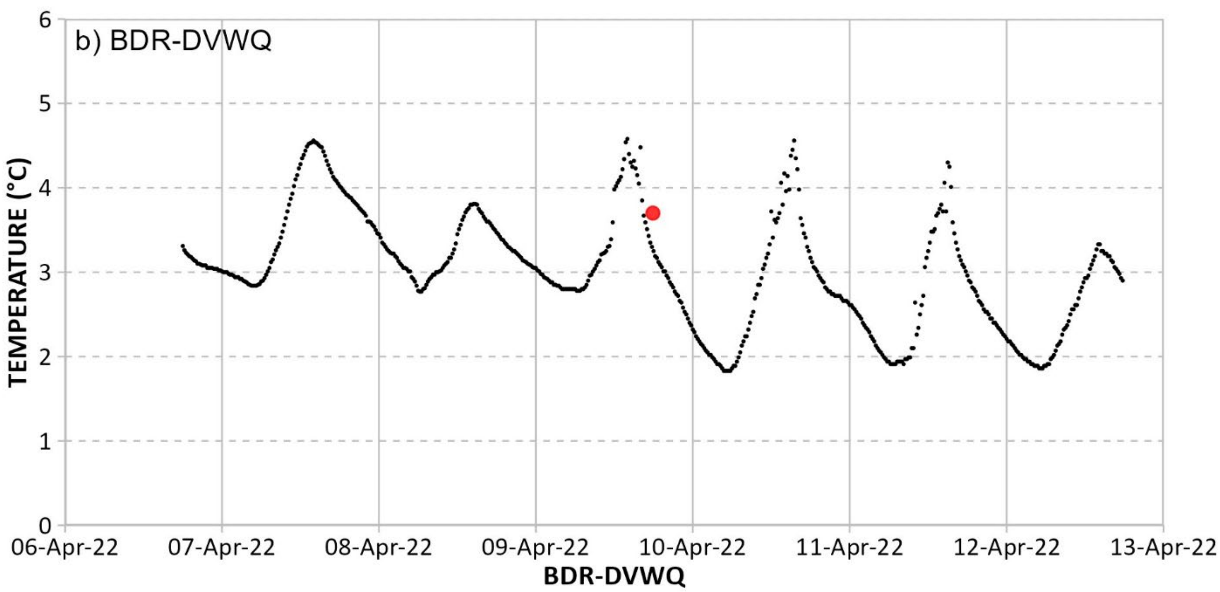




1.2. Boulder Creek

Figure 5. Spot temperature QA/QC plots for BDR-DVWQ.





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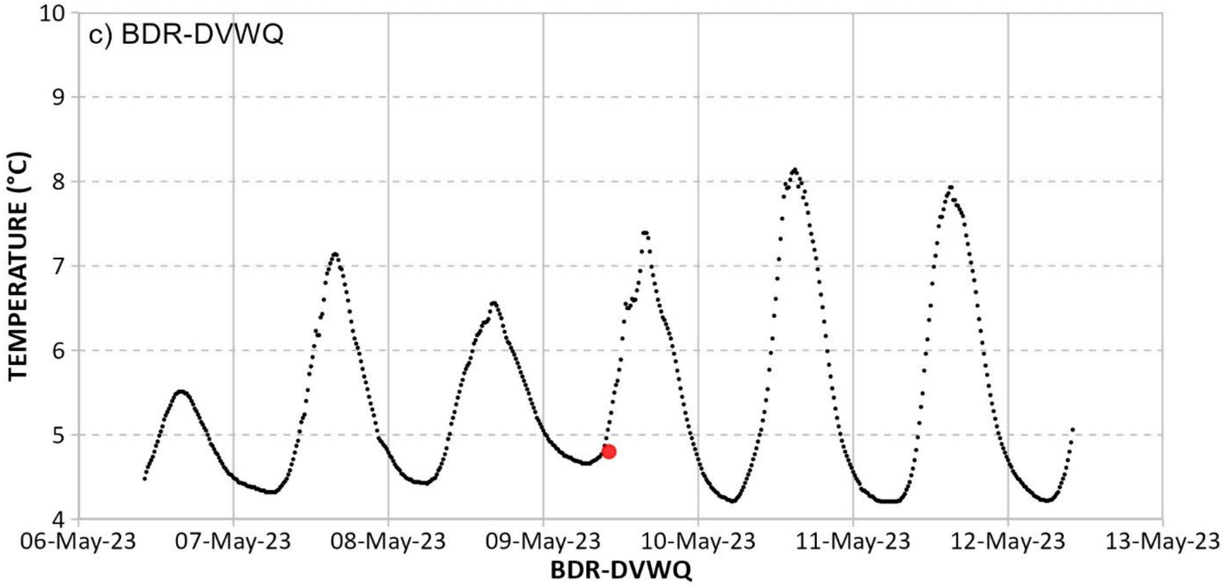


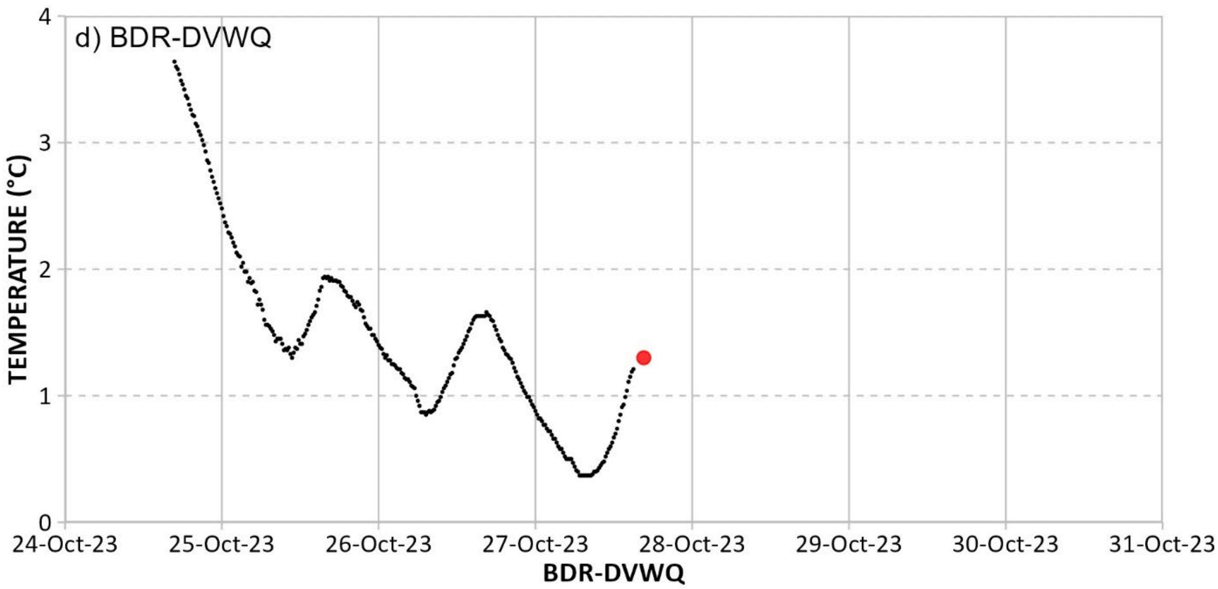
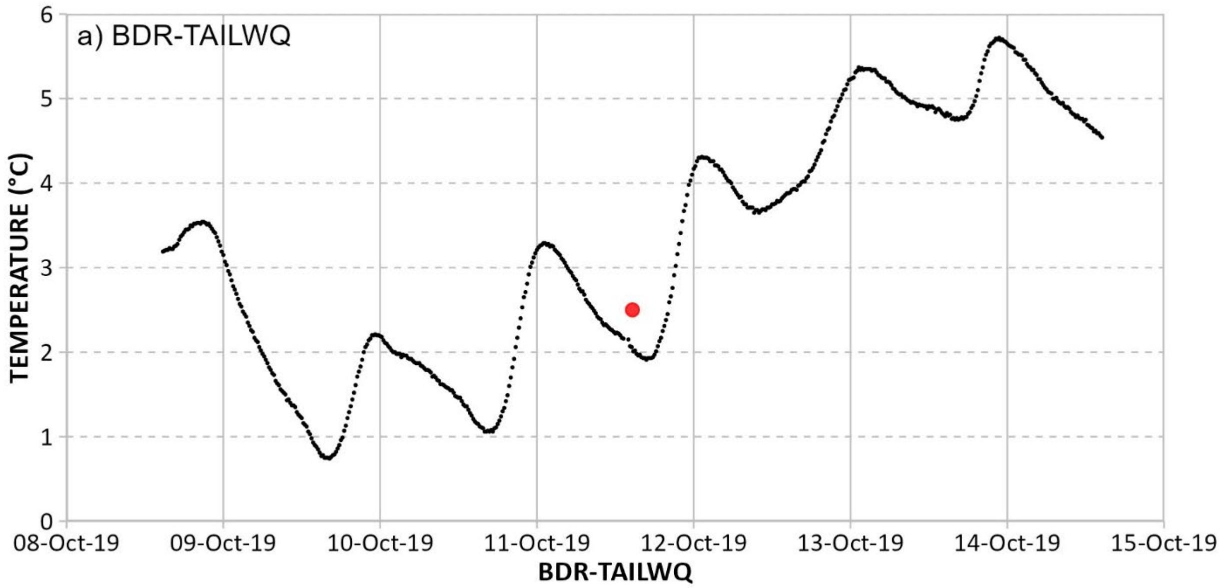
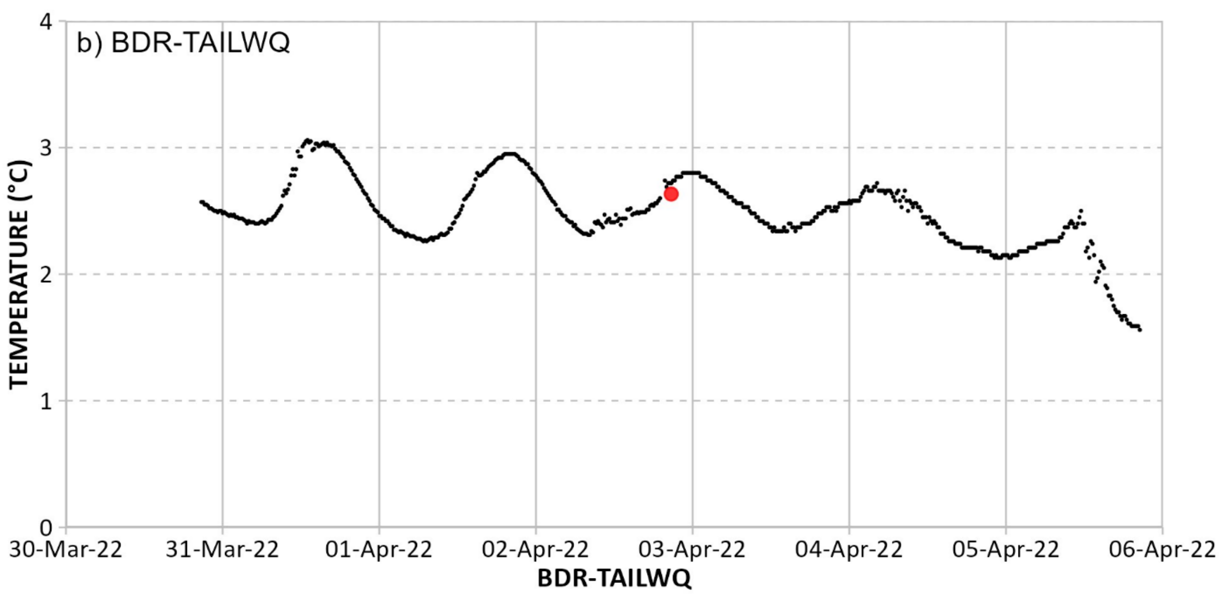


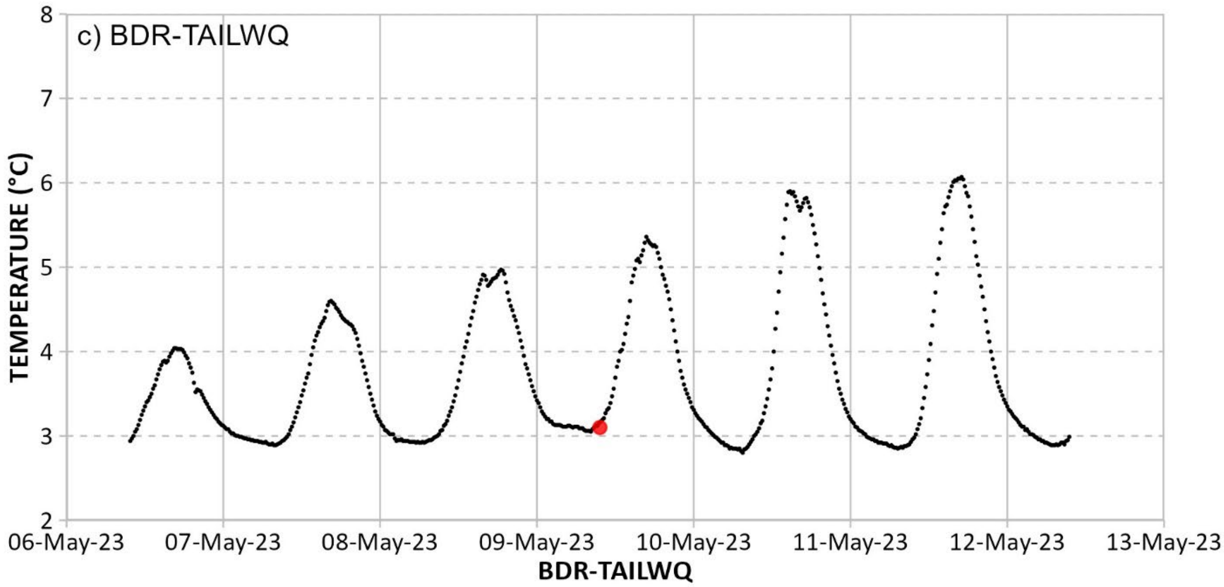
Figure 6. Spot temperature QA/QC plots for BDR-TAILWQ.





ECOFISH RESEARCH

Figure 6. Continued.



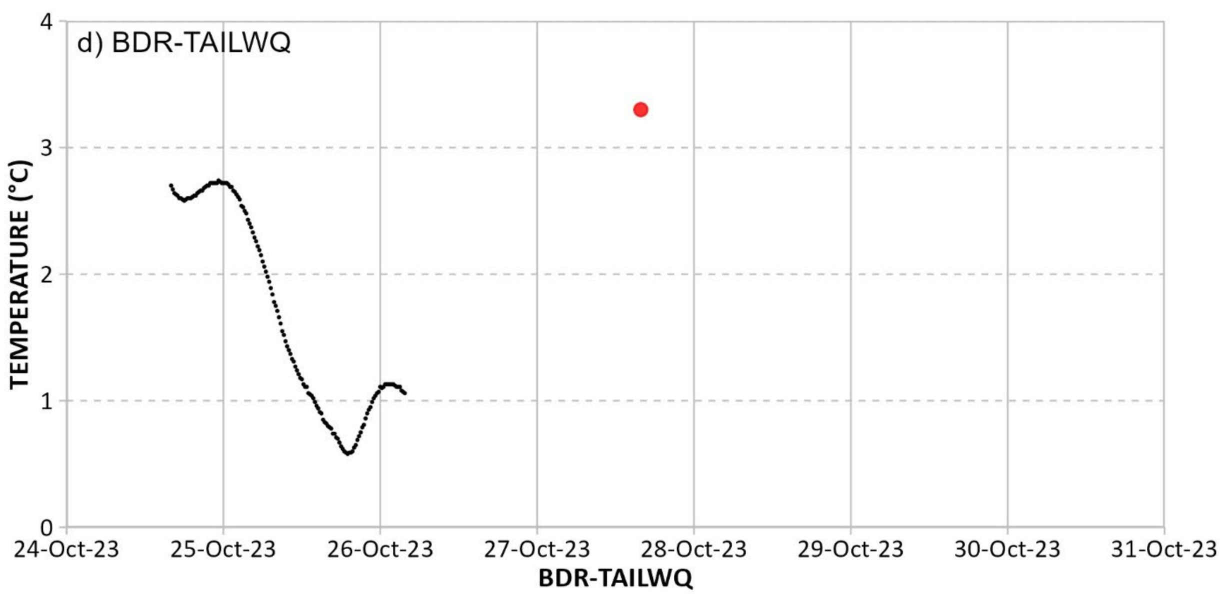
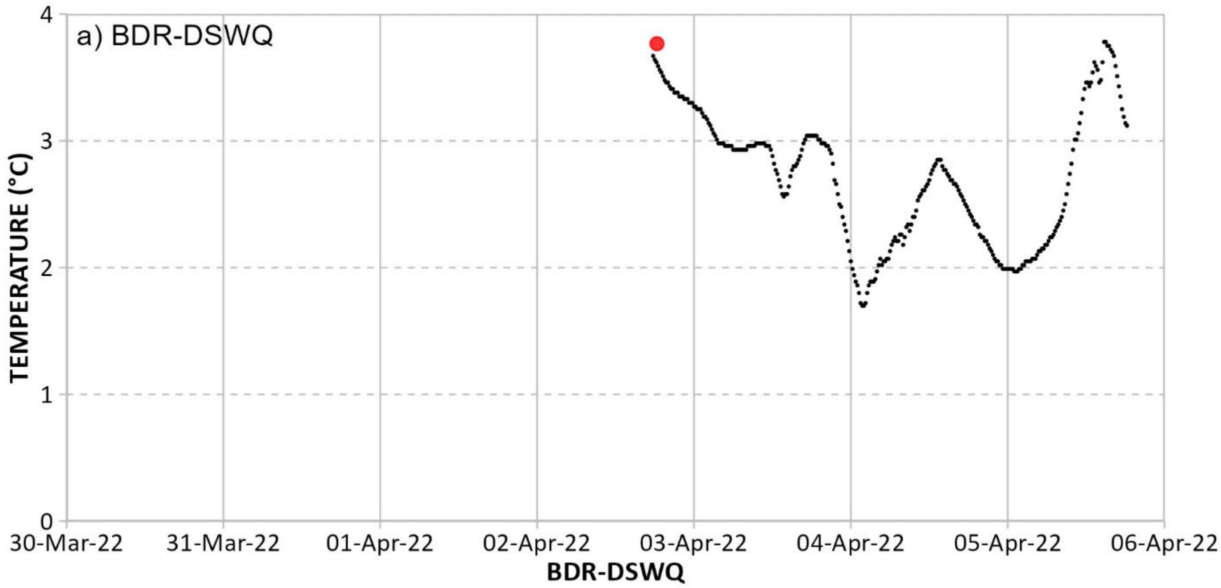
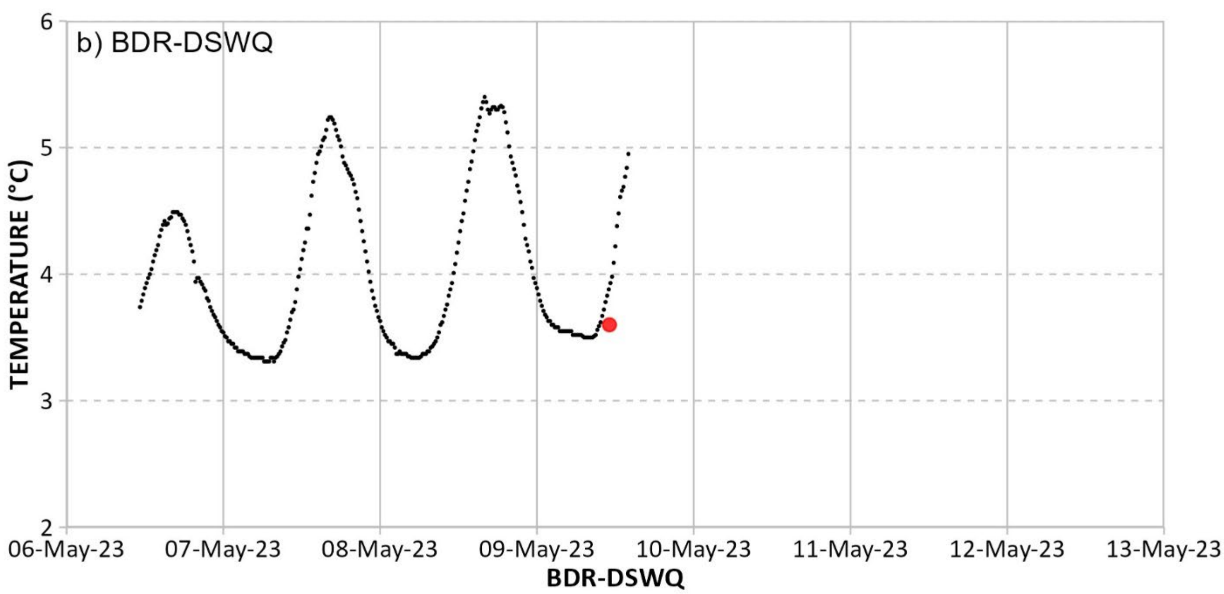


Figure 7. Spot temperature QA/QC plots for BDR-DSWQ.





Appendix E. Upper Lillooet River Geomorphic Photographic Monitoring

LIST OF FIGURES

Figure 1. Upper Lillooet River at ULL-USGMPP01, Overview photos taken on September 22, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.

b) Looking downstream.

Figure 1. Continued.

c) Looking towards river left.

d) Looking towards river right.

Figure 2. Upper Lillooet River at ULL-USGMPP02, Overview photos taken on September 22, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.

b) Looking downstream.

Figure 2. Continued.

c) Looking towards river left.


d) Looking towards river right.


Figure 3. Upper Lillooet River at ULL-USGMPP03, Overview photos taken on September 22, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.

b) Looking downstream.

Figure 3. Continued.

c) Looking towards river left.

d) Looking towards river right.

Figure 4. Upper Lillooet River at ULL-USGMPP04, Overview photos taken on September 22, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.

b) Looking downstream.

Figure 4. Continued.

c) Looking towards river left.

d) Looking towards river right.

Figure 5. Upper Lillooet River at ULL-USGMPP05, Overview photos taken on September 22, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.


b) Looking downstream.


Figure 5. Continued.

c) Looking towards river left.

d) Looking towards river right.

Appendix F. Boulder Creek Geomorphic Photographic Monitoring

LIST OF FIGURES

Figure 1. Boulder Creek at BDR-USGMPP01, Overview photos taken on September 24, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.


b) Looking downstream.


Figure 1. Continued.

c) Looking towards river left.

d) Looking towards river right.

Figure 2. Boulder Creek at BDR-USGMPP02, Overview photos taken on September 24, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.

b) Looking downstream.

Figure 2. Continued.

c) Looking towards river left.

d) Looking towards river right.

Figure 3. Boulder Creek at BDR-USGMPP03, Overview photos taken on September 24, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.

b) Looking downstream.

Figure 3. Continued.

c) Looking towards river left.

d) Looking towards river right.

No Image Captured in 2023

Figure 4. Boulder Creek at BDR-USGMPP04, Overview photos taken on September 24, 2016 (left) and October 28, 2023 (right).

a) Looking upstream.

b) Looking downstream.

Figure 4. Continued.

c) Looking towards river left.

d) Looking towards river right.

Figure 5. Boulder Creek at BDR-USGMPP05, Overview Photos taken on September 24, 2016 (left) and October 28, 2023 (right).

a) Looking downstream.

b) Looking towards river left.

Figure 5. Continued.

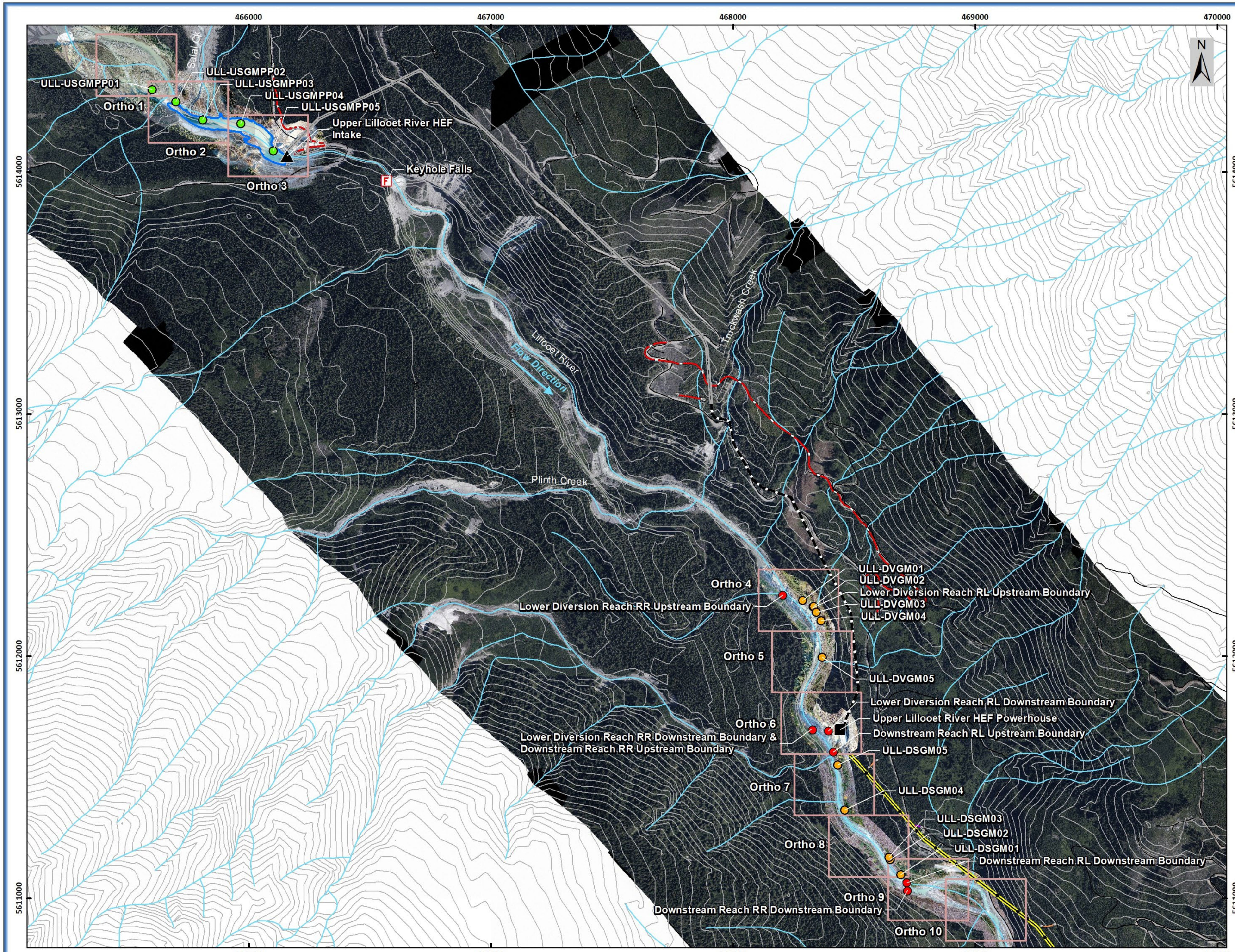
c) Looking towards river right.

Appendix G. Upper Lillooet River Orthomosaic Baseline and Year 5 – 2016 and 2023

LIST OF MAPS

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey



Legend

- Geomorphology Transect
- Headpond Oblique Photo Points
- Spawning Gravel Survey
- Falls/Obstruction
- Map Index

ULHP Infrastructure

- Intake
- Powerhouse
- New Facility Road
- New Tower Road
- Upgraded Existing Road
- Penstock
- Tunnel
- Transmission Line
- Estimated Headpond Backwater Extent
- Roads
- Forestry Service Road
- Contours (20 m)

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 100 200 400 600 800 m

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Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 1

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UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

- Headpond Oblique Photo Points

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 2

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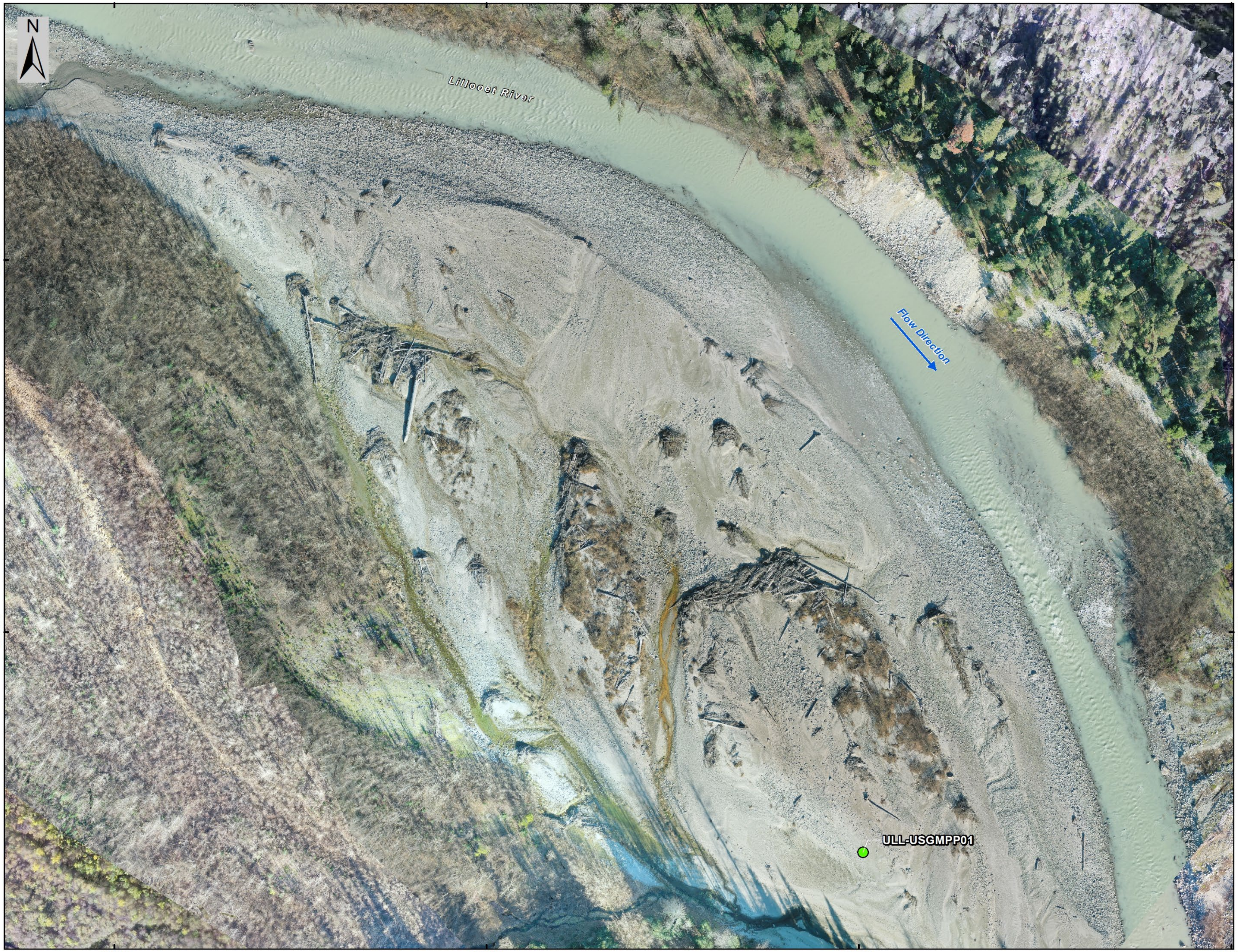

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

Headpond Oblique Photo Points

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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ECOFISH RESEARCH

Map 3

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UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

- Headpond Oblique Photo Points
- Estimated Headpond Backwater Extent

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 4

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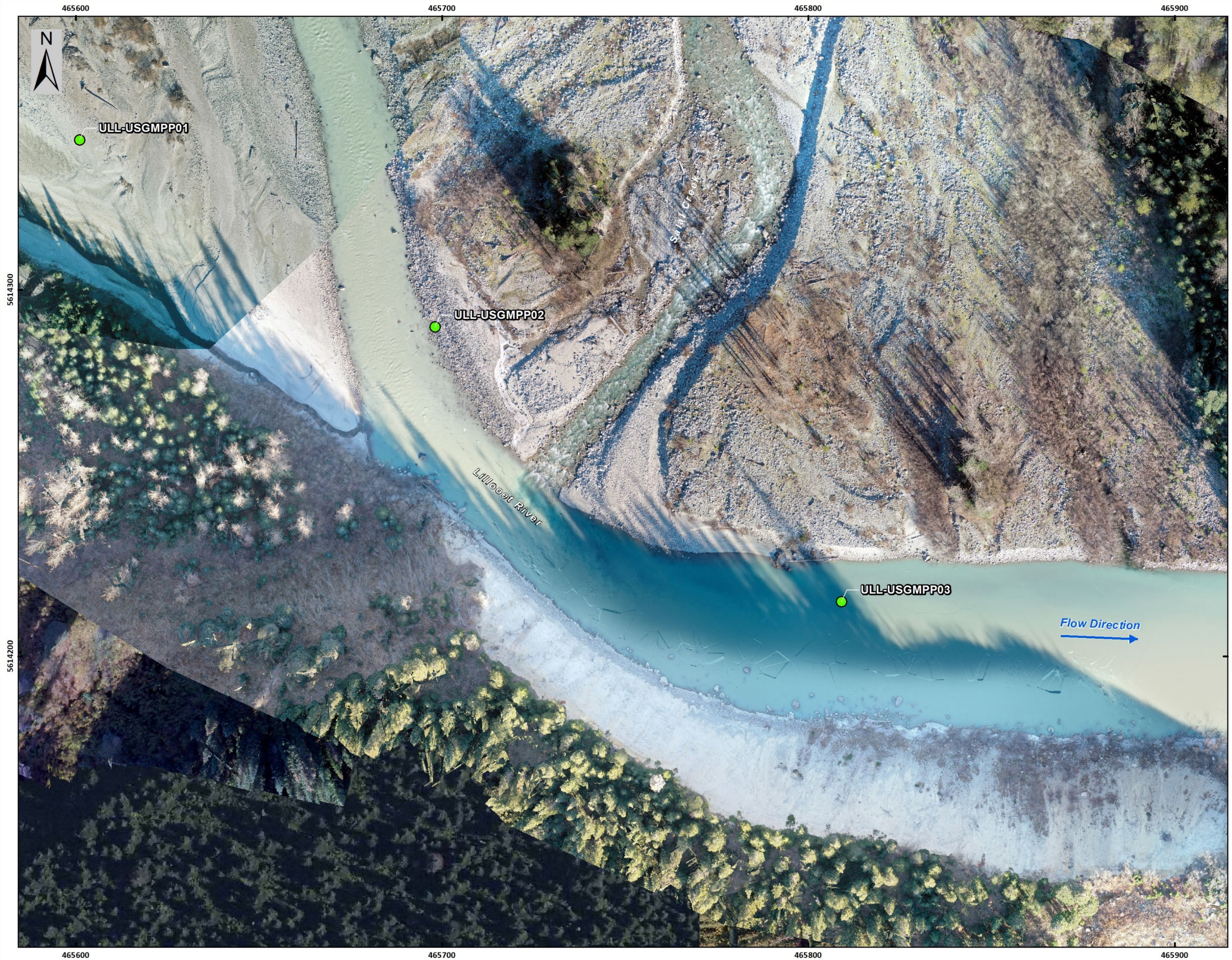

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

Headpond Oblique Photo Points

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 5

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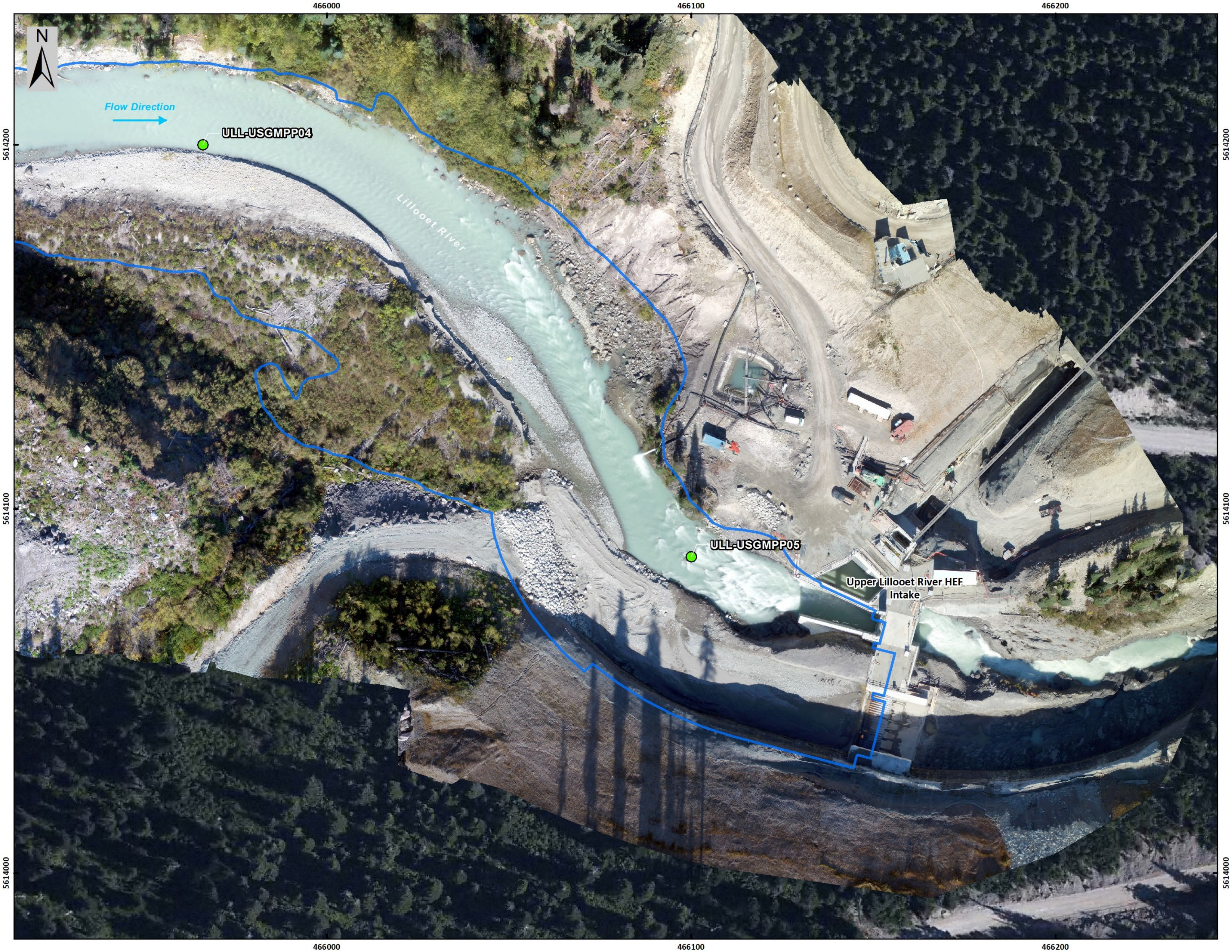

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

- Headpond Oblique Photo Points
- Tunnel
- Estimated Headpond Backwater Extent

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 6

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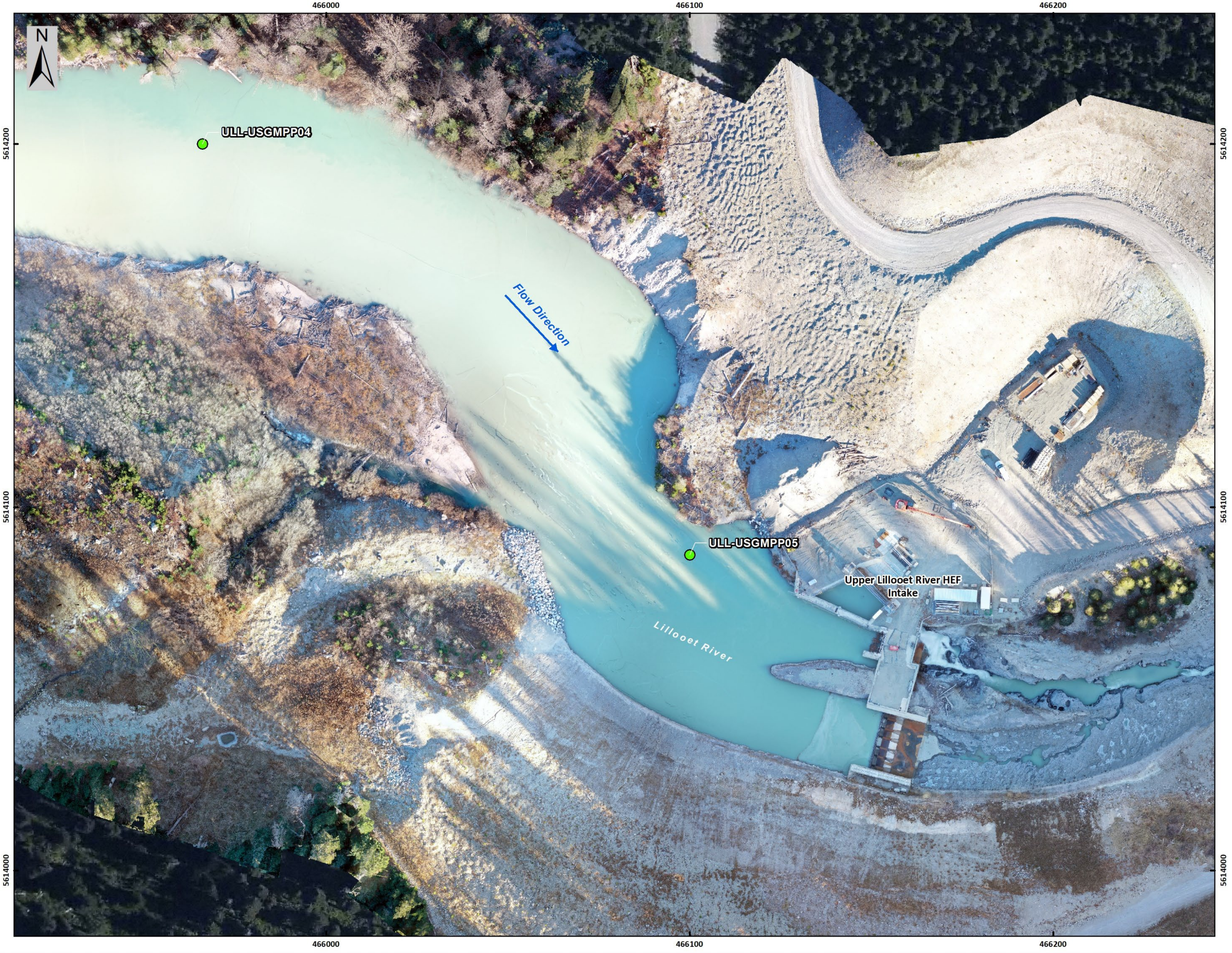
UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023



Legend

Headpond Oblique Photo Points

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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ECOFISH RESEARCH

Map 7

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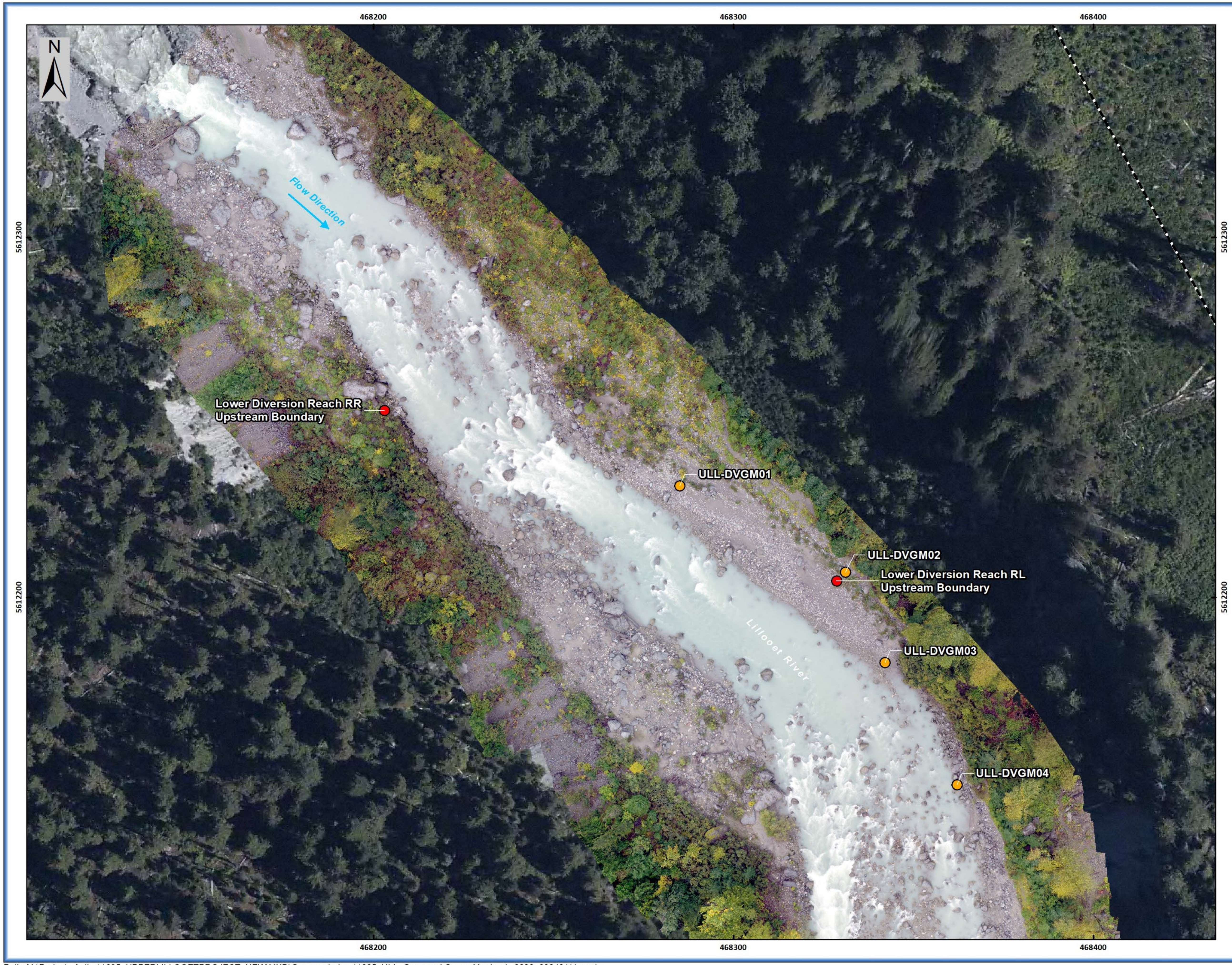

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

- Geomorphology Transect
- Spawning Gravel Survey
- Penstock

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 8

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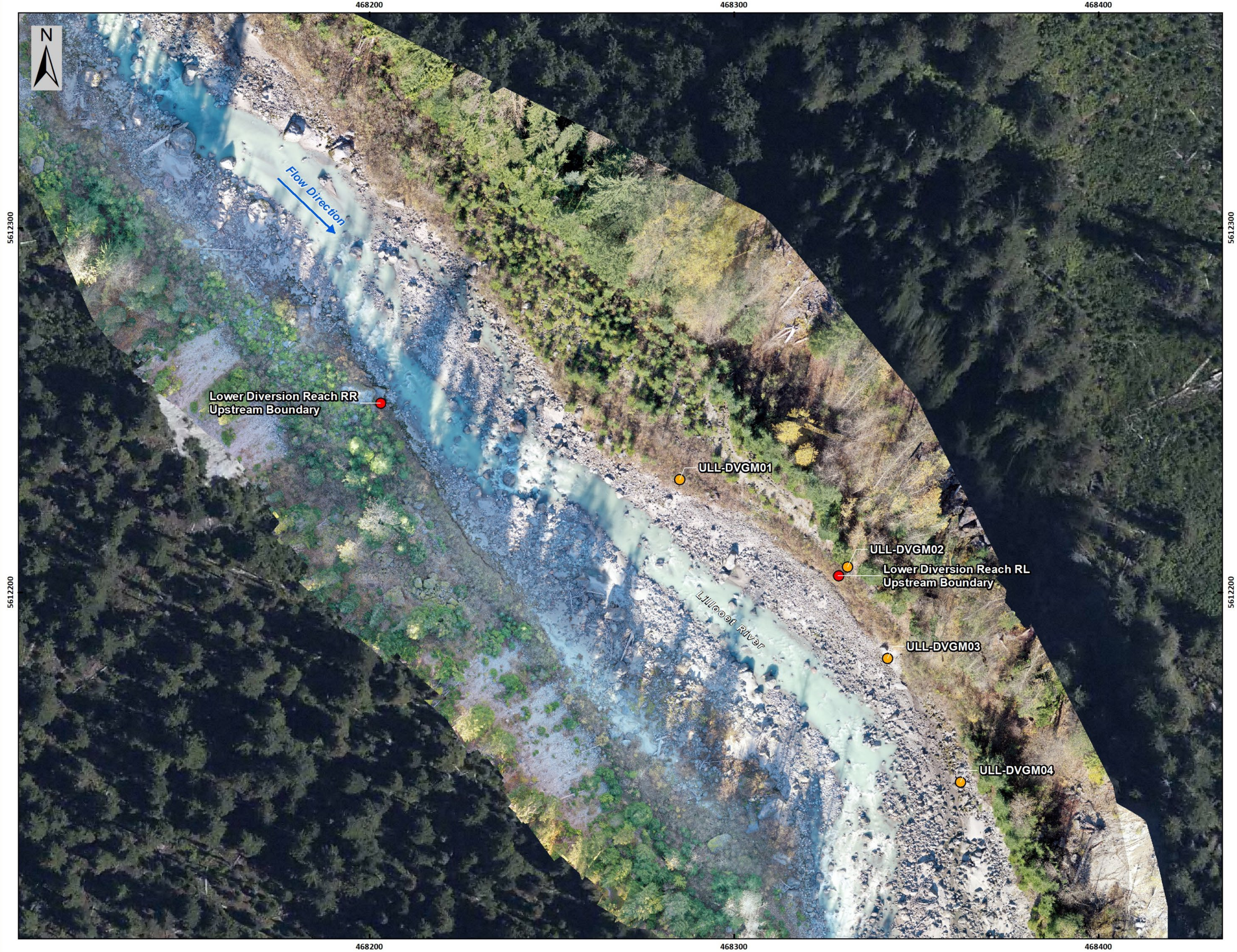

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

- Geomorphology Transect
- Spawning Gravel Survey

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 9

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UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

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ECOFISH RESEARCH

Map 10

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UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

- Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 11

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UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

- Spawning Gravel Survey
- Penstock
- Transmission Line

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 12

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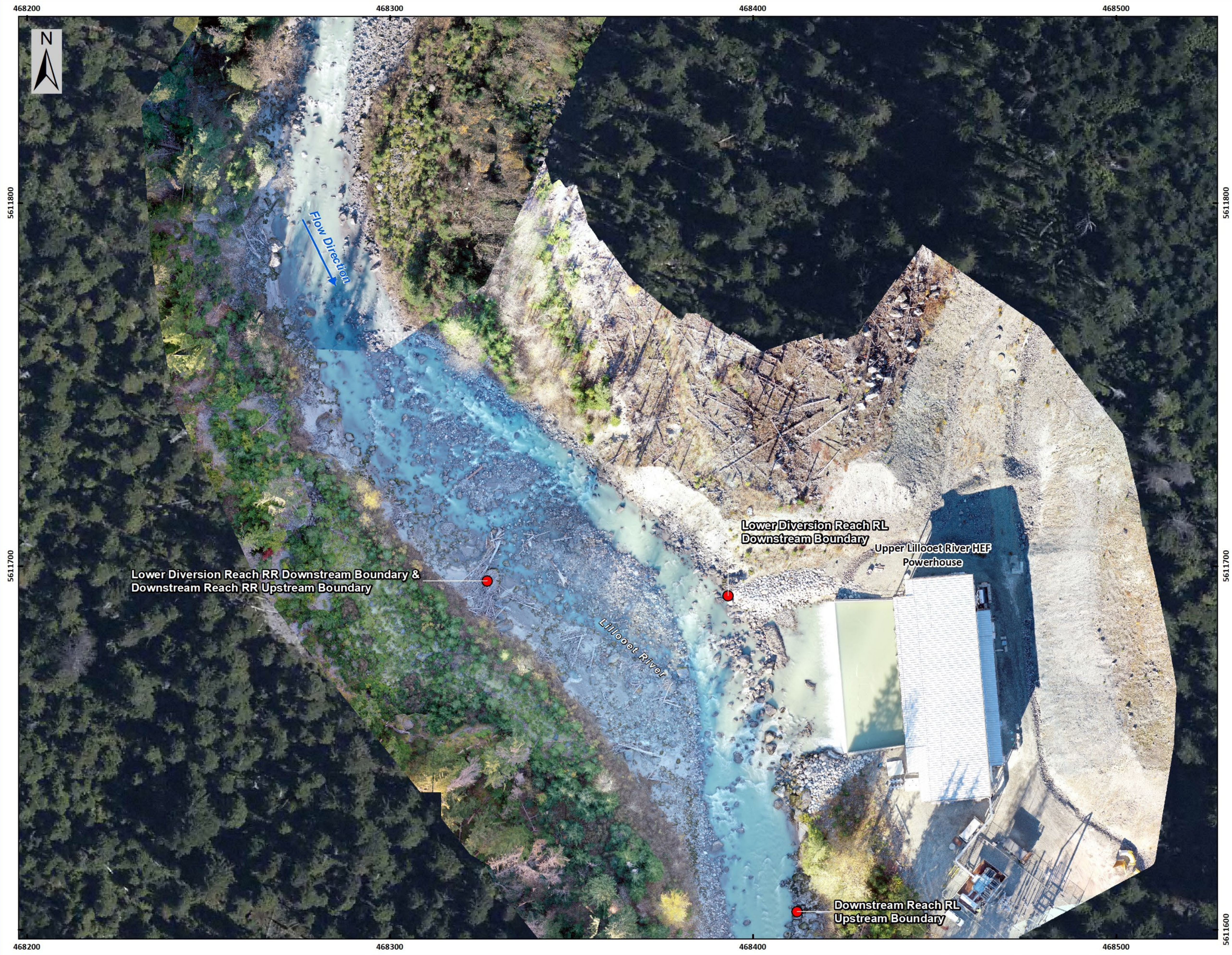
UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023



Legend

● Spawning Gravel Survey

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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ECOFISH RESEARCH

Map 13

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UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

- Geomorphology Transect
- Transmission Line

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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ECOFISH RESEARCH

Map 14

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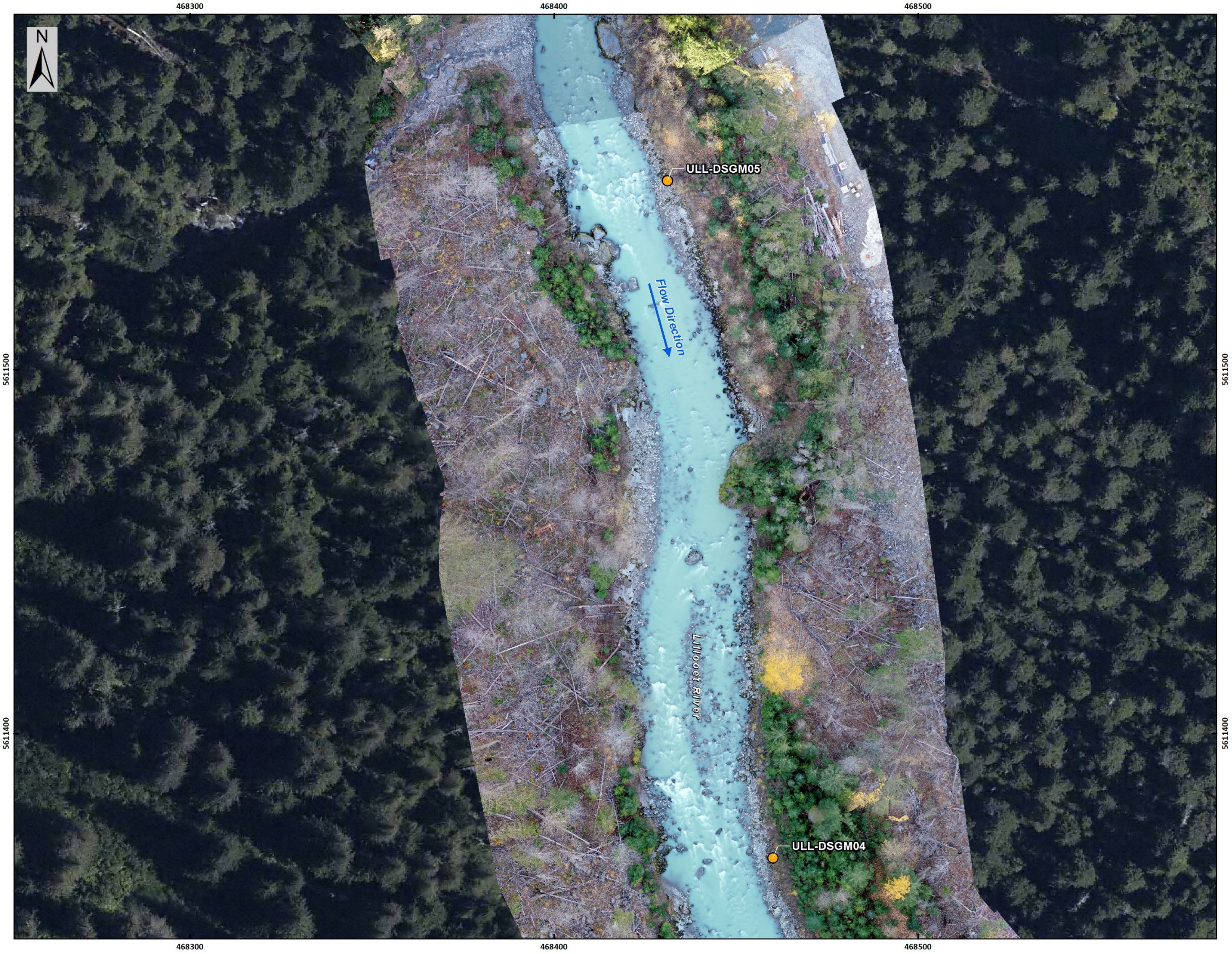

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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Map 15

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UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016

Legend

- Geomorphology Transect
- Transmission Line

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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Date Saved: 1/11/2024
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 16

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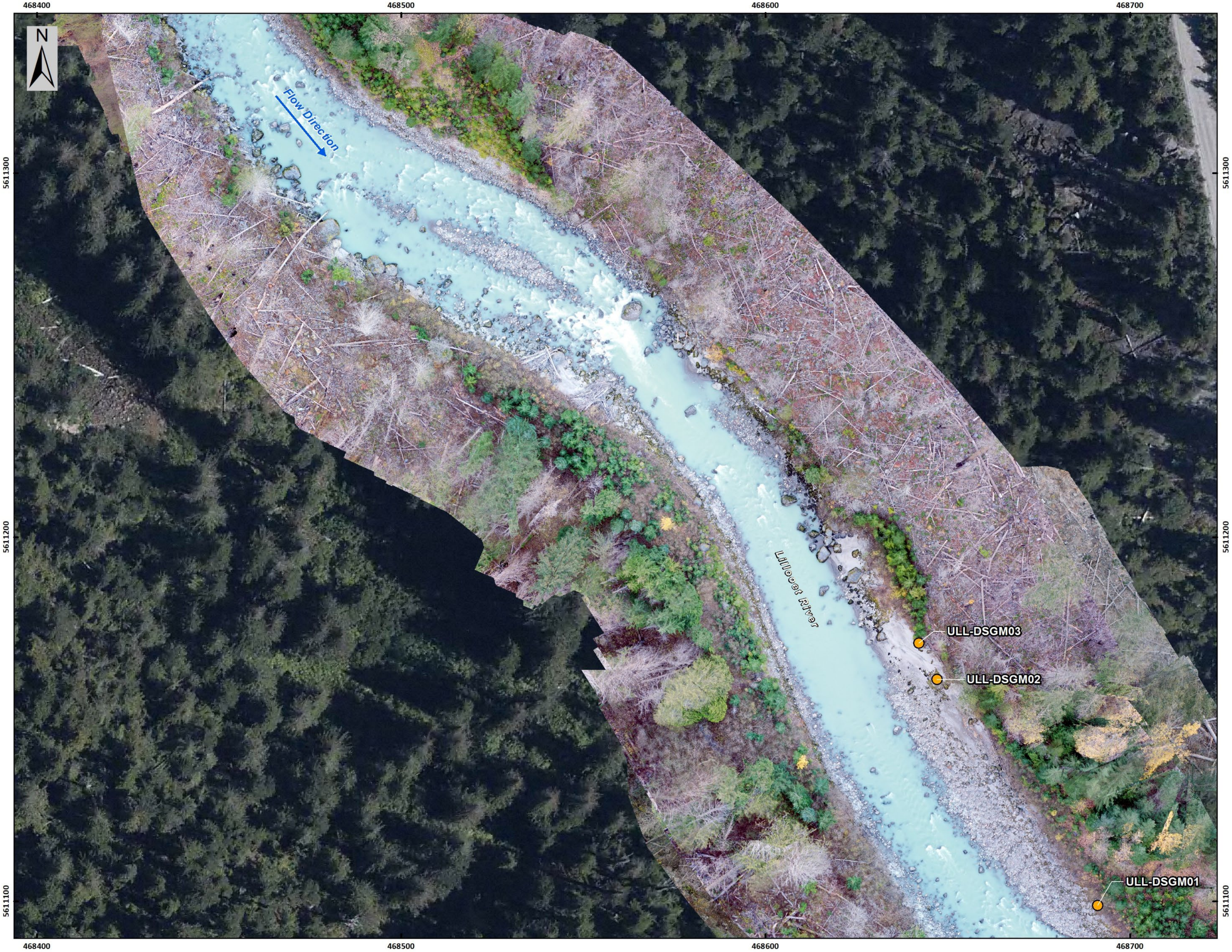

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

- Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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Scale: 1:1,000

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Date Saved: 1/11/2024
Coordinate System: WGS 1984 UTM Zone 10N

ECOFISH RESEARCH

Map 17

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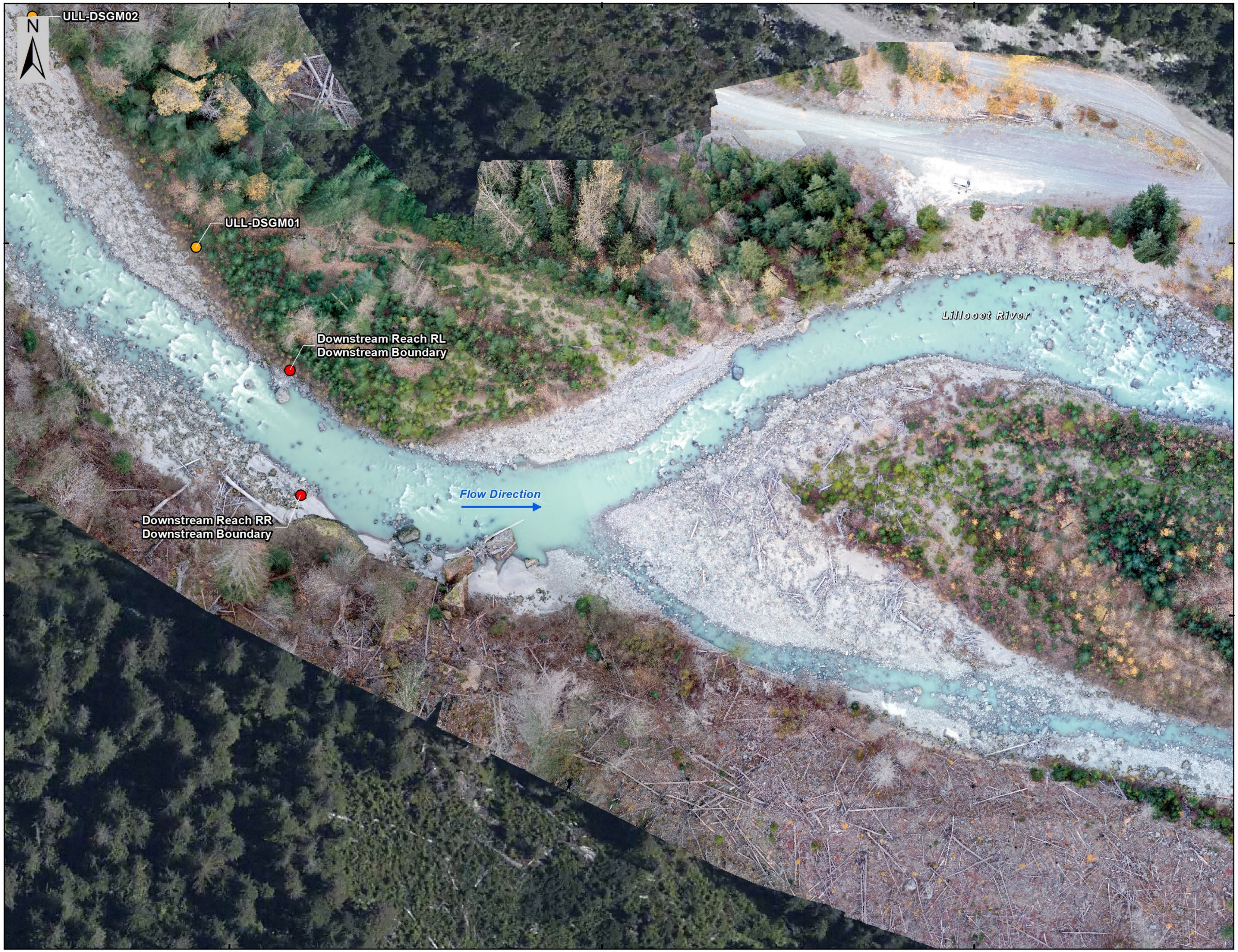

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

- Geomorphology Transect
- Spawning Gravel Survey

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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Date Saved: 1/11/2024
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ECOFISH RESEARCH

Map 19

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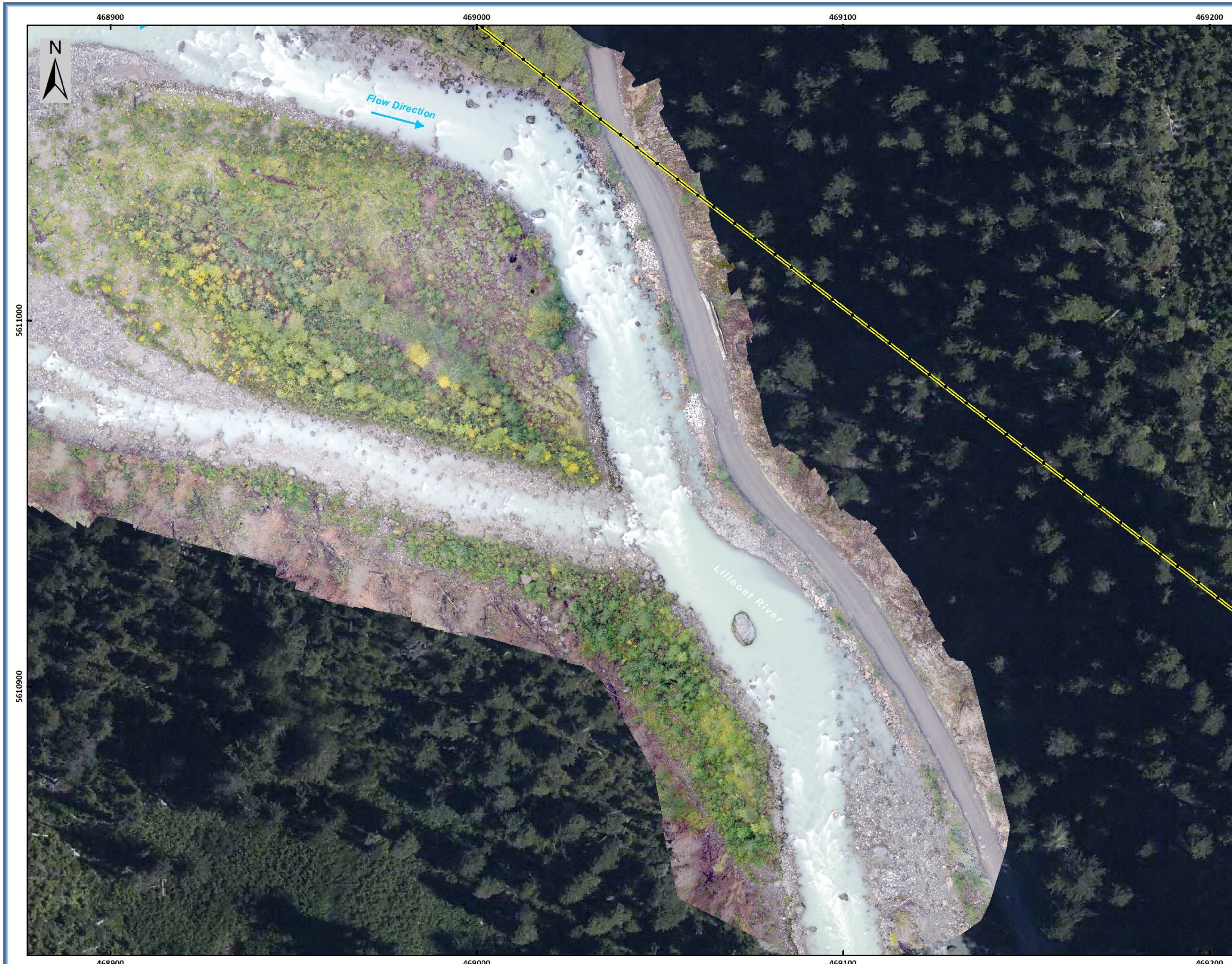
UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2016



Legend

Transmission Line

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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ECOFISH RESEARCH

Map 20

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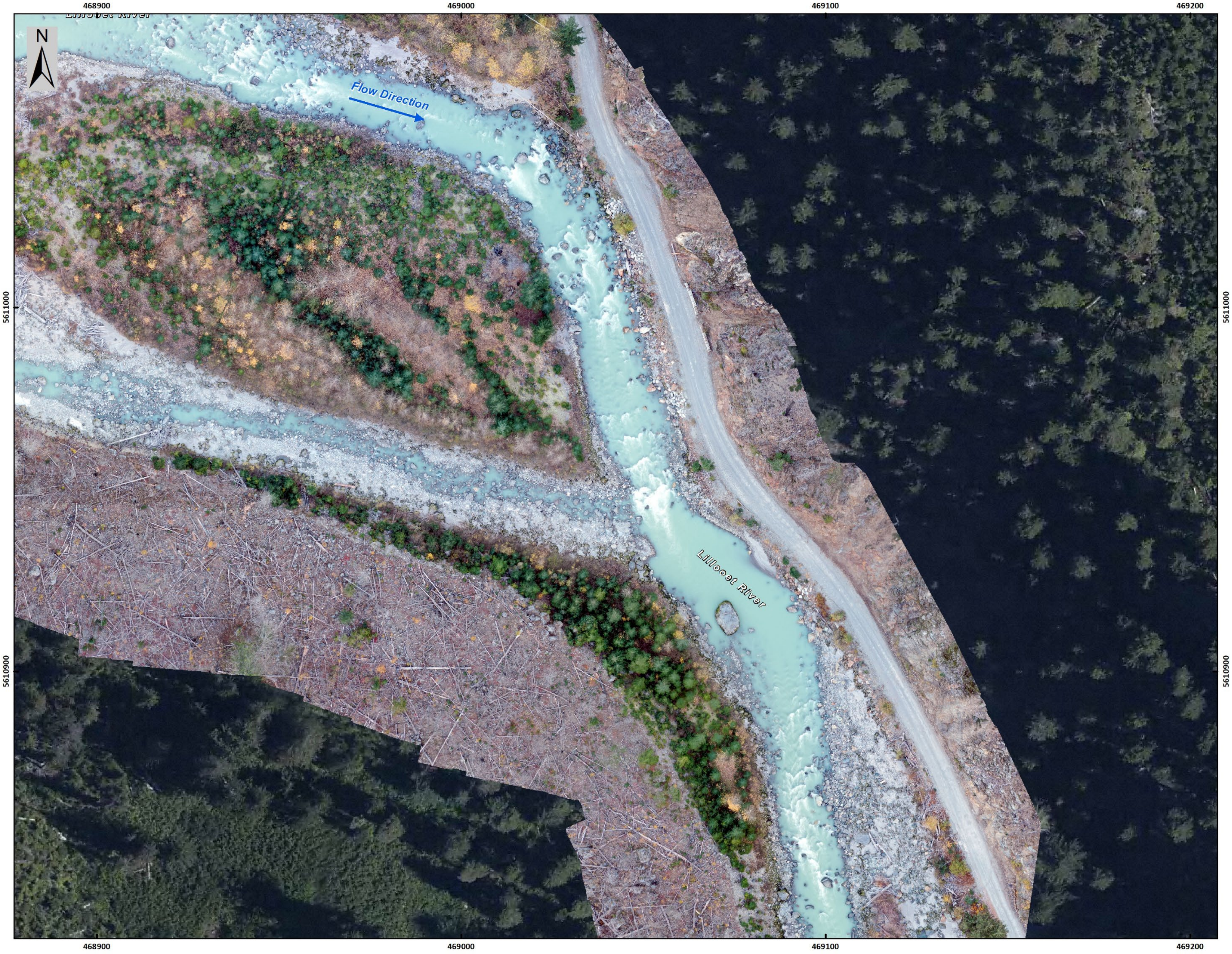

UPPER LILLOOET HYDRO PROJECT

Upper Lillooet River Geomorphic Survey 2023

Legend

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

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ECOFISH RESEARCH

Map 21

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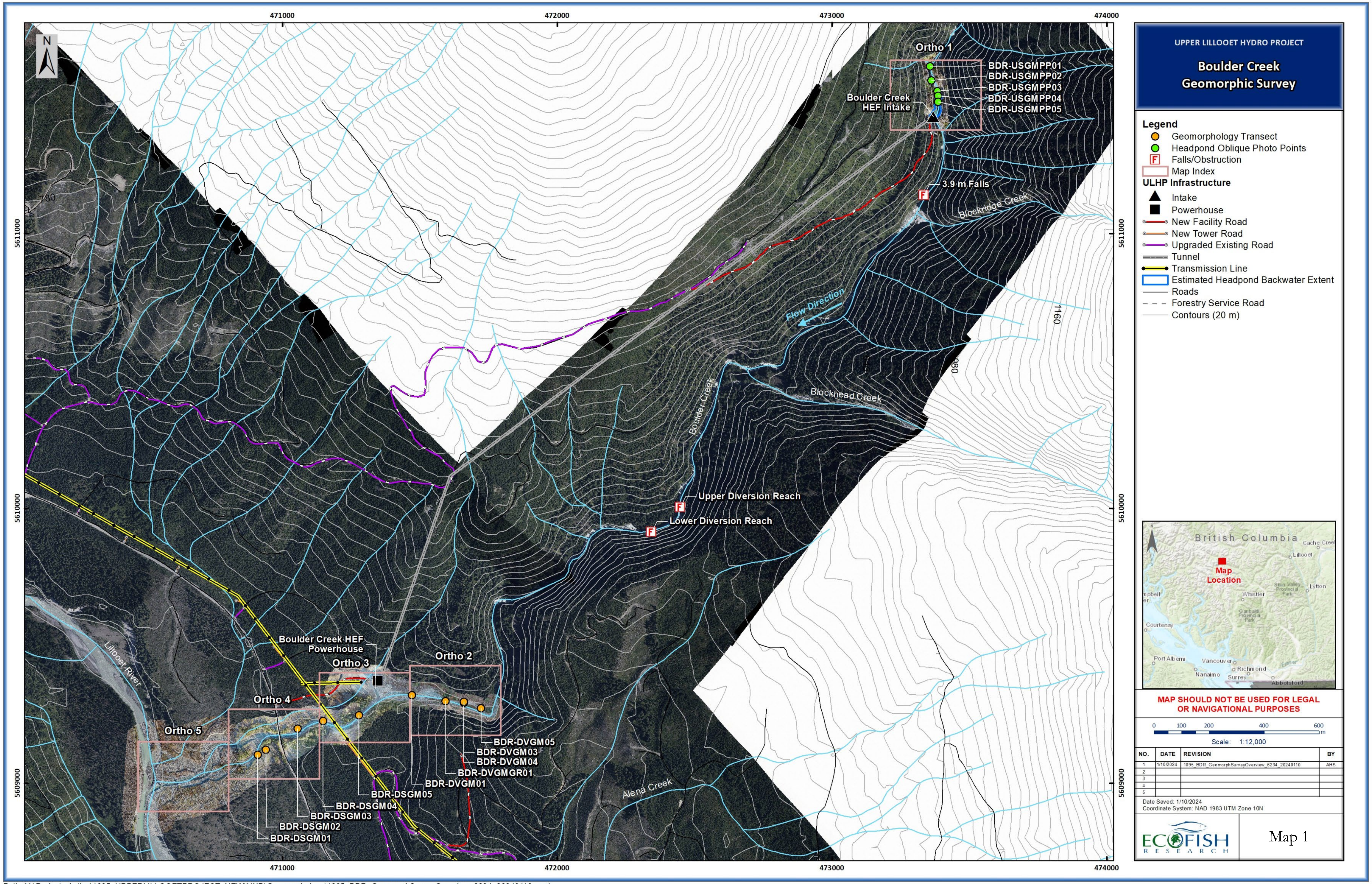
Appendix H. Boulder Creek Orthomosaic Baseline and Year 5 Photographs – 2016 and 2023

LIST OF MAPS



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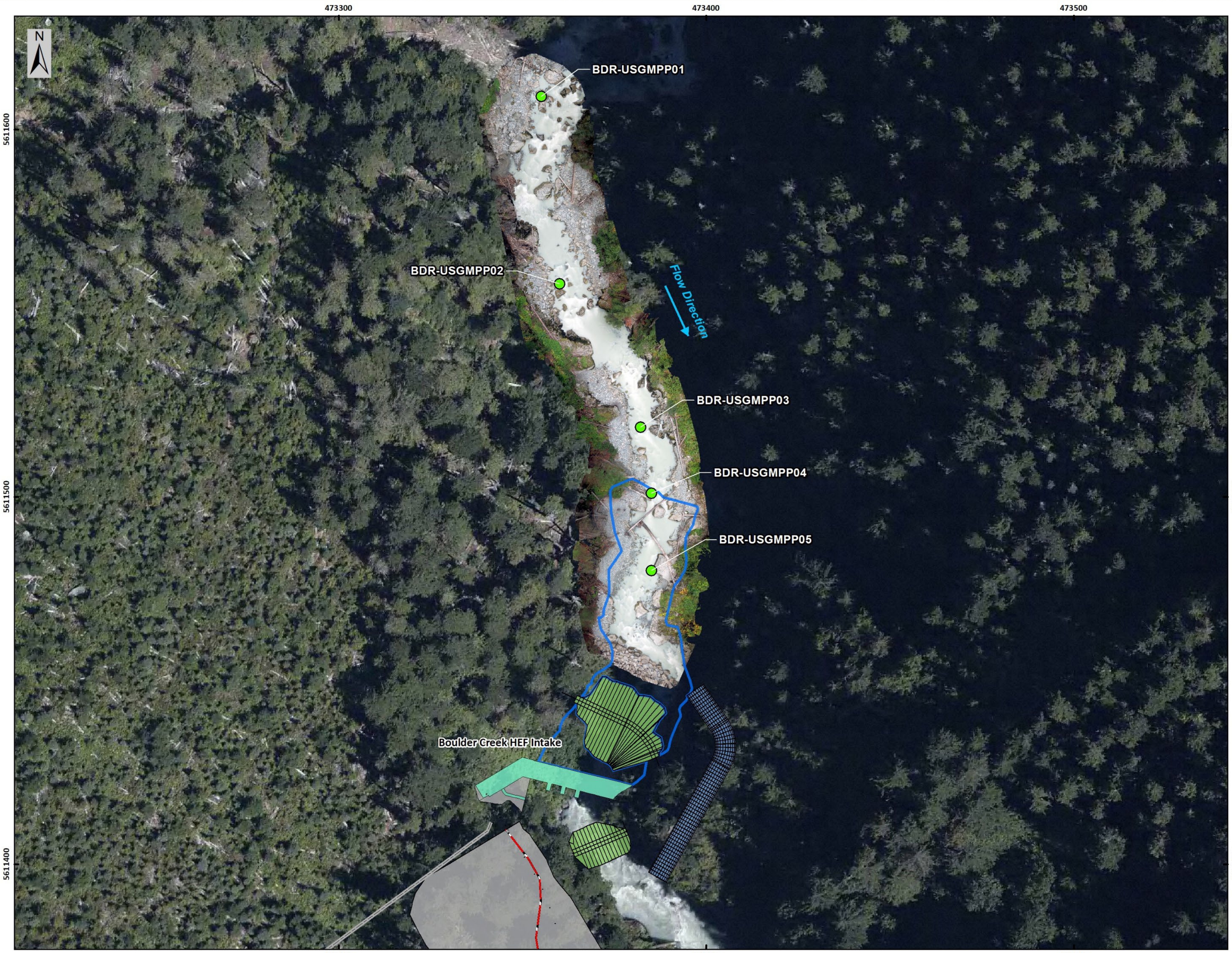

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2016

Legend

- Headpond Oblique Photo Points

ULHP Infrastructure

- New Facility Road
- Tunnel
- Estimated Headpond Backwater Extent
- Intake Structure
- Temporary Diversion Berm
- Temporary Diversion Channel
- Permanent Clearing Area

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

NO.	DATE	REVISION	BY
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Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 2

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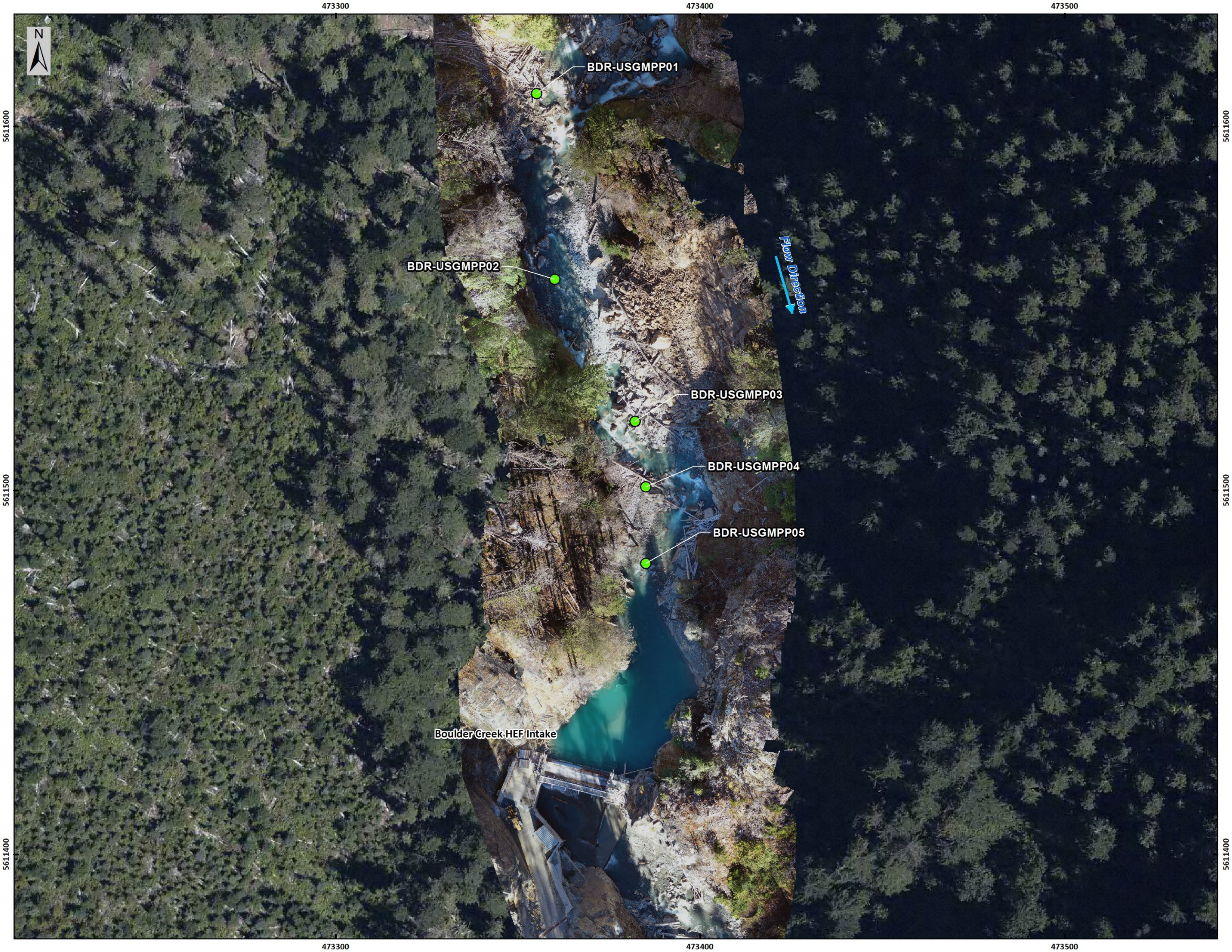

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2023

Legend

- Headpond Oblique Photo Points

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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Date Saved: 1/10/2024
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 3

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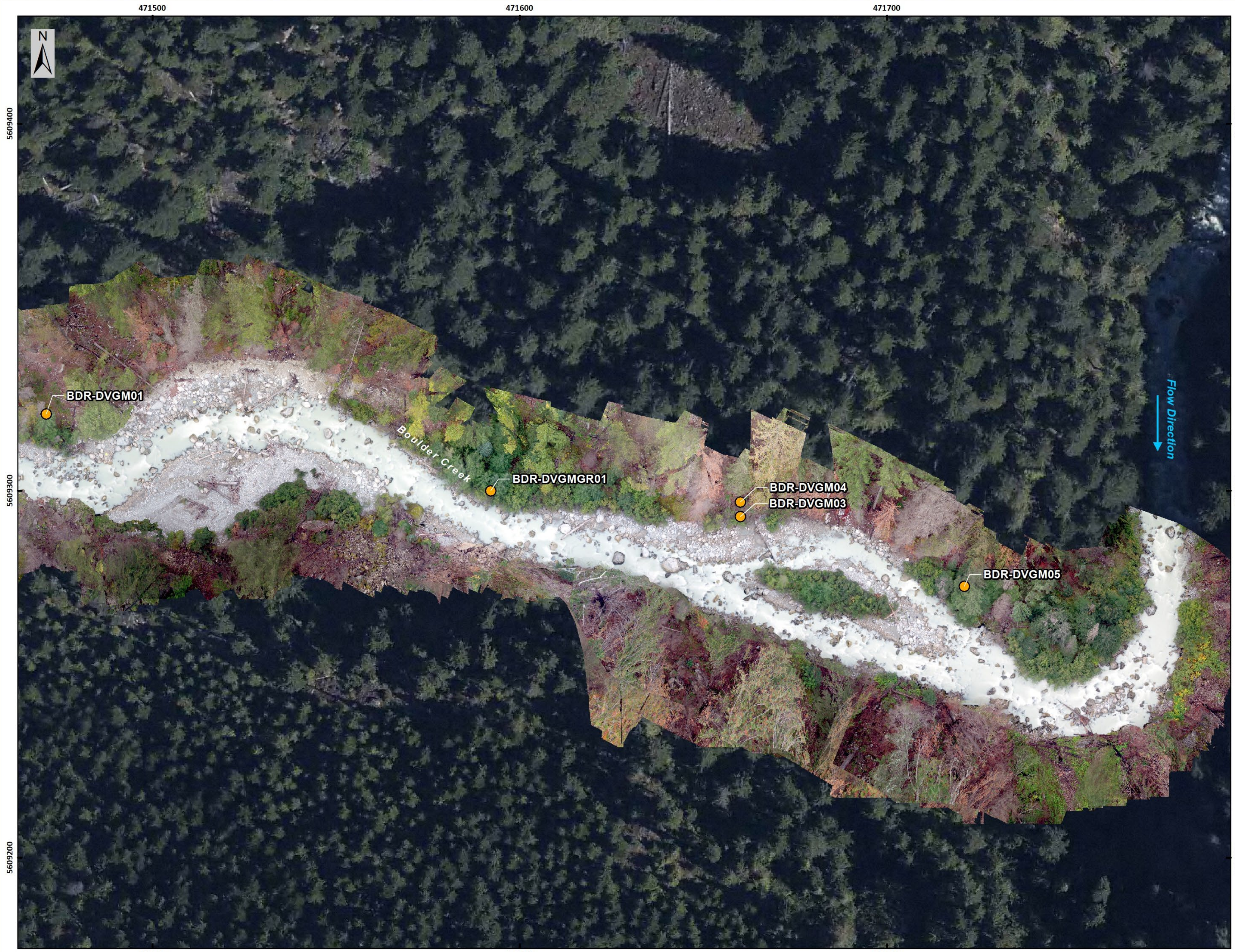

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2016

Legend

Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 4

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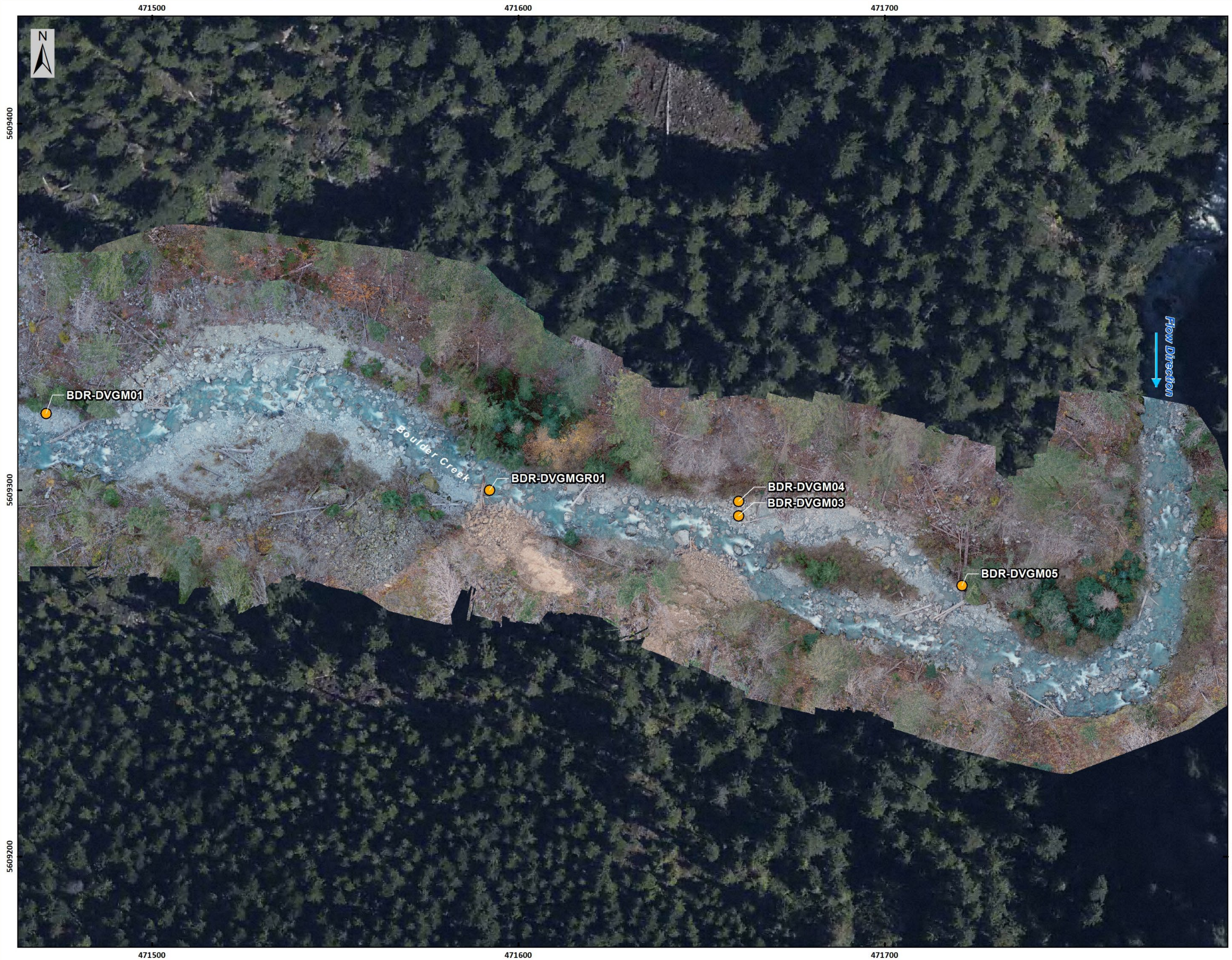

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2023

Legend

Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 5

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Geomorphology\1095_BDR_GeomorphSurveyMapbook_6234_20240110.mxd

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2016

Legend

- Geomorphology Transect

ULHP Infrastructure

- New Facility Road
- New Tower Road
- Tunnel
- Transmission Line
- Rip Rap
- Powerhouse Building
- Switchyard
- Tailrace
- Spoil/Borrow Area
- Permanent Clearing Area
- Temporary Clearing Area
- New Road ROW

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

NO.	DATE	REVISION	BY
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Date Saved: 1/10/2024
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 6

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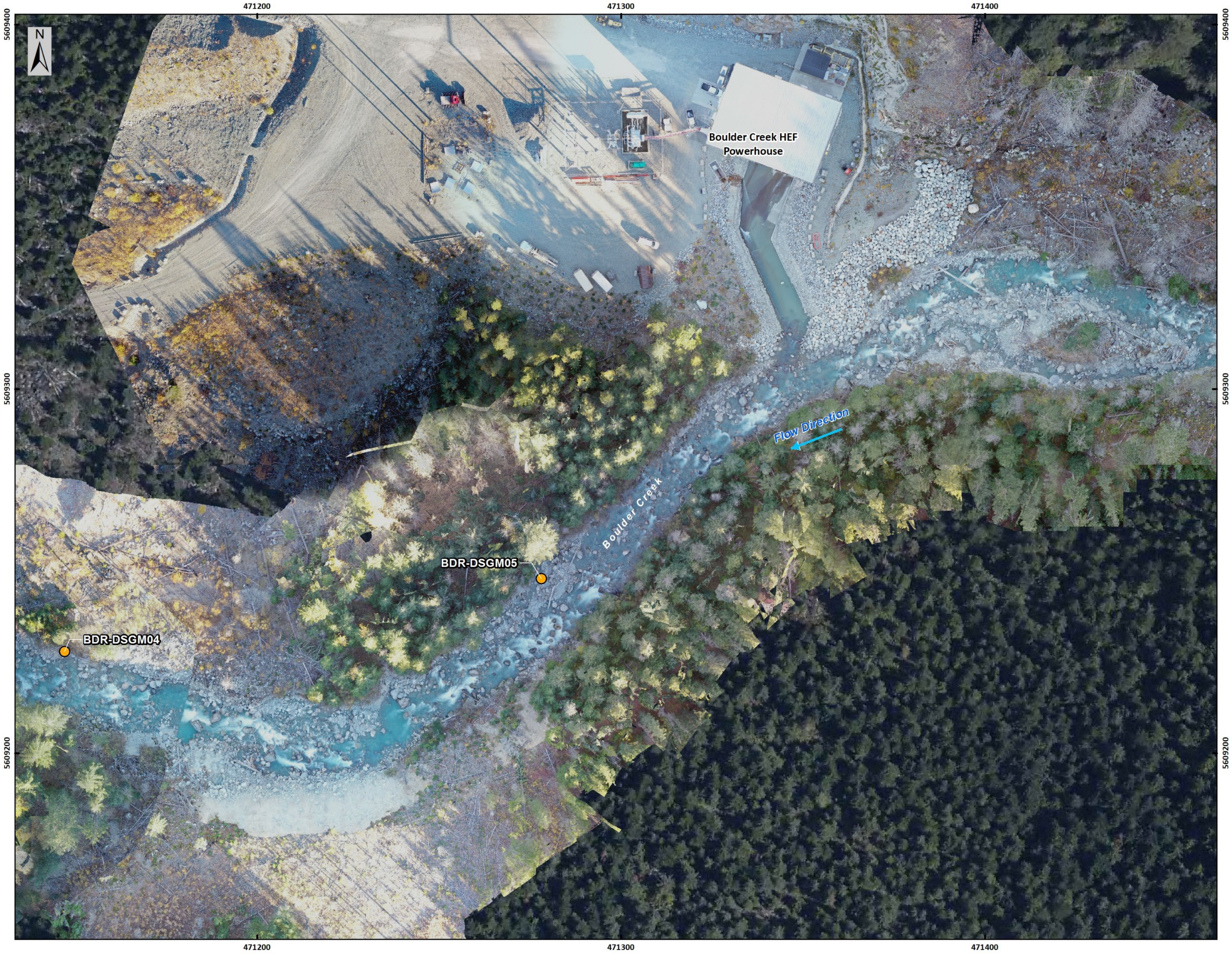

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2023

Legend

Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 7

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Geomorphology\1095_BDR_GeomorphSurveyMapbook_6234_20240110.mxd

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2016

Legend

- Geomorphology Transect
- Laydown Area
- Temporary Clearing Area

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

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ECOFISH RESEARCH

Map 8

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Geomorphology\1095_BDR_GeomorphSurveyMapbook_2016Dec08.mxd

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2023

Legend

Geomorphology Transect

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

NO.	DATE	REVISION	BY
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Date Saved: 1/10/2024
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 9

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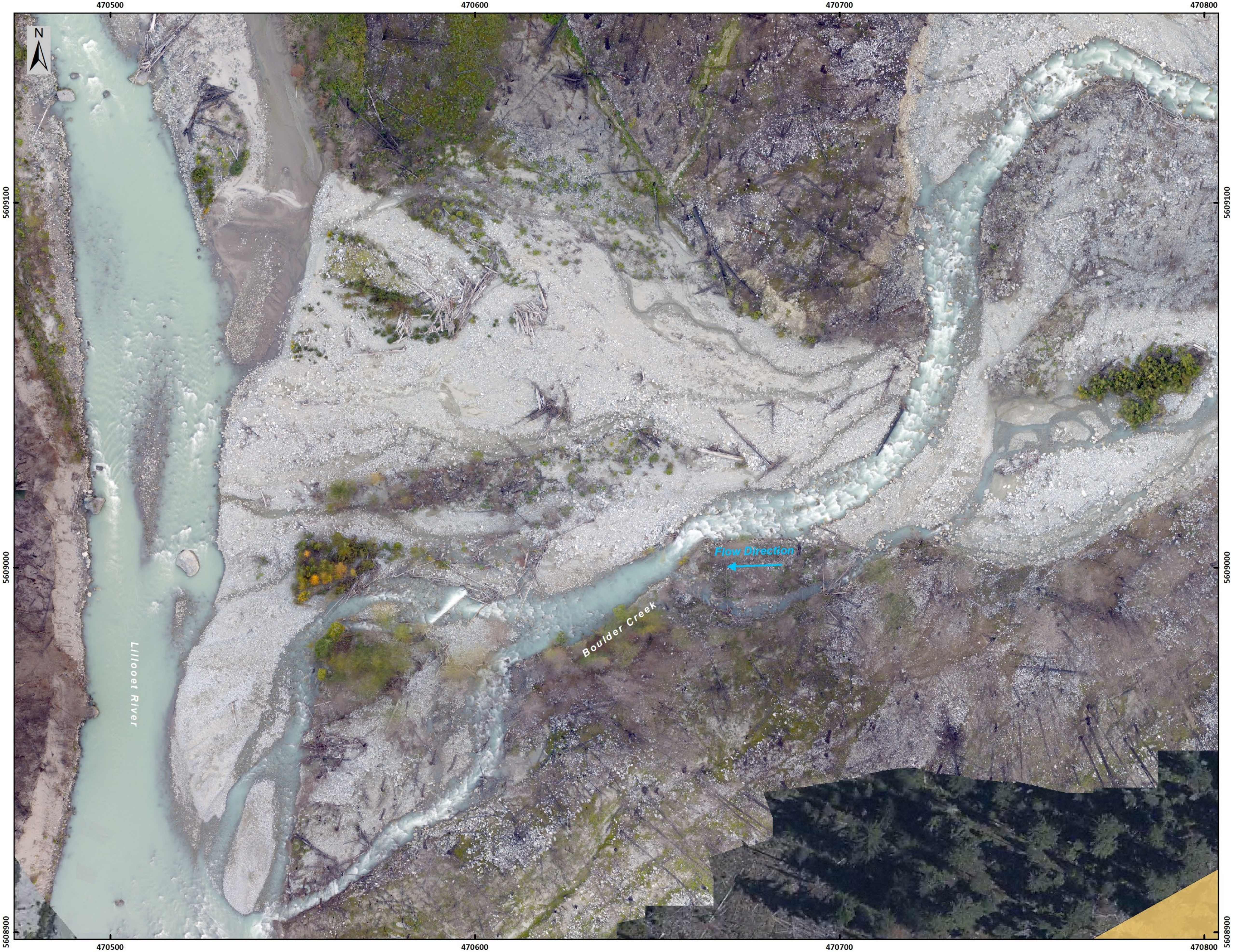

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2016

Legend

Laydown Area

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

Scale: 1:1,000

NO.	DATE	REVISION	BY
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Date Saved: 1/10/2024
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ECOFISH RESEARCH

Map 10

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Geomorphology\1095_BDR_GeomorphSurveyMapbook_6234_20240110.mxd

UPPER LILLOOET HYDRO PROJECT

Boulder Creek Geomorphic Survey 2023

Legend

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 10 20 40 m

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ECOFISH RESEARCH

Map 11

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Geomorphology\1095_BDR_GeomorphSurveyMapbook_6234_20240110.mxd

Appendix I. Upper Lillooet Hydro Project Standard Operating Procedure: Harlequin Duck Spot Check Protocol

ECOFISH RESEARCH

UPPER LILLOOET HYDRO PROJECT

STANDARD OPERATING PROCEDURE

Harlequin Duck Spot Check Protocol

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1. INTRODUCTION

Harlequin Duck spot checks are a requirement of the Upper Lillooet Hydro Project (the Project) Operational Environmental Monitoring Plan. Spot checks are intended to record the presence or absence of Harlequin Ducks and any evidence of successful breeding in the Project area. Spot checks are scans that are conducted from specific vantage points and at specific times during the Harlequin Duck breeding season. It is important to record some information every time a spot check is conducted, even if no Harlequin Ducks are observed. Timing, locations, and methods of spot checks should be consistent so that annual results are comparable.

2. SPOT CHECK METHODS

Specific methods should be followed for each spot check to keep data comparable. The methods to be followed are:

- Always conduct spot checks from the same vantage point for each Location ID (Table 1).
- Conduct a thorough scan of the visible area from the vantage point using binoculars and/or a spotting scope. Note that female Harlequin Ducks and juveniles are much less conspicuous than males and extra effort is required to spot them. Pay close attention to riparian areas where ducks may be partly concealed in overhanging riparian vegetation and scan exposed instream rocks where birds may haul out. Due to their brownish colour, females that are hauled out on rocks may blend in and can be difficult to see. Foraging birds may be diving in which case they will be underwater part of the time thus several scans of the water are required.

2.1. Locations

Spot checks will be conducted at the intake and powerhouse to focus on the locations where Harlequin Ducks were observed during baseline studies. Harlequin Ducks were also observed approximately 600 m upstream of the powerhouse, incidentally during baseline data collection for other monitoring components; however, this area is not visible from an easily accessible vantage point so observations in this area will continue to be collected incidentally when Ecofish crews download the logger and conduct potential fish stranding searches in this area. Spot checks should always take place from the same vantage points, and any deviation in methodology must be recorded. Each location has a label (ID) that should be entered into the "Location" field of the datasheet (Table 2). Each Location ID is associated with UTM coordinates. Spot check locations were flagged in May 2018 and are described below.

- Harlequin Ducks will be monitored from one of two vantage points at the intake to capture potential activity in the headpond as well as slightly upstream and downstream (ULL-HADU01a, ULL-HADU01b; Table 1, Figure 2). The vantage point at ULL-HADU01a is accessible early in the season when snow prohibits safe access to potential vantage points closer to the river. The vantage point at ULL-HADU01b is only accessible when snow does not prevent safe access. When monitoring from ULL-HADU01b it is recommended that the surveyor walk out onto the intake for the best view.

- Harlequin Ducks will be monitored from a vantage point at the powerhouse to capture potential activity near the tailrace as well as slightly upstream and downstream (NST-HADU02; Table 1, Figure 3).

Table 1. Harlequin Duck monitoring points at the intake.

Infrastructure	Location ID	UTM Coordinates (Zone 10U)		Description
		Easting	Northing	
Intake	ULL-HADU01a	466156	5614170	Above the road at the intake. To be used when snow prevents access to ULL-HADU01b.
	ULL-HADU01b	466105	5614110	Adjacent to the intake fence. To be used when accessible. To get the best view, walk out onto the intake from here when safe.
Powerhouse	ULL-HADU02	468416	5611634	On the boulders immediately downstream of the powerhouse.

Figure 1. View of ULL-HADU01a on April 30, 2018.

Figure 2. View of ULL-HADU01b on May 31, 2018.

Figure 3. View of ULL-HADU02 on May 3, 2018.

2.2. Timing

There are two time periods that are most valuable for conducting spot checks. These are:

1) the pre-incubation period (month of May), when Harlequin Duck pairs are on the river but before the female begins to incubate. Once incubation begins the male leaves and the female becomes secretive; and
2) the brood-rearing period (late July to late August) after ducklings hatch, adult males have departed, and the female is rearing her brood. At this time family groups, as well as females that have not bred successfully, can be seen on the river.

Spot checks will be scheduled to occur during these two time periods. Each time a spot check is conducted, the date and time will be recorded on the datasheet (Table 2).

2.2.1. Pre-incubation (May)

- Three spot checks will be conducted at each location during May; spot checks should be at least five days apart.

2.2.2. Brood-rearing (August 1 – August 30)

- Three spot checks will be conducted at each location from August 1 through to August 30; spot checks should be at least five days apart, with two of the spot checks occurring between August 1 and August 15.

2.3. What to Record

All required information listed below must be recorded on the Harlequin Duck spot check survey datasheet (Table 2) every time a spot check is conducted, regardless of what is seen. Please review the **Harlequin Duck Fact Sheet** for important information on identification and species biology.

Information that must be recorded includes:

- Date of the spot check.
- Time of the spot check.
- Initials of the person(s) conducting the spot check.
- Location of the spot check (specify the Location ID).
- The total number of Harlequin Ducks seen, including “0” if none were seen (enter in “Total Number” field in the datasheet). The numbers of each sex/age category should be entered into the appropriate fields of the datasheet. Including the total numbers of:
    - adult males;
    - adult female-like birds (note that juveniles are hard to distinguish from adult females and are therefore included in this group);
    - ducklings (smaller than adults early in the brood-rearing period); and
    - individuals of unknown sex (cannot be identified as adult males or adult female-like birds, and are not ducklings that can be distinguished by size).

- Record comments in the "Comments" column of the datasheet for every spot check:
  - if no Harlequin Ducks are seen, state this in words;
  - pair(s) (male and female close together) or family group (for example: a female with three female-like birds that may be juveniles based on their proximity and synchronous behaviour);
  - other species (e.g., American Dippers, mergansers, Barrow's Goldeneye); and
  - visibility limitations (e.g., due to poor weather, or if the water level in the river is unusually high or low.
- Take photos of all Harlequin Ducks and other wildlife observaed and record photo numbers in the appropriate field of the data sheet.

2.4. Equipment Required

Equipment required for spot check includes:

- Clipboard with datasheets and Harlequin Duck Fact Sheet.
- Binoculars and/or spotting scope.
- Digital Camera.

Table 2. Harlequin Duck spot check datasheet.

Ecofish Research Ltd.
Suite F, 450 8th Street,
Courtenay, B.C.
V9N 1N5

Date	Time	Location[1]	Total Number[2]	Number of Adult Males	Number of female-like[3]	Number of Ducklings	Number of Unknown Sex	Comments (describe behaviour and other observations of interest such as weather conditions and other species observed)[4]	Photo Number	Observer Initials

[1] Location ID as described in Spot Check Protocols. If location is different, note at UTM or mark on a map.

[2] Indicate zero if no Harlequin Ducks are seen.

[3] Includes adult females and large juveniles that look like adult females.

[4] Describe behaviour (e.g., feeding, preening, hauled out on rocks, flying upstream or downstream) and wether birds are behaving as a group (e.g., "feeding together; appear to be a pair"); note any other observations of interest such as other riverine species (e.g., American Dippers); any limitations on survey methods (e.g., poor visibility due to poor weather) or unusual conditions (e.g., water levels very high). Include some comments for every spot check.

3. HARLEQUIN DUCK FACT SHEET

3.1. Physical Description

Male

- Dark from a distance, white streaks and colourful patches can be seen closer up;
- Slate blue plumage and belly, chestnut sides and streaks of white on the head and body; and
- Crown has a black stripe with a larger white patch in front of the eye and a small white ear patch.

Female

- Plain brownish-grey with lighter underside;
- The face in front of the eye is light in colour and has distinctive white ear patch; and
- Roughly half the size of a Mallard duck.

Immature

- After hatching, ducklings can be distinguished by their small size relative to the adult female;
- When larger but while still on the breeding stream, juveniles of both sexes resemble the adult female; and
- Young males begin to look like adults in fall, but they do not gain full adult plumage until the next summer.

3.2. Life History

- Arrive on breeding streams shortly after spring break-up;
- Females lay 3-10 eggs that hatch after approximately one month;

- Males leave the breeding stream once the female begins to incubate;
- Females and their young return to the coast together in late September; and
- Individuals often return to the same breeding site year after year.

3.3. Habitat

- Spend their winters at the coast and breed near fast-flowing rivers and streams;
- Require streams with adequate amounts of aquatic invertebrates for consumption;
- Riparian vegetation is an important component of their habitat requirements;
- Usually nest under shrubs within 30 m of the stream; and
- Ducklings require overhanging vegetation along stream banks for protection from predators.

4. OTHER WATERFOWL COMMON IN HEADPONDS

4.1. Barrow's Goldeneye and Common Goldeneye

Barrow's Goldeneye and Common Goldeneye are usually slightly larger than Harlequin Ducks.

Female

- Can be distinguished from Harlequin Ducks by their orange bills and dark grey bodies which contrast with their brown heads. (Harlequin Duck females and juveniles have uniformly brown bodies and heads.)

Male

- Can be distinguished from Harlequin Ducks by their black and with bodies, and dark green heads with a single white spot near the bill.

4.2. Bufflehead

Buffleheads are smaller than Harlequin Ducks.

Female

- Can be distinguished from Harlequin Ducks by their single cheek spot and their smaller size. (Harlequin Duck females and juveniles have a large pale patch near their bill in addition to a small white spot further back on their cheek.)

Male

- Can be distinguished from Harlequin Ducks by their wedge shaped white patch from their eyes to the back of their head, as well as their solid black back and solid white sides.

4.3. Common Merganser

Common Mergansers are larger than Harlequin Ducks.

Female

- Can be distinguished from Harlequin Ducks by their reddish head and bill, greyish body plumage, white chest and their larger size.

Male

- Can be distinguished from Harlequin Ducks by their red bill, dark green head, black and grey back, white body and chest plumage and their larger size.

Appendix J. Upper Lillooet River Aerial Stream Morphology Assessment 2016 and 2023

LIST OF FIGURES

Figure 1. **Upper Lillooet River Upstream Reach at the confluence of Salal Creek displaying channel migration towards river left, scouring riparian area outline in red in 2016 (top). Channel migration towards the left bank has caused the mid channel gravel bar to widen outline in white in 2023 (bottom) due to gravel deposition on the right side of the channel cause by slower flows. Blue outline displays 2016 channel path for visual representation of stream morphology changes in 2023.**

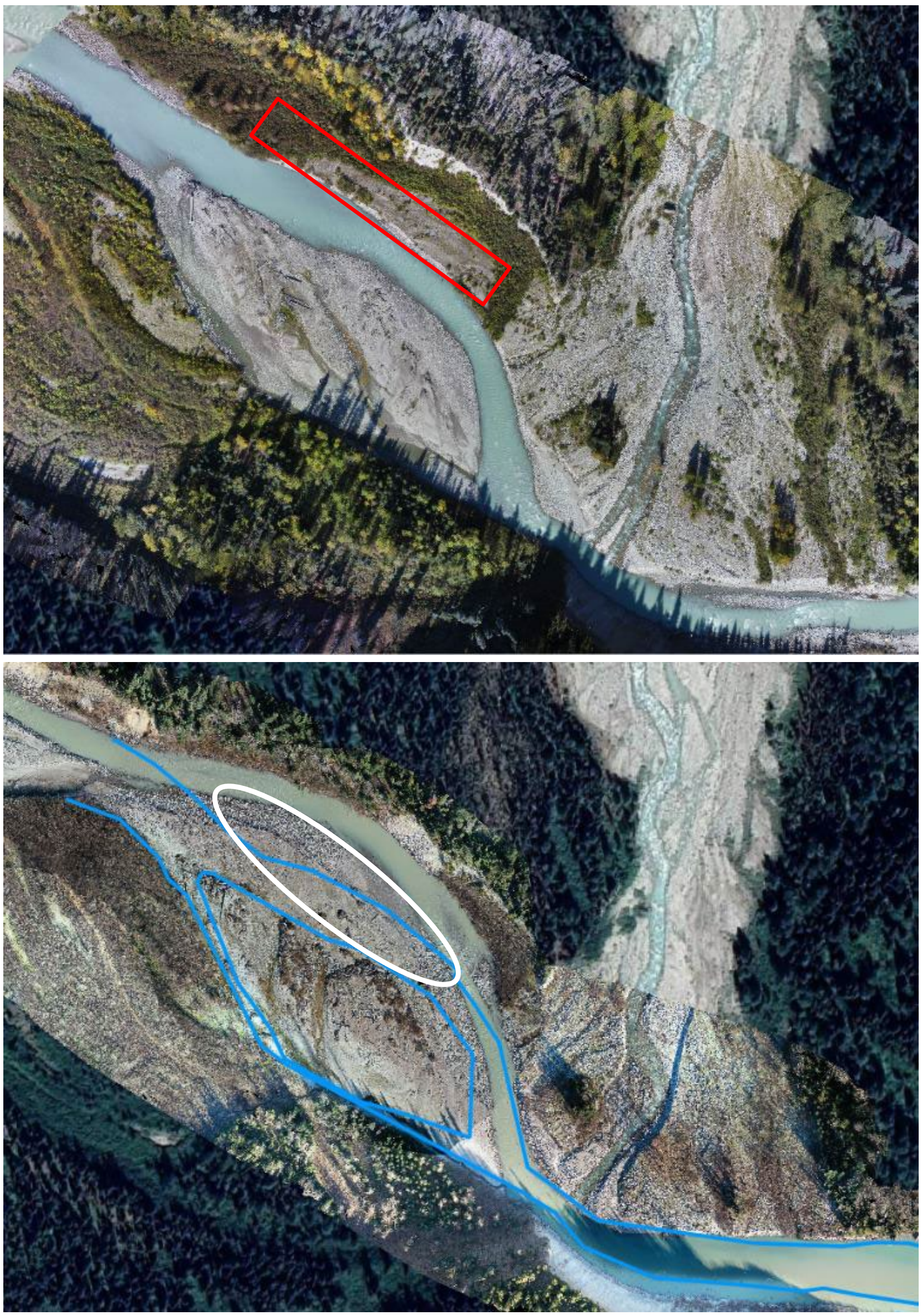

Figure 2. **Upper Lillooet River Upstream Reach at the confluence of Salal Creek displaying accumulation of fines and gravel outline in green and coarsening of sediment outline in red at the mouth of Salal Creek in 2023 (bottom) in comparison to 2016 (top). Gravel bar downstream of confluence now submerged below water in 2023. Blue outline displays 2016 channel path for visual representation.**

Figure 3. Upper Lillooet River Upstream Reach displaying back watering of channel caused by Upper Lillooet Intake in 2023 (bottom) in comparison to 2016 (top). Blue outline displays 2016 channel path for visual representation. Loss of riparian habitat outline in red on the river left and right bank. Exposed gravel bar outlined in white in 2016 is submerged (green) in 2023.

Figure 4. Upper Lillooet River Upstream Reach displaying river left bank erosion in headpond (yellow outline) in 2023 (bottom) in comparison to 2016 (top). Toe of slope outline in black has moved upslope due to water level rise and is no longer protected from flow erosion by larger cobble boulders bar causing some erosion on steep left bank into the headpond. Blue outline displays 2016 channel path for visual representation.

Figure 5. Upper Lillooet River Diversion Reach displaying some coarsening of gravel and loss of fines outline in red in 2023 (bottom) in comparison to 2016 (top). Two gravel patches indicated in orange spray painted in 2016 are present in 2023 outline in green.

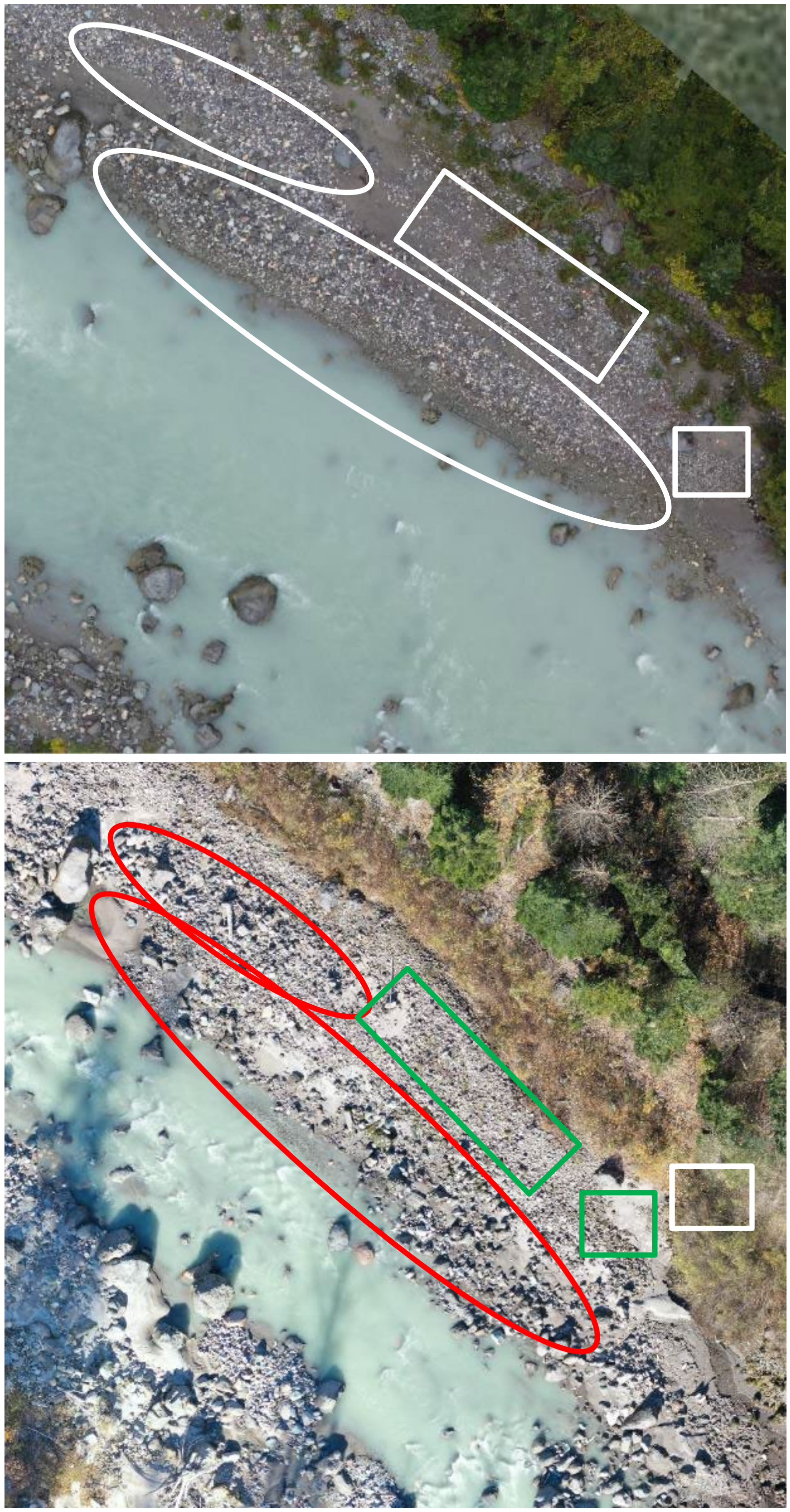

Figure 6. Upper Lillooet River Diversion Reach displaying fine sediment accumulation from 2016 (top) to 2023 (bottom).

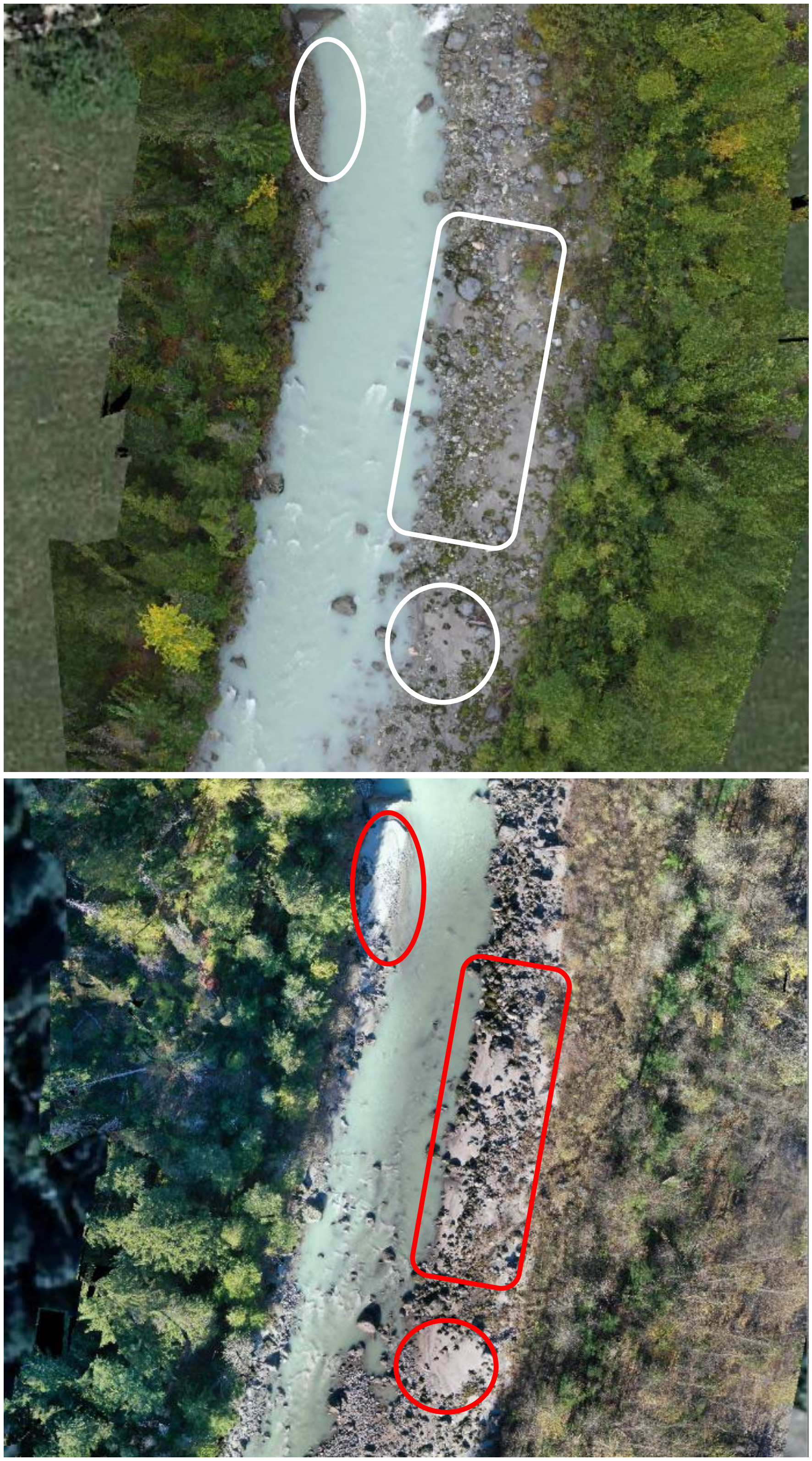

Figure 7. Upper Lillooet River Diversion Reach displaying coarsening of sediment on river left and fine sediment accumulation covering gravel on river right in 2023 (bottom) in comparison to 2016 (top).

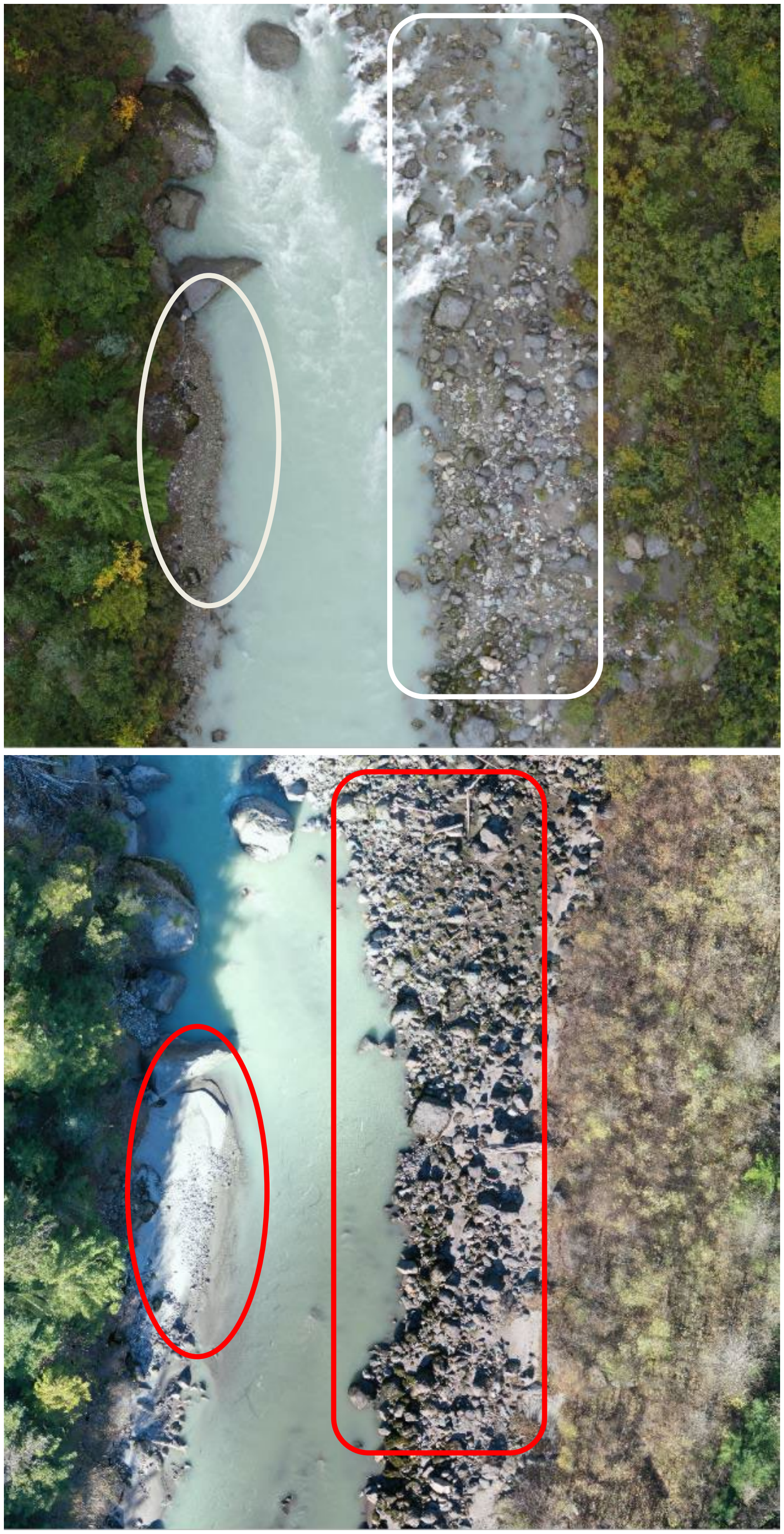

Figure 8. Upper Lillooet River Diversion Reach displaying a gain in gravel deposition on the river left gravel bar in 2023 (bottom) in comparison to 2016 (top).

Figure 9. **Upper Lillooet River Diversion Reach displaying both no change in gravel density outlined in green and coarsening of gravel outline in red in 2023 (bottom) in comparison to 2016 (top).**

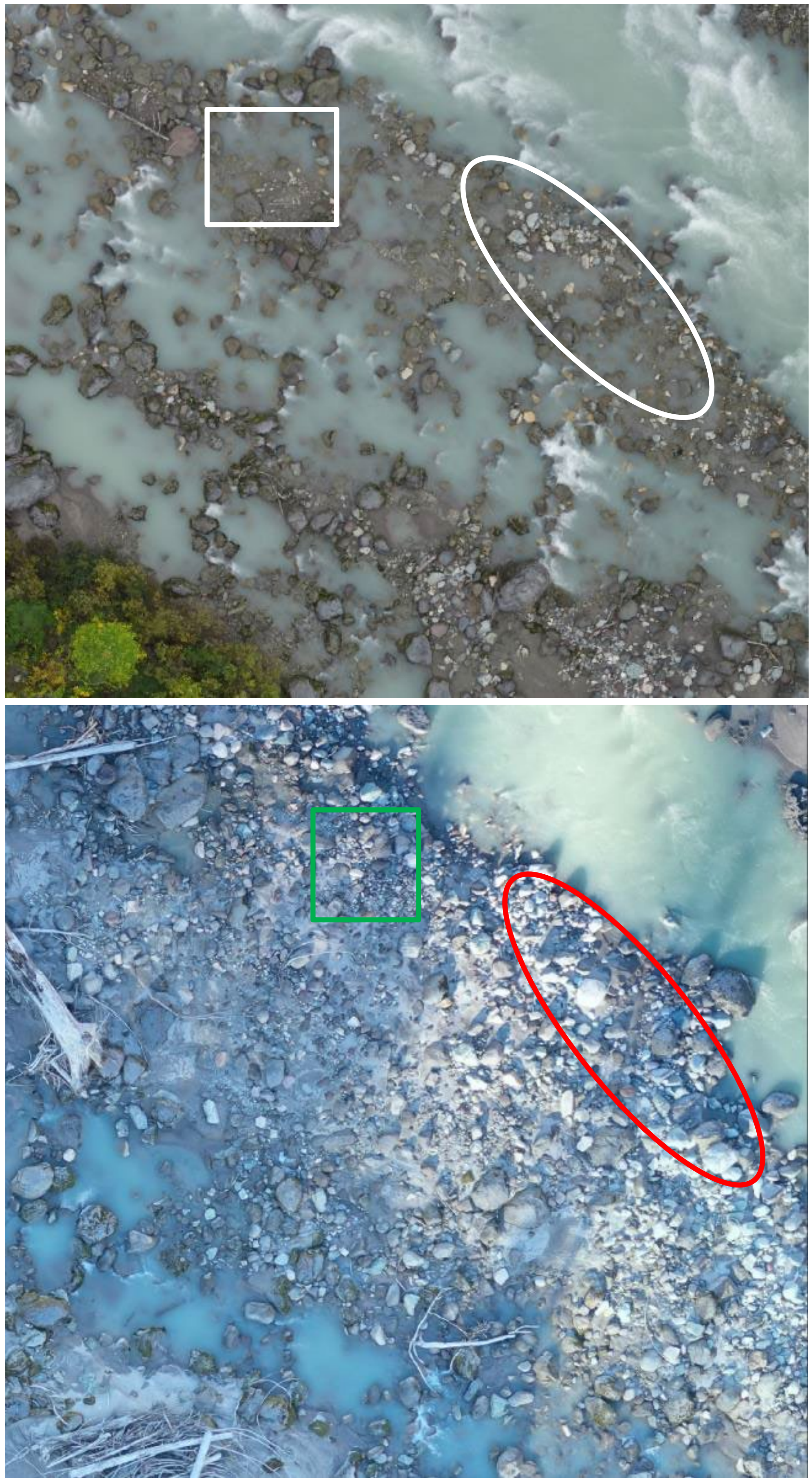

Figure 10. Upper Lillooet River Downstream Reach displaying scouring of gravel outline in red on river left margins caused by substantial gravel input from the river right tributary in 2023 (bottom). Gravel at the outlet of the tributary has been maintained with some gravel gain downstream of patch in 2023 in comparison 2016 (top).

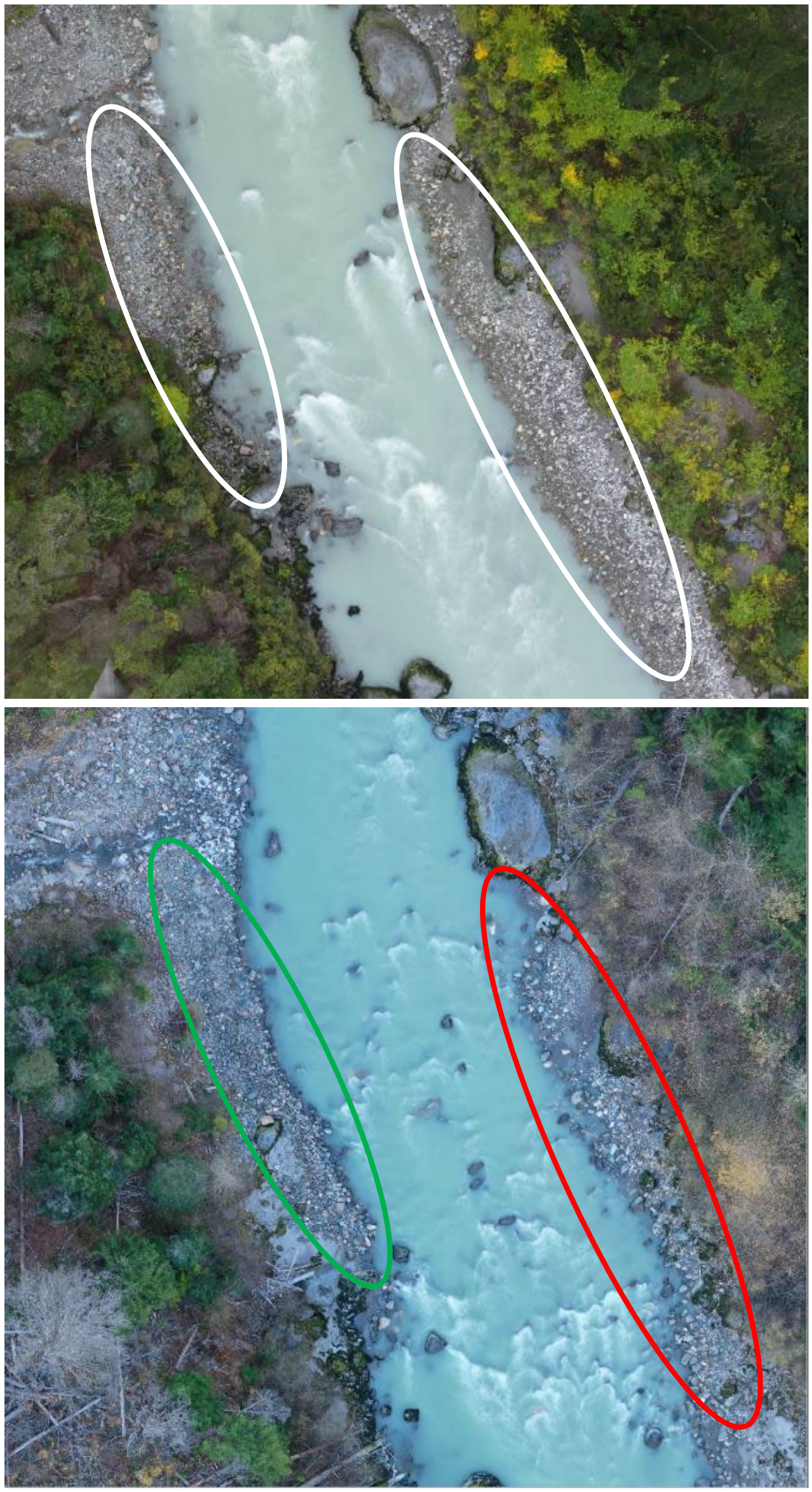

Figure 11. **Upper Lillooet River Downstream Reach displaying similar gravel distribution and size outline in green from 2016 (top) to 2023 (bottom).**

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Figure 12. Upper Lillooet River Downstream Reach displaying gravel patches identified in 2016 (top image; orange spray paint) that were covered in fine sediment outlined in red in 2023 (bottom).

Figure 13. Upper Lillooet River Downstream Reach displaying similar gravel distribution and density outline in green in 2023 (bottom) in comparison to 2016 (top).

Figure 14. Upper Lillooet River Downstream Reach displaying both change in gravel distribution and coarsening of sediment outline in red and similar density of gravel outlined in green from 2016 (top) to 2023 (bottom). Addition of non-functional small woody debris in 2023 was likely attributed to 2015 firers.

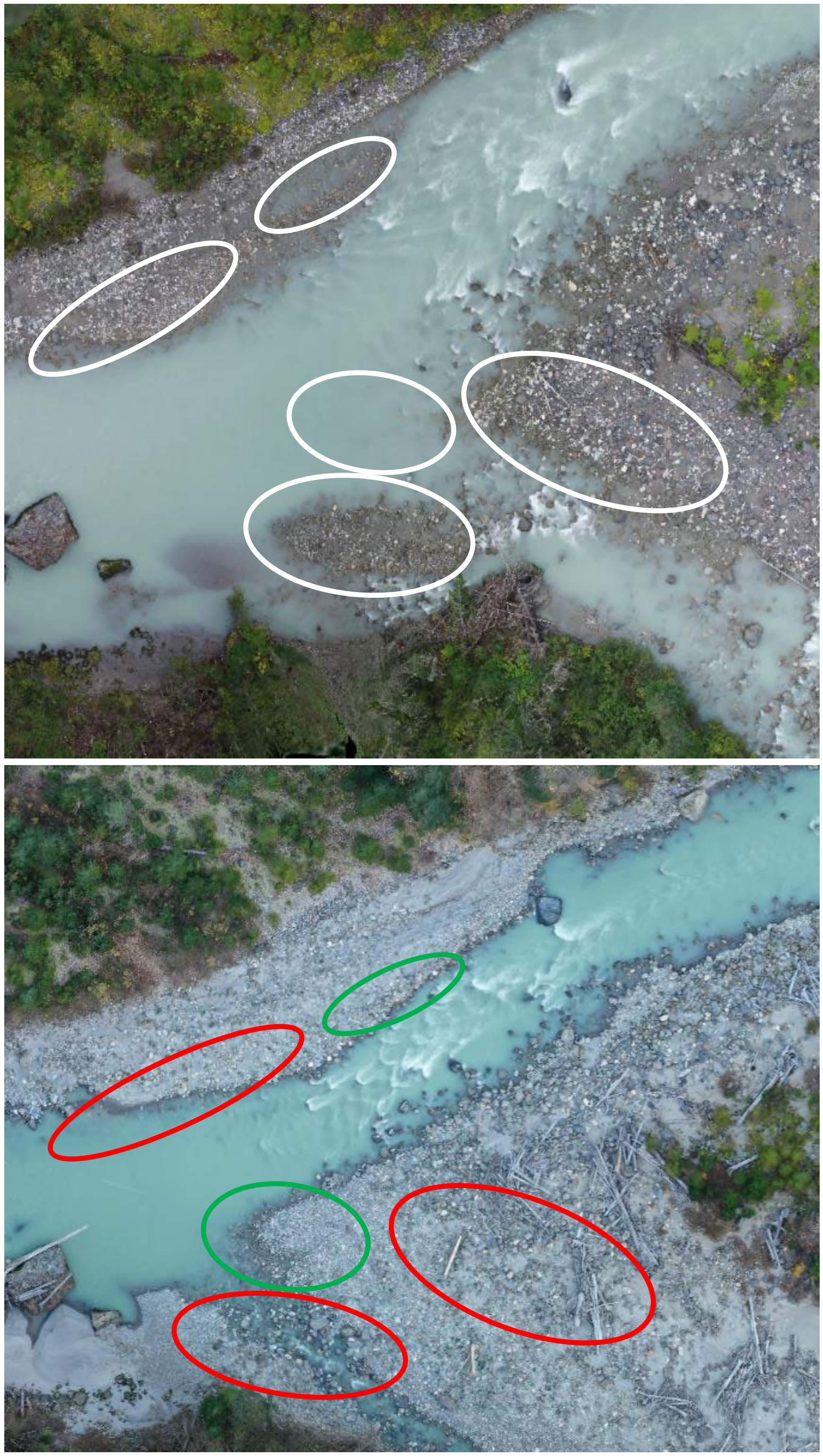
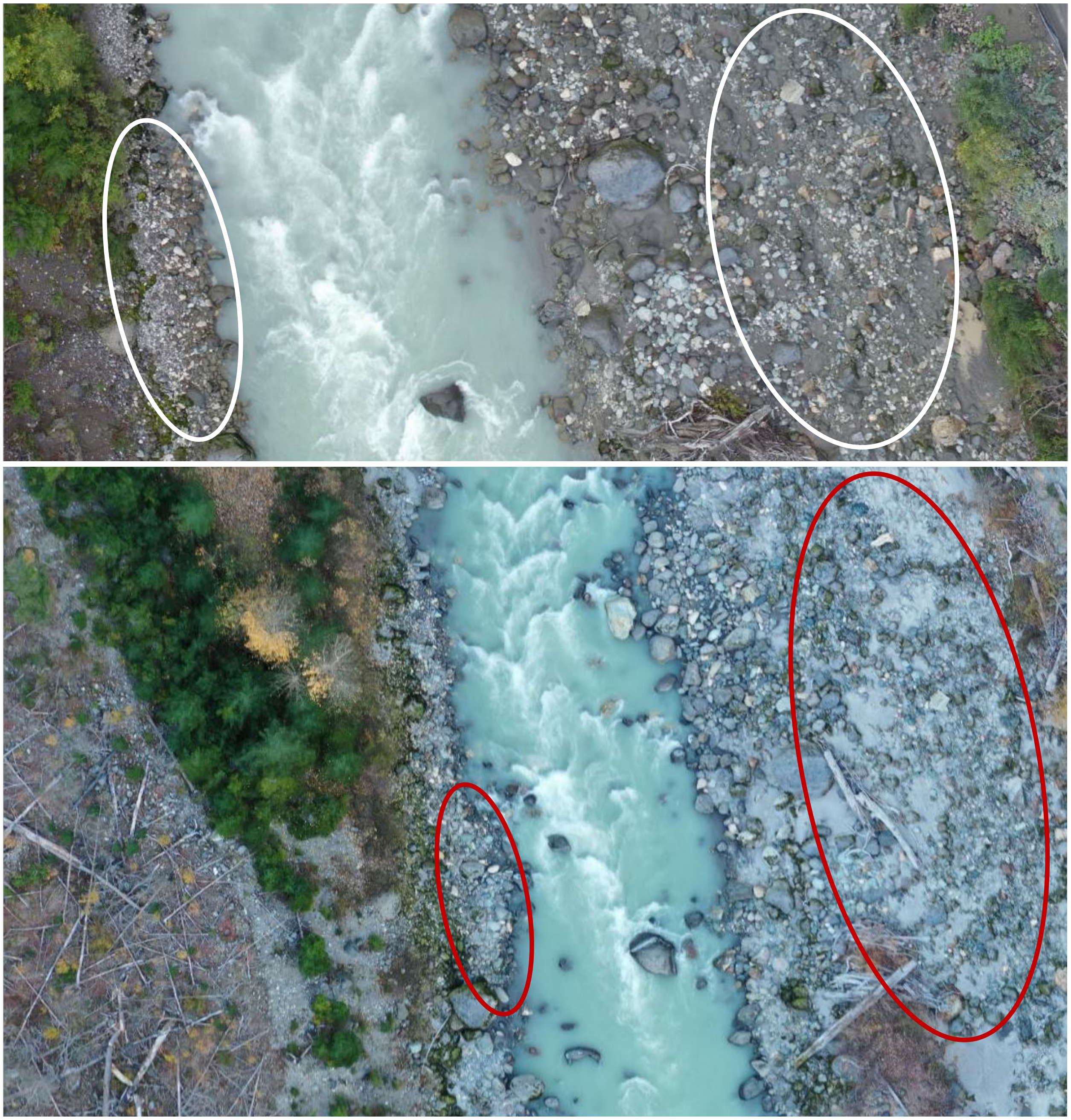


Figure 15. Upper Lillooet River Downstream Reach displaying change in gravel distribution, coarsening, and fine sediment accumulation outlined in red while green outline indicates minimal change from 2023 (bottom) to 2016 (top). Addition of nonfunctional small woody debris likely caused by 2015 firers.

Figure 16. Upper Lillooet River Downstream Reach displaying the redistribution of gravel from 2023 (bottom) to 2016 (top).

Figure 17. Upper Lillooet River Downstream Reach displaying similar gravel distribution and density in 2023 (bottom) in comparison to 2016 (top). Green outline showing increase in gravel, red outline showing loss in gravel.

Figure 18. Upper Lillooet River Downstream Reach displaying coarsening of gravel on river right and fine sediment accumulation on river left outline in red in 2023 (bottom) in comparison to 2016 (top).



Appendix K. Boulder Creek Stream Morphology Assessment 2016 to 2023

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Figure 1. **Boulder Creek Upstream Reach displaying retained gravel distribution and density above the landslide shown in green outline from 2016 (top) to 2023 (bottom).**

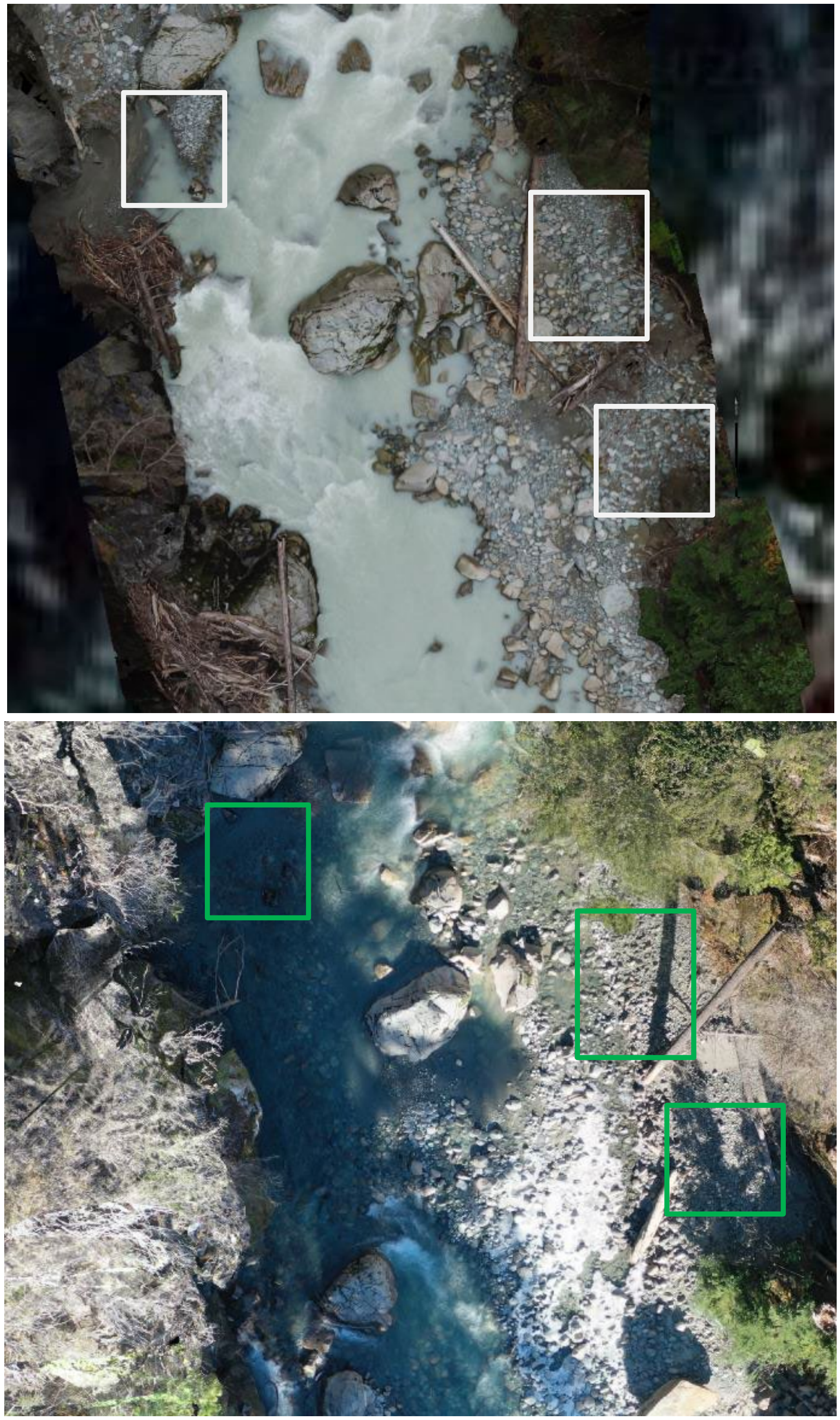

Figure 2. Boulder Creek Upstream Reach displaying river left colluvial material outlined in red from landslide input causing the active channel to shift to river right from 2016 (top) to 2023 (bottom).

Figure 3. **Boulder Creek Upstream Reach displaying shift in channel path caused by landslide. Channel in 2023 (bottom) has higher sinuosity than in 2016 (top) causing scour of gravel outlined in red along the margins of the channel.**

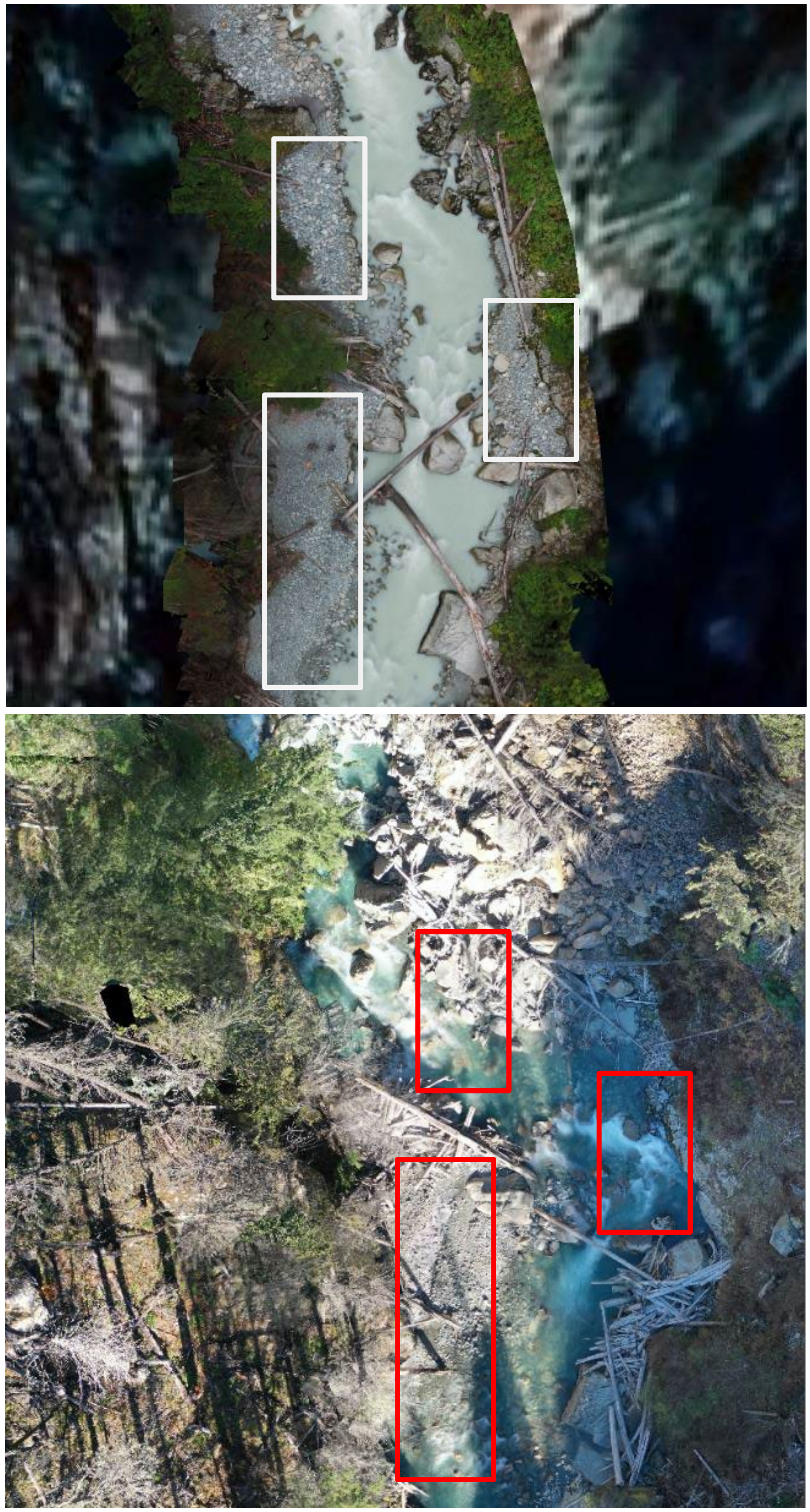

Figure 4. **Boulder Creek Upstream Reach displaying large woody debris increase outlined in green, contribution potentially caused by adjacent river left forest harvest. Evidence of channel widening indicated by white arrow caused by back watering of headpond from 2016 (top) to 2023 (bottom).**

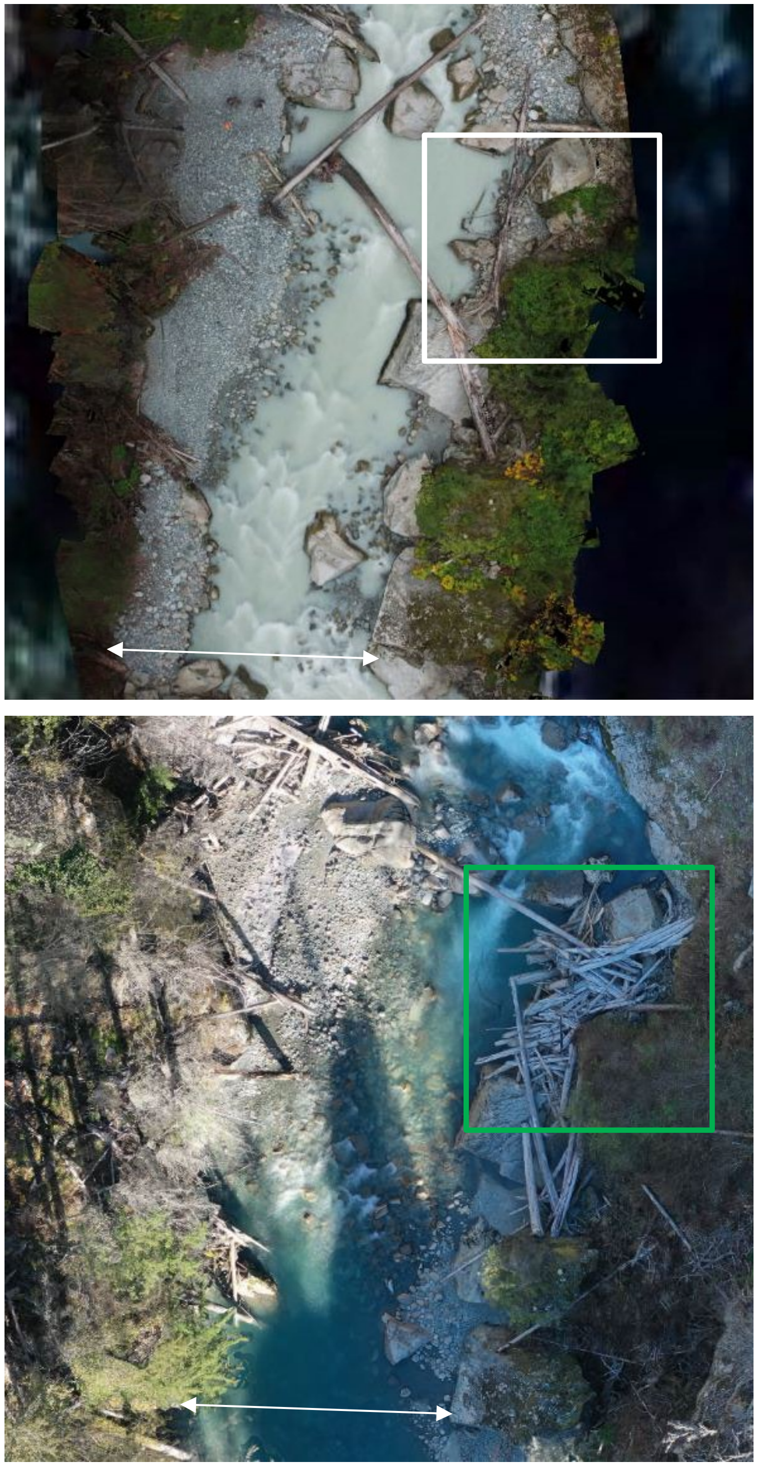

Figure 5. Boulder Creek Diversion Reach displaying gravel deposits outlined in green below the weir captured in 2023 imagery. Evidence of large wood transported through headpond can also be observed. No imagery was collected in 2016 for comparison.

Figure 6. Boulder Creek Diversion Reach displaying scouring of gravel outline in red from 2016 (top) to 2023 (bottom).

Figure 7. Boulder Creek Diversion Reach displaying gravel accumulation outline in green in most areas and some gravel loss outline in red from 2016 (top) to 2023 (bottom).

Figure 8. Boulder Creek Diversion Reach displaying naturally occurring landslides outline in red along river left bank in 2023 (bottom) compared to 2016 (top).

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Figure 9. Boulder Creek Diversion Reach displaying retained gravel outline in green with some gravel loss outlined in red from 2016 (top) to 2023 (bottom).

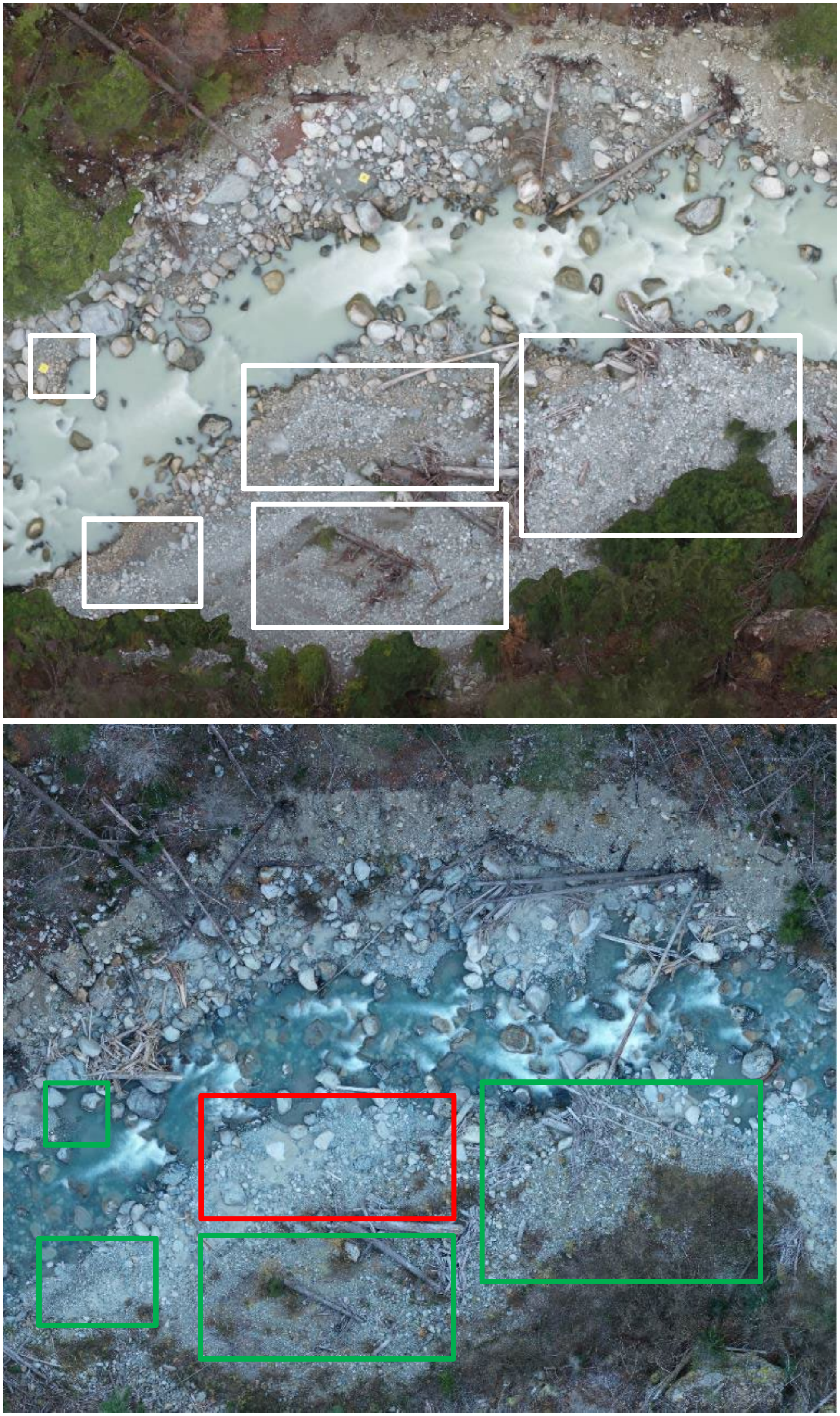

Figure 10. Boulder Creek Diversion Reach displaying loss of gravel outlined in red with some gravel retention outlined in green from 2016 (top) to 2023 (bottom).

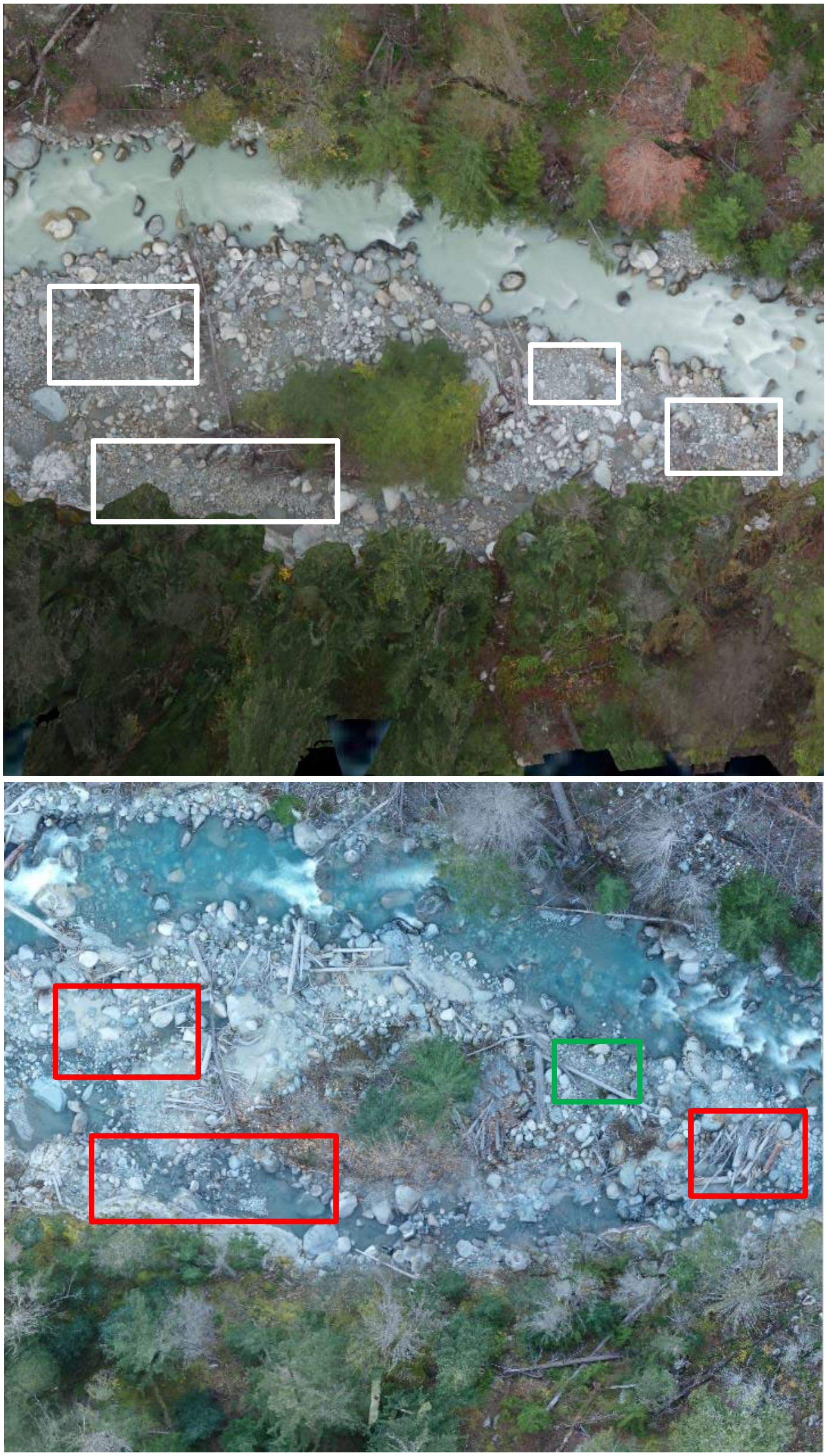

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Figure 11. Boulder Creek Downstream Reach displaying similar gravel distribution and density outline in green from 2016 (top) to 2023 (bottom).

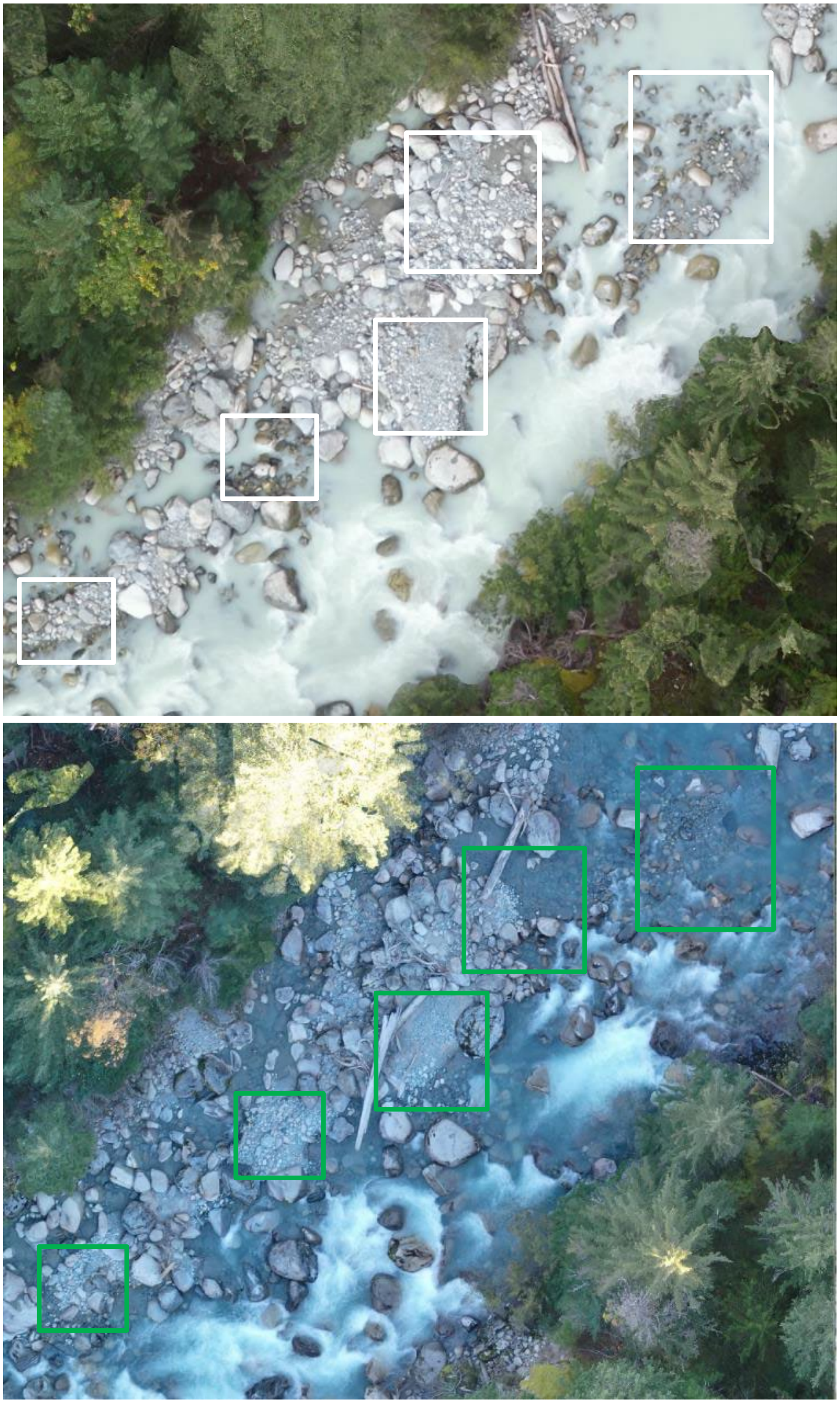

Figure 12. Boulder Creek Downstream Reach Google Earth imagery displaying potential Project related bank erosion outline in red from 2010 (top) to 2014 (bottom).

Figure 13. Boulder Creek Downstream Reach showing potential Project related slope failure below the transmission line outline in red and the shifting of the active channel from river right to river left from 2016 (top) to 2023 (bottom). Yellow line indicating toe of slope in both images for visual representation of gravel bar scouring cause be channel shifting.

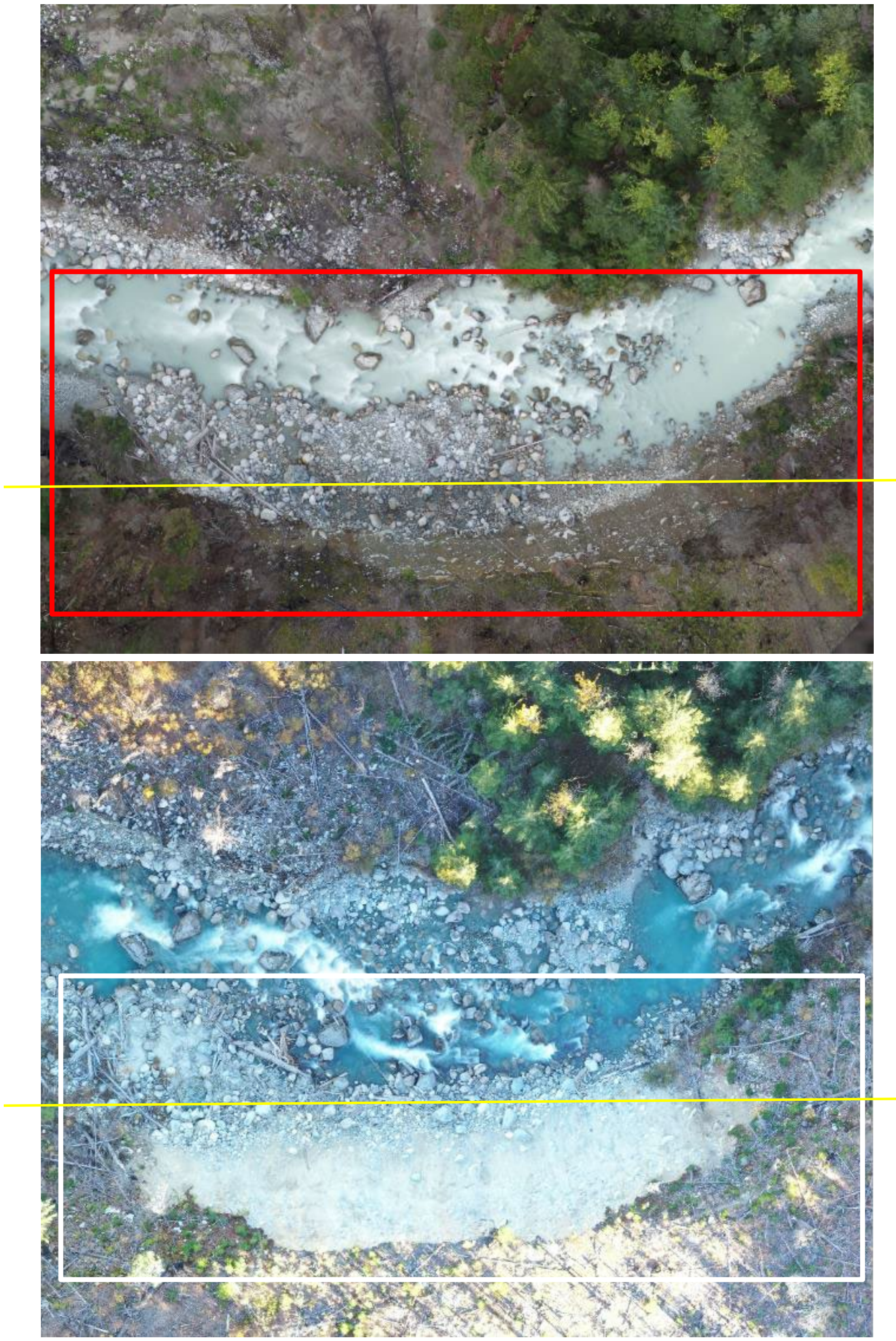

Figure 14. Boulder Creek Downstream Reach displaying both loss outline in red and gain outlined in green of gravel from 2016 (top) to 2023 (bottom).

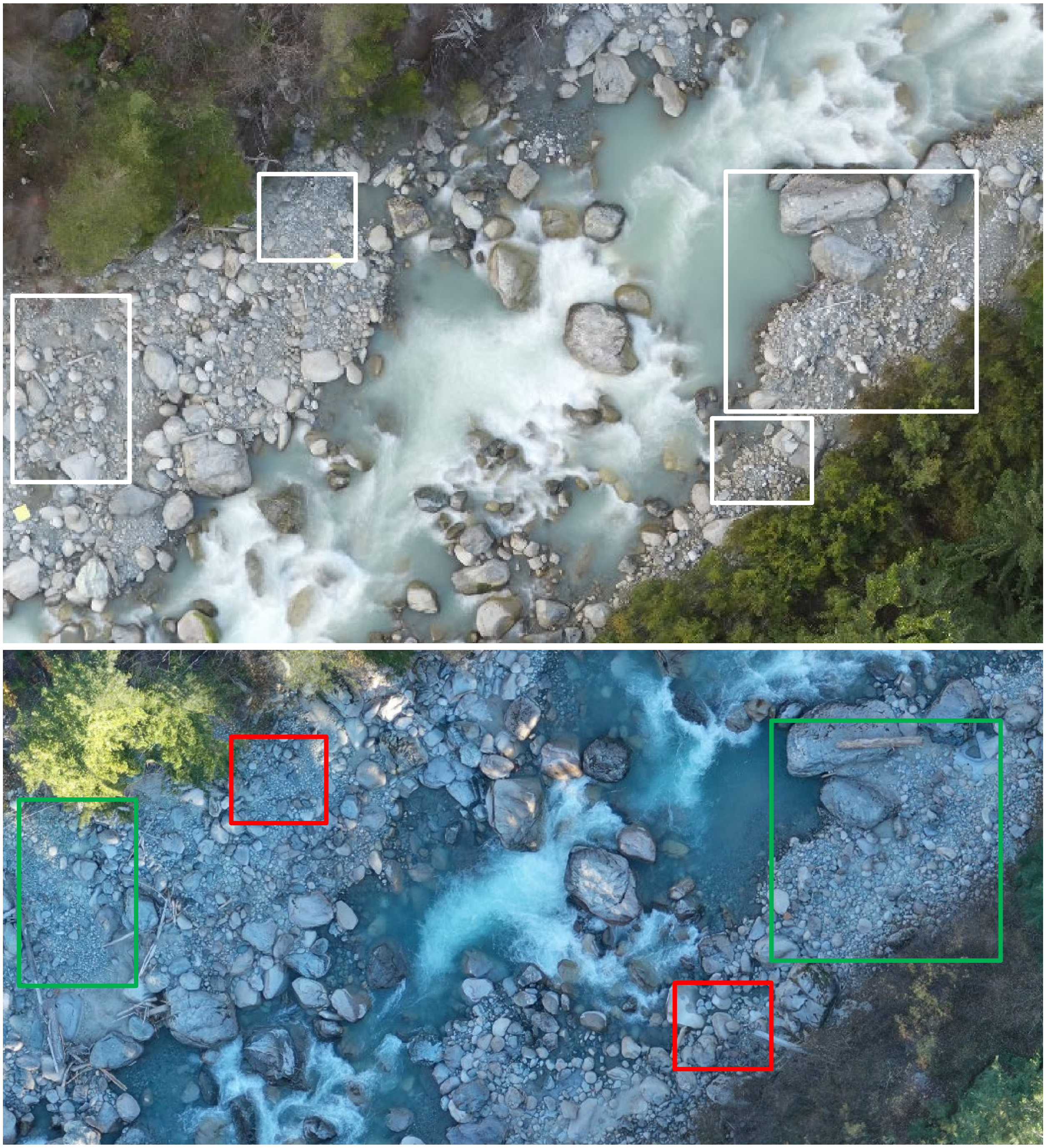

Figure 15. Boulder Creek Downstream Reach displaying both gravel loss outline in red and gravel gain outlined in green from 2016 (top) to 2023 (bottom).

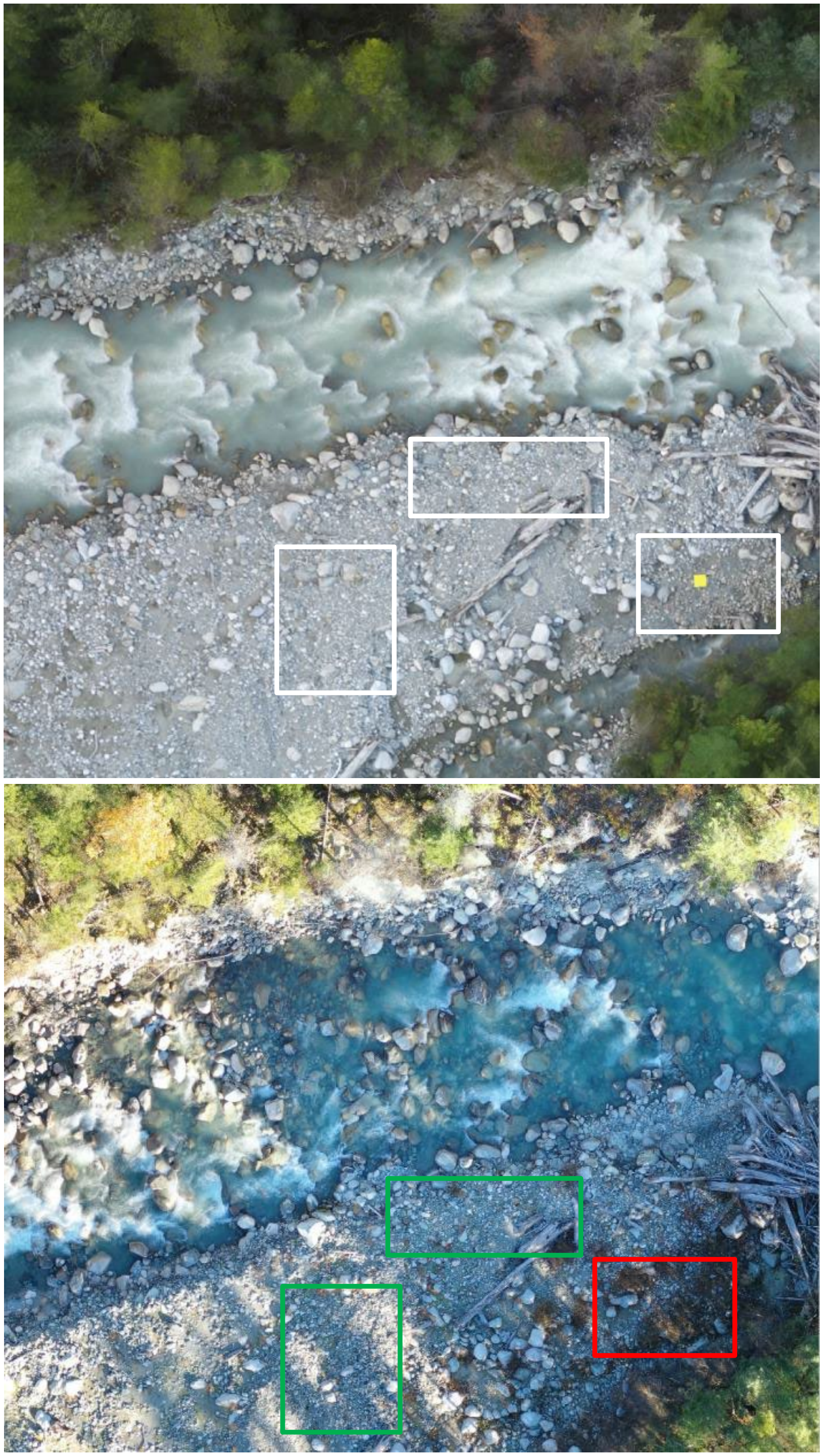

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Figure 16. Boulder Creek Downstream Reach displaying both gravel loss outline in red and gravel gain outlined in green from 2016 (top) to 2023 (bottom).

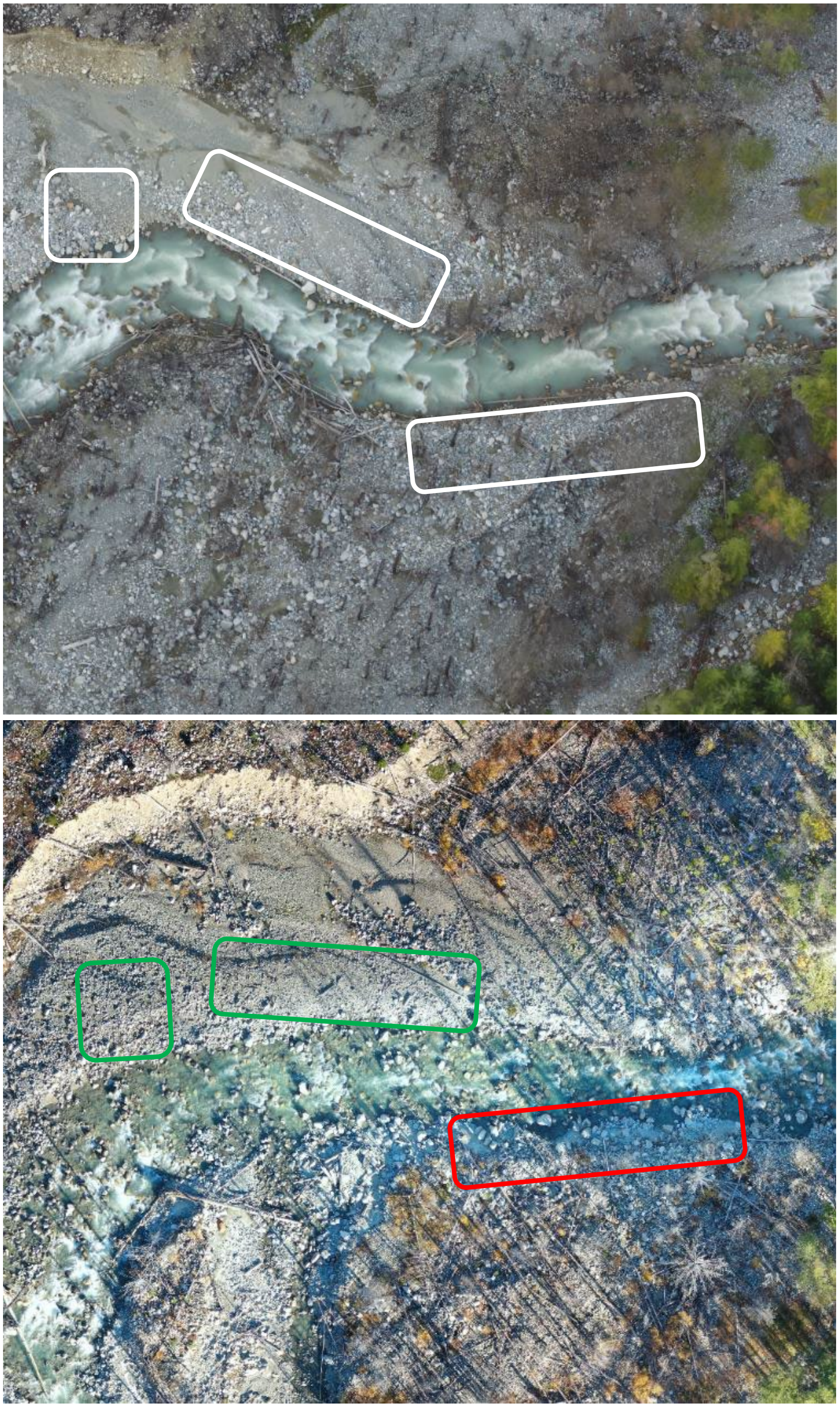

Figure 17. Boulder Creek Downstream Reach River left channel displaying signs of revegetation outlined in green since active channel shifted from river left to river right. 2016 (top) to 2023 (bottom).

Figure 18. Boulder Creek Downstream Reach Google Earth imagery displaying the shifting of the active channel outline in red from river left to a new river right channel from 2014 (top) to 2022 (bottom).

Figure 19. Boulder Creek Downstream Reach displaying minimal change at the confluence of Boulder Creek and Lillooet River. Braided outlet in 2016 (top) has become a single channel outline in green in 2023 (bottom).

Appendix L. Habitat Summaries and Representative Photographs of Closed-Site Electrofishing Sites

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Table 1. Summary of habitat, cover, and substrate at closed-site electrofishing sites in the diversion reach of the Upper Lillooet River in 2022.

Site	Habitat	Cover¹		Substrate (%)²						Gradient (%)
		Dom.	Sub. Dom.	BR	BO	CO	LG	SG	F	
ULL-DVEF02b	Cascade	BO	CO/DP	0	25	15	20	20	20	4.0
ULL-DVEF04	Run	CO	BO	0	15	20	40	15	10	1.5
ULL-DVEF07	Riffle	DP	CO/BO	0	25	5	5	15	50	1.0
ULL-DVEF09	Run	CO	BO	0	10	10	10	10	60	1.0
ULL-DVEF10	Riffle	BO	CO	0	25	30	20	20	5	2.0
ULL-DVEF11	Riffle	BO	CO	0	10	10	5	60	15	1.0
ULL-DVEF12	Cascade	BO	CO/DP	0	40	25	15	5	15	4.0

¹ Cover Codes: Dom. = Dominant, Sub-Dom. = sub-dominant, BO = boulder, CO = cobble, LWD = Large woody debris.
² F = fine (<2 mm), SG = small gravel (2 - 16 mm), LG = large gravel (16 - 64 mm), CO = cobble (64 - 256 mm), BO = boulder (256-4,000 mm), and BR = bedrock (>4,000 mm).

Figure 1. Looking upstream at ULL-DVEF02b on April 03, 2022.

Figure 2. Looking downstream at ULL-DVEF02b on April 03, 2022.

Figure 3. Looking upstream at ULL-DVEF04 on April 03, 2022.

Figure 4. Looking downstream at ULL-DVEF04 on April 03, 2022.

Figure 5. Looking upstream at ULL-DVEF07 on April 03, 2022.

Figure 6. Looking downstream at ULL-DVEF07 on April 03, 2022.

Figure 7. Looking upstream at ULL-DVEF09 on April 08, 2022.

Figure 8. Looking downstream at ULL-DVEF09 on April 08, 2022.

Figure 9. Looking upstream at ULL-DVEF10 on April 08, 2022.

Figure 10. Looking downstream at ULL-DVEF10 on April 08, 2022.

Figure 11. Looking upstream at ULL-DVEF11 on April 08, 2022.

Figure 12. Looking downstream at ULL-DVEF11 on April 08, 2022.

Figure 13. Looking upstream at ULL-DVEF12 on April 08, 2022.

Figure 14. Looking downstream at ULL-DVEF12 on April 08, 2022.

Appendix M. Closed-Site Electrofishing Fish Figures and Individual Fish Data

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Figure 1. Length-frequency of Cutthroat Trout captured during closed-site electrofishing in 87.0 km Tributary in 2023.

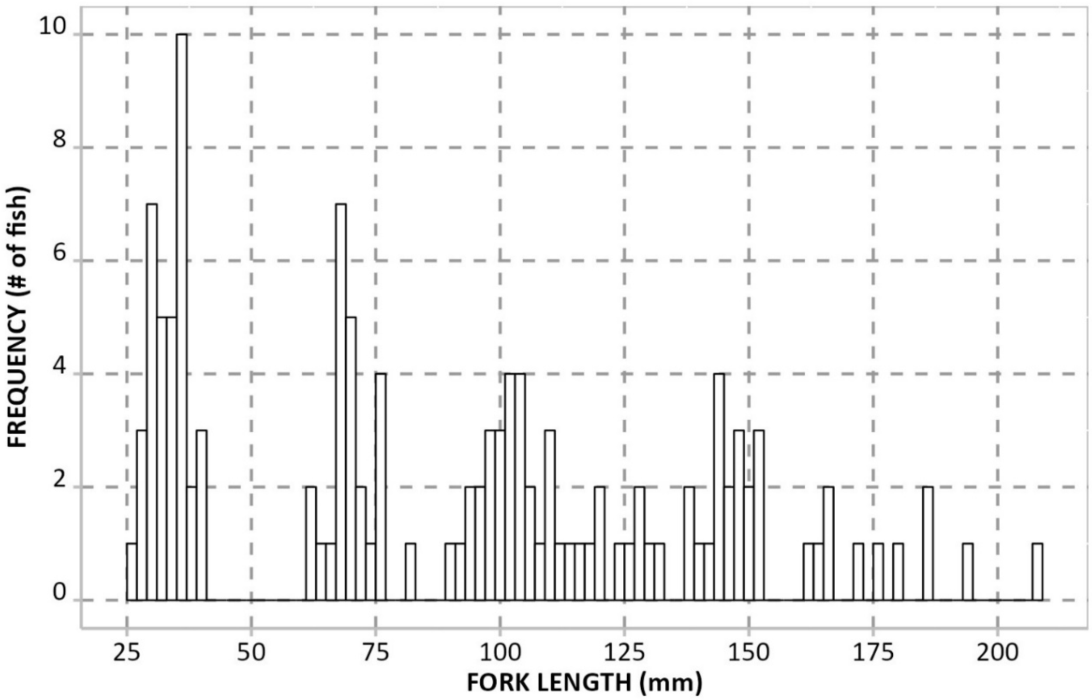

Figure 2. Length-weight regression for Cutthroat Trout captured during closed-site electrofishing in 87.0 km Tributary in 2023.

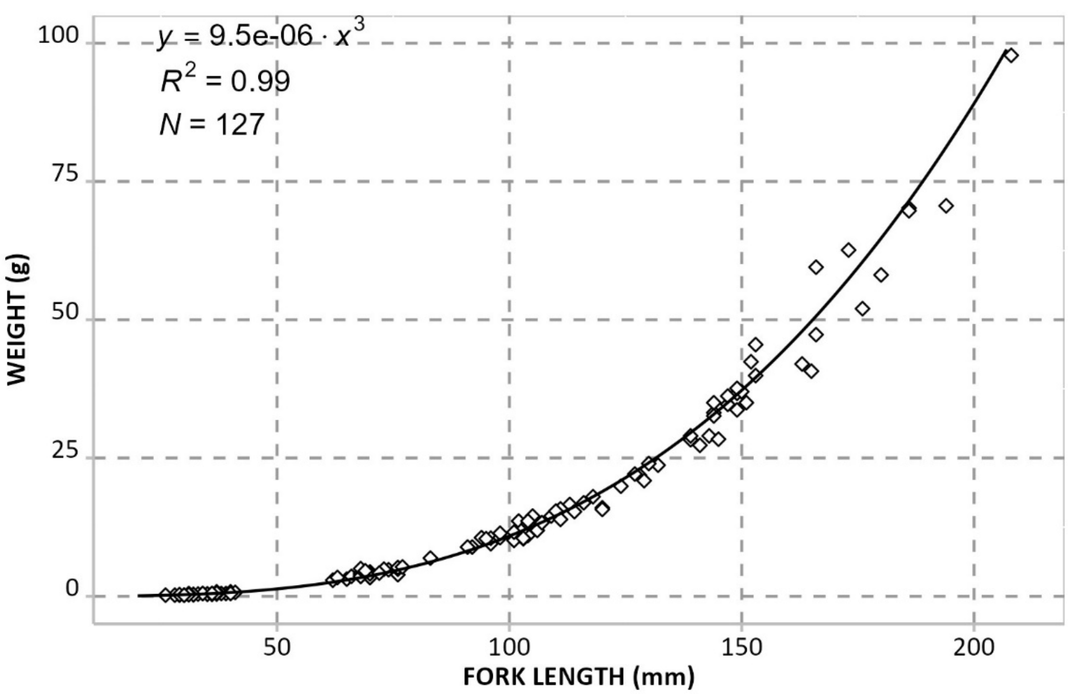

Figure 3. Length at age relationship for Cutthroat Trout captured during closed-site electrofishing in 87.0 km Tributary in 2023.

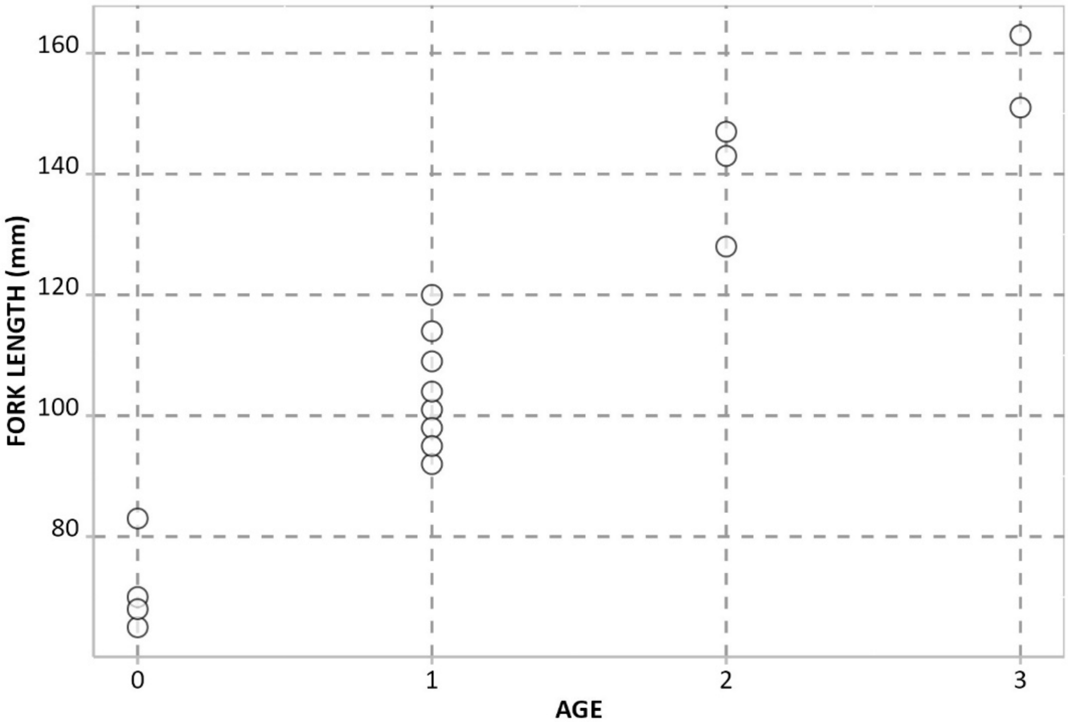

Figure 4. Length-frequency of Bull Trout captured during closed-site electrofishing in the diversion reach of the Upper Lillooet River in 2022.

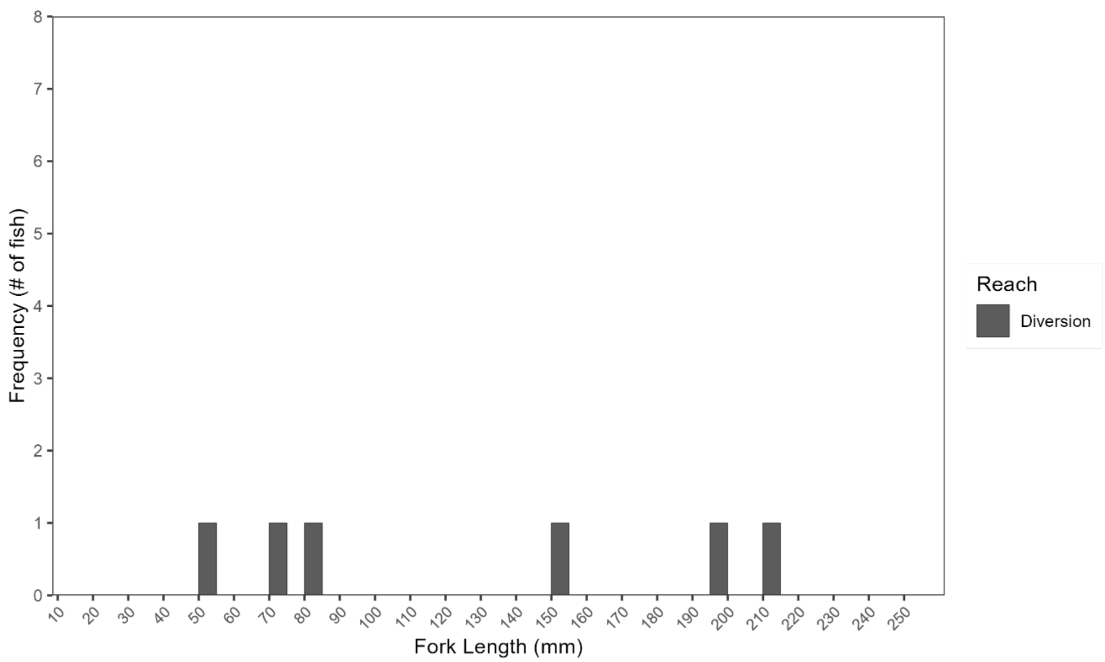

Figure 5. Length-weight regression of Bull Trout captured during closed-site electrofishing in the diversion reach of the Upper Lillooet River in 2022.

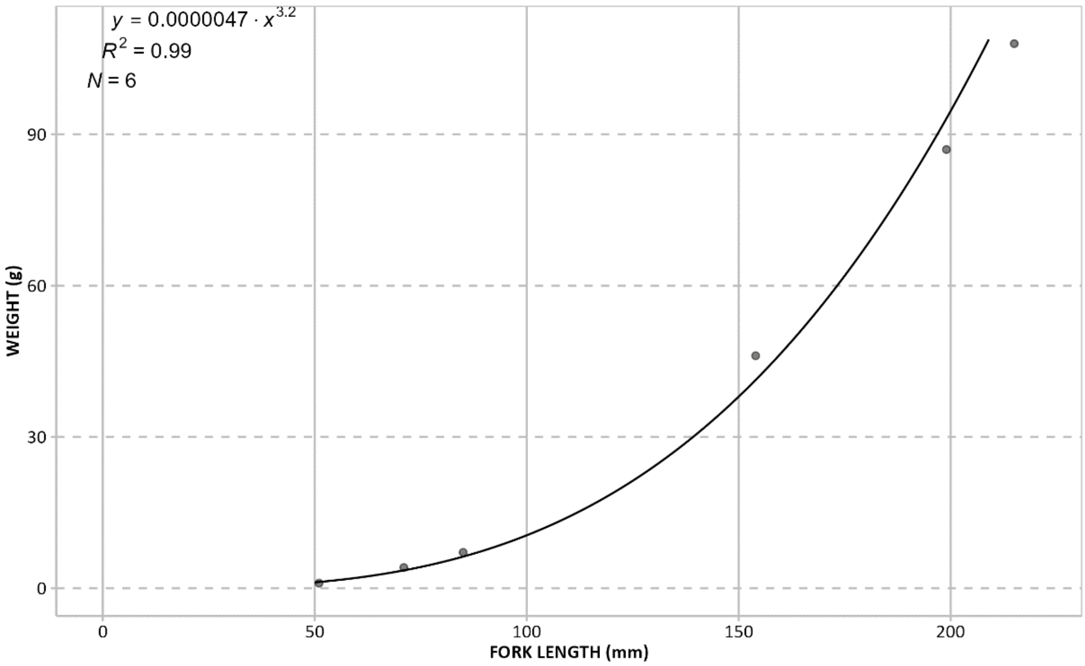

Figure 6. Length-frequency of Cutthroat Trout captured during closed-site electrofishing in diversion reach of the Upper Lillooet River in 2022.

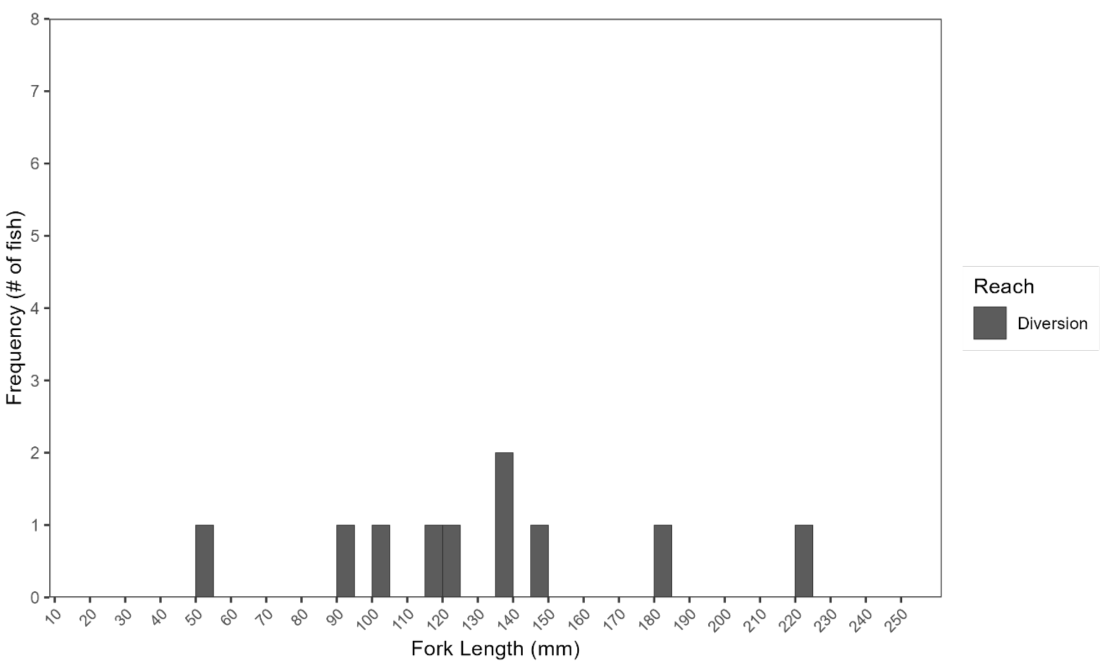

Figure 7. Length-weight regression of Cutthroat Trout captured during closed-site electrofishing in the diversion reach of the Upper Lillooet River in 2022.

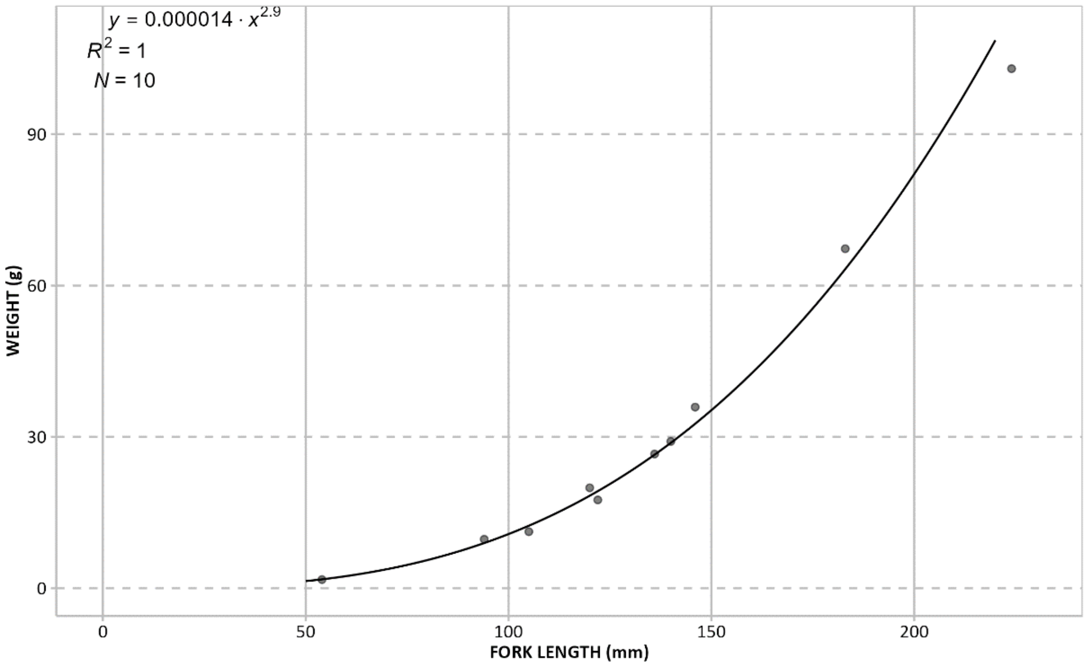

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Table 1. Summary of all fish captured during closed-site electrofishing in 87.0 km Tributary in 2023.

Site	Date	Capture Method[1]	Pass/ Trap #	Species[2]	Measured Length (mm)	Weight (g)	K_R	Scale Sample #	DNA Sample #	Assigned Age	Pit Tag #
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	32	0.3	0.92			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	35	0.4	0.93			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	38	0.5	0.91			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	39	0.5	0.84			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	62	2.9	1.22			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	65	3.1	1.13	6	6	1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	66	3.6	1.25			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	68	3.9	1.24			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	68	4.1	1.30			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	70	3.4	0.99			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	70	3.4	0.99			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	70	4.1	1.20			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	73	4.9	1.26			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	74	4.8	1.18	7	7	1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	76	3.9	0.89			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	76	4.9	1.12			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	92	8.9	1.14	5	5	2	Tag: 989001045508652
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	96	9.5	1.07			2	Tag: 989001045508744
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	101	10.1	0.98	8	8	2	Tag: 989001045508743
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	101	10.4	1.01			2	Tag: 989001045508662
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	102	13.6	1.28			2	Tag: 989001045508653
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	103	10.4	0.95			2	Tag: 989001045508663

[1] EF = Electrofishing

[2] CT= Cutthroat Trout, NFC = No Fish Captured.

Table 1. Continued.

Site	Date	Capture	Pass/ Trap	Species[2]	Measured Length (mm)	Weight (g)	K_R	Scale Sample #	DNA Sample #	Assigned Age	Pit Tag #
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	103	12.2	1.12			2	Tag: 989001045508644
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	104	11	0.98	1	1	2	Tag: 989001045508687
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	105	14.5	1.25			2	Tag: 989001045508651
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	113	16.6	1.15	11	11	2	
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	127	22.1	1.08			3	Tag: 989001045508674
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	128	21.9	1.04	4	4	3	Tag: 989001045508767
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	132	23.7	1.03	9	9	3	Tag: 989001045508611
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	139	28.3	1.05			3	Tag: 989001045508669
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	141	27.3	0.97			3	Tag: 989001045508696
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	143	29	0.99	2	2	3	Tag: 989001045508629
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	145	28.4	0.93			3	Tag: 989001045508621
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	147	34.7	1.09	10	10	3	Tag: 989001045508615
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	149	36.7	1.11			3	Tag: 989001045508677
ULL-HPTB87.0EF01	06-Oct-23	EF	1	CT	176	52	0.95	3	3	3	Tag: 989001045508721
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	34	0.5	1.27			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	37	0.8	1.58			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	70	4.4	1.28			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	96	10.5	1.19			2	Tag: 989001045508619
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	98	10.6	1.13			2	Tag: 989001045508707
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	98	10.7	1.14			2	Tag: 989001045508703
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	116	16.9	1.08	13	13	2	Tag: 989001045508706
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	149	33.7	1.02			3	Tag: 989001045508608
ULL-HPTB87.0EF01	06-Oct-23	EF	2	CT	151	35	1.02	12	12	3	Tag: 989001045508645
ULL-HPTB87.0EF01	06-Oct-23	EF	3	CT	33	0.4	1.11			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	3	CT	40	0.8	1.25			0	
ULL-HPTB87.0EF01	06-Oct-23	EF	3	CT	63	3.4	1.36			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	3	CT	76	5.2	1.18			1	
ULL-HPTB87.0EF01	06-Oct-23	EF	3	CT	106	11.9	1.00			2	Tag: 989001045508635
ULL-HPTB87.0EF01	06-Oct-23	EF	3	CT	109	14.5	1.12	14	14	2	Tag: 989001045508637

[1] EF = Electrofishing

[2] CT= Cutthroat Trout, NFC = No Fish Captured.

Table 1. Continued.

Site	Date	Capture	Pass/ Trap	Species[2]	Measured Length (mm)	Weight (g)	K_R	Scale Sample #	DNA Sample #	Assigned Age	Pit Tag #
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	32	0.3	0.92			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	35	0.4	0.93			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	35	0.4	0.93			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	37	0.4	0.79			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	70	4.1	1.20	6	6	1	
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	94	10.6	1.28			2	Tag: 989001045508695
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	98	11.4	1.21	2	2	2	Tag: 989001045508693
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	104	13.1	1.16	5	5	2	Tag: 989001045508613
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	111	15.8	1.16	4	4	2	Tag: 989001045508610
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	130	24	1.09	3	3	3	Tag: 989001045508701
ULL-HPTB87.0EF02	06-Oct-23	EF	1	CT	144	33.2	1.11	1	1	3	Tag: 989001045508762
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	31	0.4	1.34			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	32	0.3	0.92			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	36	0.4	0.86			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	36	0.4	0.86			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	68	3.6	1.14			1	
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	68	3.6	1.14			1	
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	68	4.1	1.30	7	7	1	
ULL-HPTB87.0EF02	06-Oct-23	EF	2	CT	68	5	1.59			1	
ULL-HPTB87.0EF02	06-Oct-23	EF	3	CT	29	0.2	0.82			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	3	CT	36	0.4	0.86			0	
ULL-HPTB87.0EF02	06-Oct-23	EF	3	CT	69	4.6	1.40			1	
ULL-HPTB87.0EF02	06-Oct-23	EF	3	CT	91	8.9	1.18			2	
ULL-HPTB87.0EF02	06-Oct-23	EF	3	CT	152	42.4	1.21	8	8	3	Tag: 989001045508638
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	28	0.2	0.91			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	31	0.3	1.01			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	32	0.3	0.92			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	34	0.5	1.27			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	36	0.4	0.86			0	

[1] EF = Electrofishing

[2] CT= Cutthroat Trout, NFC = No Fish Captured.

Table 1. Continued.

Site	Date	Capture	Pass/ Trap	Species[2]	Measured Length (mm)	Weight (g)	K_R	Scale Sample #	DNA Sample #	Assigned Age	Pit Tag #
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	36	0.5	1.07			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	37	0.6	1.18			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	37	0.6	1.18			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	41	0.7	1.02			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	72	4.2	1.13	12	12	1	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	95	10.4	1.21	8	8	2	
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	104	13.6	1.21			2	Tag: 989001045508692
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	107	13.3	1.09	11	11	2	Tag: 989001045508657
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	110	15.4	1.16			2	Tag: 989001045508665
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	114	15.3	1.03	5	5	2	Tag: 989001045508656
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	120	15.7	0.91			2	Tag: 989001045508633
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	120	16	0.93	3	3	2	Tag: 989001045508768
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	129	20.9	0.97	2	2	3	Tag: 989001045508705
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	144	32.6	1.09			3	Tag: 989001045508647
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	147	36.2	1.14			3	Tag: 989001045508640
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	149	37.6	1.14			3	Tag: 989001045508700
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	150	37	1.10	7	7	3	Tag: 989001045508754
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	163	42	0.97	4	4	3	Tag: 989001045508673
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	165	40.7	0.91			3	Tag: 989001045508728
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	166	47.3	1.03			3	Tag: 989001045508694
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	166	59.5	1.30			3	Tag: 989001045508617
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	180	58.1	1.00	9	9	3	Tag: 989001045508630
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	186	69.7	1.08			3	Tag: 989001045508704
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	186	70.2	1.09	1	1	3	Tag: 989001045508628

[1] EF = Electrofishing

[2] CT= Cutthroat Trout, NFC = No Fish Captured.

Table 1. Continued.

Site	Date	Capture Method[1]	Pass/ Trap #	Species[2]	Measured Length (mm)	Weight (g)	K_r	Scale Sample #	DNA Sample #	Assigned Age	Pit Tag #
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	194	70.6	0.96694	10	10	3	Tag: 989001045508778
ULL-HPTB87.0EF03	07-Oct-23	EF	1	CT	208	97.8	1.086798	6	6	3	Tag: 989001045508667
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	30	0.2	0.7407407			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	31	0.4	1.3426874			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	31	0.5	1.6783592			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	77	5.3	1.1609237			1	
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	83	6.9	1.2067431	14	14	1	
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	101	11.6	1.1258846			2	Tag: 989001045508668
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	103	10.5	0.9608987			2	Tag: 989001045508664
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	118	18	1.0955356			2	Tag: 989001045508672
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	139	29	1.0798255			3	Tag: 989001045508686
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	144	35	1.1721429			3	Tag: 989001045508634
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	153	39.9	1.1140344			3	Tag: 989001045508689
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	153	45.5	1.2703901			3	Tag: 989001045508612
ULL-HPTB87.0EF03	07-Oct-23	EF	2	CT	173	62.6	1.2090271			3	Tag: 989001045508620
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	26	0.2	1.1379153			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	29	0.3	1.2300627			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	30	0.2	0.7407407			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	31	0.3	1.0070155			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	36	0.5	1.0716735			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	40	0.5	0.78125			0	
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	111	13.9	1.016356			2	Tag: 989001045508655
ULL-HPTB87.0EF03	07-Oct-23	EF	3	CT	124	19.9	1.0437296			2	Tag: 989001045508780

[1] EF = Electrofishing

[2] CT = Cutthroat Trout, NFC = No Fish Captured.

ECOFISH RESEARCH

Table 2. Summary of all fish captured during closed-site electrofishing in the Upper Lillooet River in 2022.

Site	Date	Pass #	Species[1]	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Recapture (Yes/No)	PIT Tag #
ULL-DVEF02b	3-Apr-22	1	BT/DV	51	1.0	0.75		No	
ULL-DVEF02b	3-Apr-22	1	BT/DV	71	4.1	1.15		No	
ULL-DVEF02b	3-Apr-22	1	BT/DV	154	46.1	1.26	FR3	No	98900104643327
ULL-DVEF02b	3-Apr-22	1	BT/DV	215	108.0	1.09	FR1	No	89001040643355
ULL-DVEF02b	3-Apr-22	1	MW	235	141.7	1.09	SC4	No	89001040643348
ULL-DVEF02b	3-Apr-22	2	NFC					No	
ULL-DVEF04	3-Apr-22	1	BT/DV	85	7.1	1.16	FC5	No	89001040642325
ULL-DVEF04	3-Apr-22	1	MW	250	180.4	1.15	SC2	No	89001040642351
ULL-DVEF04	3-Apr-22	1	MW	256	213.0	1.27	SC1	No	89001040642346
ULL-DVEF04	3-Apr-22	1	MW	279	217.1	1.00	SC3	No	89001040642337
ULL-DVEF04	3-Apr-22	1	MW	281	214.6	0.97	SC4	No	89001040642281
ULL-DVEF04	3-Apr-22	2	NFC					No	
ULL-DVEF07	3-Apr-22	1	MW	269	>200		SC1	No	89001040643353
ULL-DVEF07	3-Apr-22	2	NFC					No	
ULL-DVEF09	8-Apr-22	1	MW	260	176.0	1.00	SC2	No	89001040643331
ULL-DVEF09	8-Apr-22	1	MW	281	259.0	1.17	SC3	No	89001040643328
ULL-DVEF09	8-Apr-22	1	MW	292	314.0	1.26	SC1	No	89001040643337
ULL-DVEF09	8-Apr-22	2	NFC					No	
ULL-DVEF10	8-Apr-22	1	CT	94	9.7	1.17	SC1	No	89001040642276
ULL-DVEF10	8-Apr-22	1	CT	105	11.2	0.97	SC6	No	89001040642288
ULL-DVEF10	8-Apr-22	1	CT	120	19.9	1.15	SC4	No	89001040642343
ULL-DVEF10	8-Apr-22	1	CT	122	17.5	0.96	SC8	No	
ULL-DVEF10	8-Apr-22	1	CT	136	26.6	1.06	SC3	No	89001040642296
ULL-DVEF10	8-Apr-22	1	CT	140	29.1	1.06	SC2	No	89001040642772
ULL-DVEF10	8-Apr-22	1	CT	146	35.9	1.15	SC7	No	89001040642305
ULL-DVEF10	8-Apr-22	1	CT	183	67.3	1.10	SC5	No	89001040642282
ULL-DVEF10	8-Apr-22	2	NFC					No	
ULL-DVEF10	8-Apr-22	1	TR	54	1.7	1.08	SC9	No	
ULL-DVEF11	8-Apr-22	3	NFC					No	
ULL-DVEF12	8-Apr-22	1	BT/DV	199	87.0	1.10	FR2	Yes	89001040643319

[1] DV/BT = Bull Trout, CT = Cutthroat Trout, MW = Mountain Whitefish, TR = Unknown Trout, and NFC = No Fish Caught

[2] FR = Fin Ray and SC = Scale Sample.

Table 2. Continued

Site	Date		Species[1]	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Recapture (Yes/No)	PIT Tag #
ULL-DVEF12	8-Apr-22	1	CT	224	103	0.92	SC1	No	89001040643316
ULL-DVEF12	8-Apr-22	2	NFC					No	

[1] DV/BT = Bull Trout, CT = Cutthroat Trout, MW = Mountain Whitefish, TR = Unknown Trout, and NFC = No Fish Caught

[2] FR = Fin Ray and SC = Scale Sample.

Appendix N. Habitat Summaries and Representative Photographs of Snorkel Mark Re-sight Sites

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Table 1. Summary of site conditions at mark re-sight sites in Boulder Creek, 2022.

Project Reach	Sampling Event	Site	Date	Estimated Visibility (m)	Water Temp. (°C)	Air Temp. (°C)	Daily Average Flow (m^3/s)[1]
Diversion	Mark	BDR-DVSN01	4-Apr-22	3.0	2.2	5.00	0.51
		BDR-DVSN02	4-Apr-22	3.0	1.7	-0.50	0.51
		BDR-DVSN03	4-Apr-22	3.8	2.1	6.00	0.51
		BDR-DVSN04	4-Apr-22	3.8	-	-	0.51
		BDR-DVSN05	4-Apr-22	3.8	1.6	2.50	0.51
	Re-sight	BDR-DVSN01	5-Apr-22	3.0	2.9	0.00	0.46
		BDR-DVSN02	5-Apr-22	3.0	-	-	0.46
		BDR-DVSN03	5-Apr-22	3.0	2.7	-1.00	0.46
		BDR-DVSN04	5-Apr-22	3.0	-	-	0.46
		BDR-DVSN05	5-Apr-22	3.0	-	-	0.46
Downstream	Mark	BDR-DSSN01B	6-Apr-22	-	2.7	0.50	1.18
		BDR-DSSN02B	6-Apr-22	-	2.6	0.00	1.18
		BDR-DSSN03	6-Apr-22	3.0	3.0	3.50	1.18
		BDR-DSSN04	6-Apr-22	3.0	3.0	9.00	1.18
		BDR-DSSN05	6-Apr-22	3.0	3.0	5.00	1.18
	Re-sight	BDR-DSSN01B	7-Apr-22	3.5	3.9	1.00	1.19
		BDR-DSSN02B	7-Apr-22	3.5	3.2	-	1.19
		BDR-DSSN03	7-Apr-22	3.0	2.7	3.00	1.19
		BDR-DSSN04	7-Apr-22	2.0	-	-	1.19
		BDR-DSSN05	7-Apr-22	1.5	-		1.19

[1] Diversion flow was calculated by subtracting powerhouse flows from downstream flows as measured at BDR-DSPH-R3.

Table 2. Summary of habitat data at mark re-sight sites in Boulder Creek, 2022.

Reach	Site	Habitat	Site Length (m)	Site Width (m)	Site Area (m²)	Max. Depth (m)	Cover[1]		Substrate (%)[2]							Gradient (%)
							Dom.	Sub-dom.	BR	BO	LC	SC	LG	SG	F	
Diversion	BDR-DVSN01	Cascade	88	10.2	895	1.1	BO	DP	0	60	10	10	10	5	5	4.0
	BDR-DVSN02	Cascade/Riffle	100	13.3	1,333	0.8	BO	CO	0	50	25	10	5	5	5	3.0
	BDR-DVSN03	Cascade/Riffle	125	14.3	1,791	0.8	BO	DP	0	55	20	10	5	5	5	4.0
	BDR-DVSN04	Cascade	90	12.0	1,080	0.8	BO	DP	0	45	20	15	10	5	5	4.0
	BDR-DVSN05	Cascade	90	10.0	900	1.1	BO	DP	5	45	15	10	10	10	5	4.0
Downstream	BDR-DSSN01B	Riffle	95	11.7	1,109	1.2	BO	CO	0	50	20	10	10	5	5	2.5
	BDR-DSSN02B	Riffle	110	12.3	1,356	1.0	BO	CO	0	45	20	15	10	5	5	3.0
	BDR-DSSN03	Cascade	110	12.3	1,356	1.8	BO	DP	0	50	25	10	5	5	5	4.0
	BDR-DSSN04	Cascade	120	11.0	1,320	2.2	BO	DP	0	55	20	10	5	5	5	4.0
	BDR-DSSN05	Cascade	97	12.3	1,193	1.3	BO	DP	0	55	20	10	5	5	5	4.0

[1] Cover codes: Dom. = dominant, Sub-Dom. = sub-dominant, BO = boulder, CO = cobble, DP = deep pool

[2] F = fine (<2 mm), SG = small gravel (2 - 16 mm), LG = large gravel (16 - 64 mm), SC = small cobble (64 - 128 mm), LC = large cobble (128 - 256 mm), BO = boulder (256-4,000 mm), and BR = bedrock (>4,000 mm)

Figure 1. Looking upstream at BDR-DSSN01B on April 9, 2022.

Figure 2. Looking downstream at BDR-DSSN01B on April 9, 2022.

Figure 3. Looking upstream at BDR-DSSN02B on April 9, 2022.

Figure 4. Looking downstream at BDR-DSSN02B on April 9, 2022.

Figure 5. Looking upstream at BDR-DSSN03 on April 9, 2022.

Figure 6. Looking downstream at BDR-DSSN03 on April 9, 2022.

Figure 7. Looking upstream at BDR-DSSN04 on April 9, 2022.

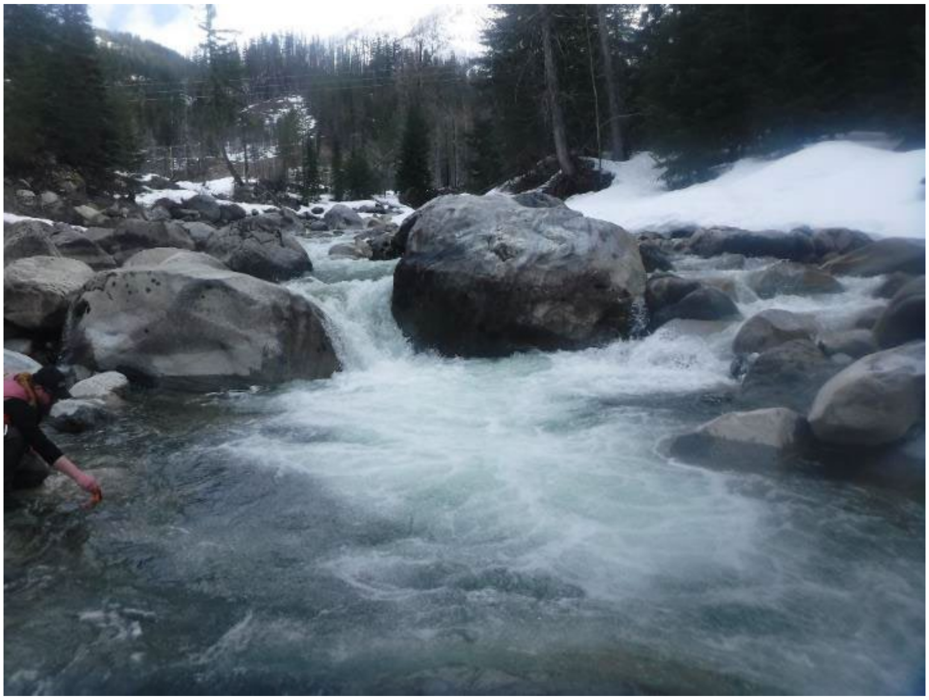

Figure 8. Looking downstream at BDR-DSSN04 on April 9, 2022.

Figure 9. Looking upstream at BDR-DSSN05 on April 9, 2022.

Figure 10. Looking downstream at BDR-DSSN05 on April 9, 2022.

Figure 11. Looking upstream at BDR-DVSN01 on April 9, 2022.

Figure 12. Looking downstream at BDR-DVSN01 on April 9, 2022.

Figure 13. Looking upstream at BDR-DVSN02 on April 9, 2022.

Figure 14. Looking downstream at BDR-DVSN02 on April 9, 2022.

Figure 15. Looking upstream at BDR-DVSN03 on April 9, 2022.

Figure 16. Looking downstream at BDR-DVSN03 on April 9, 2022.

Figure 17. Looking upstream at BDR-DVSN04 on April 9, 2022.

Figure 18. Looking downstream at BDR-DVSN04 on April 9, 2022.

Figure 19. Looking upstream at BDR-DVSN05 on April 9, 2022.

Figure 20. Looking upstream at top of BDR-DVSN05 on April 9, 2022.

Appendix O. Snorkel Mark Re-sight Individual Fish Figures and Individual Fish Data

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Figure 1. Length-frequency of Bull Trout captured during mark re-sight snorkelling in Boulder Creek in 2022.

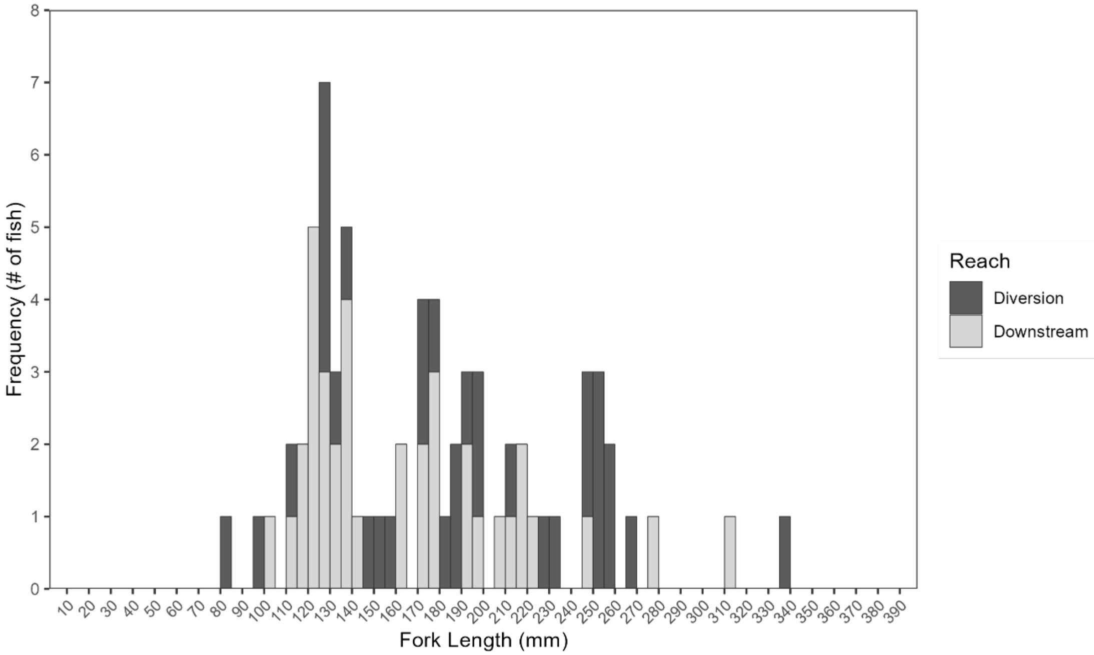

Figure 2. Length-weight regression for Bull Trout captured during mark re-sight snorkelling in Boulder Creek in 2022.

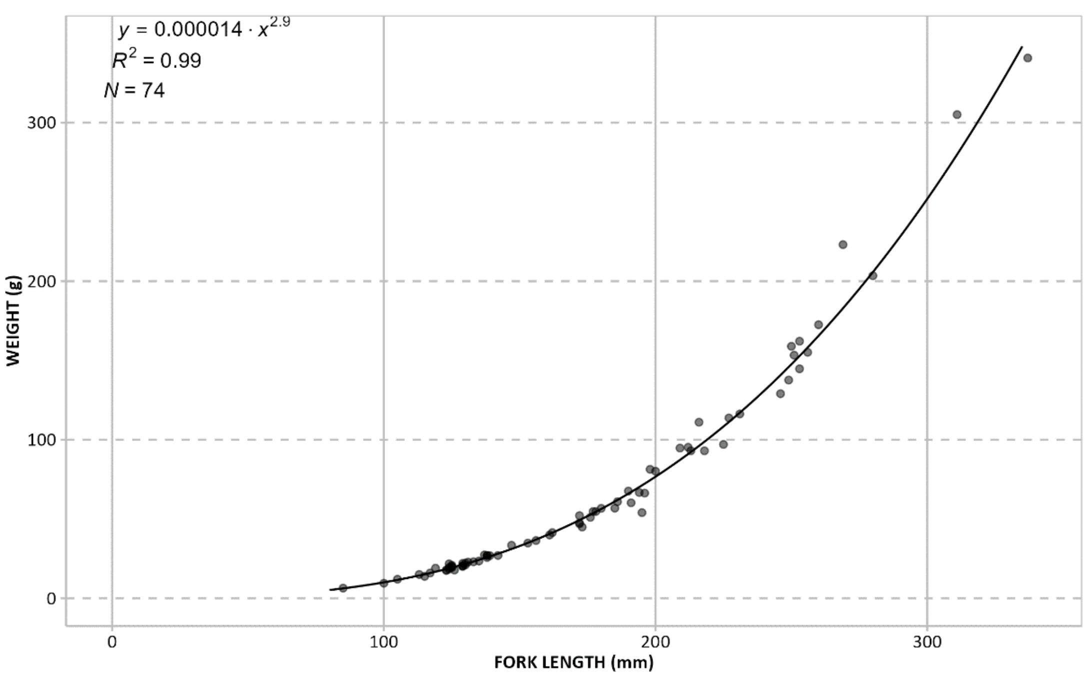

Figure 3. Length-frequency of Cutthroat Trout captured during mark re-sight snorkelling in Boulder Creek in 2022.

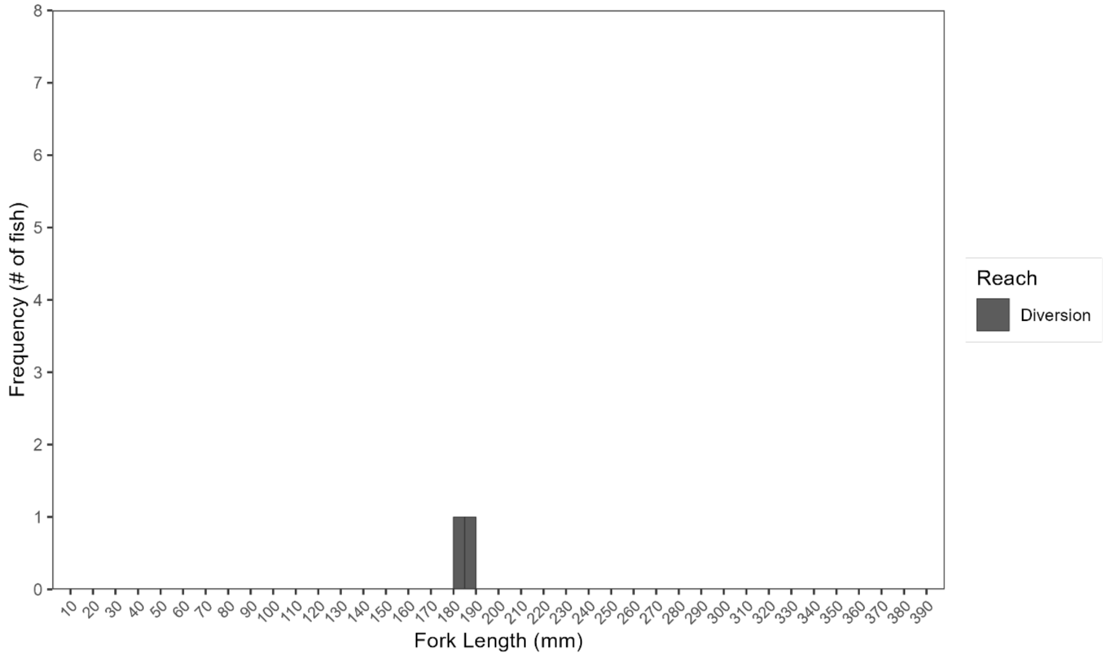

Figure 4. Length-weight regression for Cutthroat Trout captured during mark re-sight snorkelling in Boulder Creek in 2022.

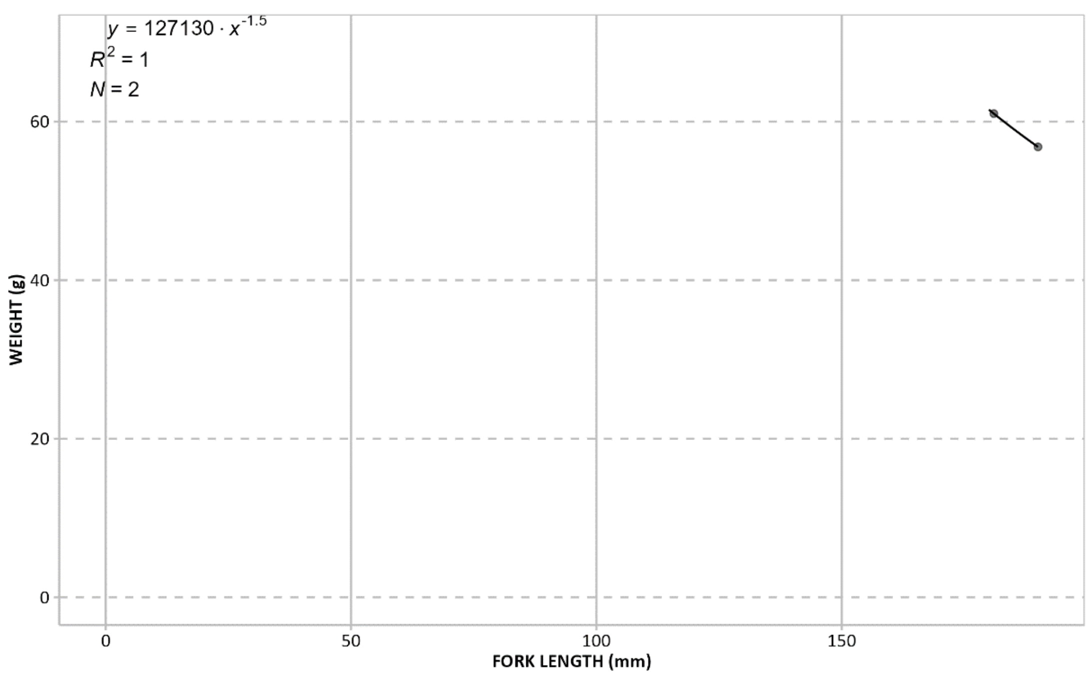

Table 1. Summary of all fish captured during mark-resight sampling in Boulder Creek, 2022.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DSSN01B	6-Apr-22	Downstream	BT	90	107				red	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	100	111				red	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	100	113				red	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	110						No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	120	120				red	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	130	122				yellow	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	130	129				yellow	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	150	126				yellow	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	170	144				yellow	No	
BDR-DSSN01B	6-Apr-22	Downstream	BT	300	305				pink	No	
BDR-DSSN01B	6-Apr-22	Downstream	MW	250	251				pink	No	
BDR-DSSN01B	6-Apr-22	Downstream	MW	260	254				pink	No	
BDR-DSSN01B	6-Apr-22	Downstream	MW	280	257				pink	No	
BDR-DSSN01B	6-Apr-22	Downstream	MW	280						No	
BDR-DSSN01B	6-Apr-22	Downstream	RB/CT	135						No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	100						No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	120	123	17.5	0.94	FR1	yellow	No	89001040642311
BDR-DSSN01B	7-Apr-22	Downstream	BT	120	125	20.8	1.06	FR2	yellow	No	89001040642341
BDR-DSSN01B	7-Apr-22	Downstream	BT	120					yellow	No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	120						No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	160						No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	190						No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	220						No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	230						No	
BDR-DSSN01B	7-Apr-22	Downstream	BT	320					pink	No	
BDR-DSSN01B	7-Apr-22	Downstream	MW	260						No	
BDR-DSSN01B	7-Apr-22	Downstream	MW	270						No	
BDR-DSSN01B	7-Apr-22	Downstream	NFC							No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	120	120				blue sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	120	125				orange sparkle	No	

[1] BT = Bull Trout, RB/CT = Cutthroat Trout, MW = Mountain Whitefish, NFC = No Fish Caught, and NFO = No Fish Observed.

[2] FR = Fin Ray and SC = Scale Sample.

Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DSSN02B	6-Apr-22	Downstream	BT	130	125				orange sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	140	123				orange sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	140						No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	150	133				orange sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	150	135				orange sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	150						No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	160	125				orange sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	160	131				orange sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	160	161				purple sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	160	176				purple sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	160						No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	170	177				purple sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	180	173				purple sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	180						No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	200	190				purple sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	BT	220	196				purple sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	MW	290	271				green sparkle	No	
BDR-DSSN02B	6-Apr-22	Downstream	MW	290						No	
BDR-DSSN02B	7-Apr-22	Downstream	BT	100						No	
BDR-DSSN02B	7-Apr-22	Downstream	BT	120	138	27	1.03	FR1		No	89001040642277
BDR-DSSN02B	7-Apr-22	Downstream	BT	120						No	
BDR-DSSN02B	7-Apr-22	Downstream	BT	130	125	19.4	0.99	FR8		No	89001040642267
BDR-DSSN02B	7-Apr-22	Downstream	BT	130	125	20.3	1.04	FR7	sparkle orange	No	89001040642260
BDR-DSSN02B	7-Apr-22	Downstream	BT	130	126	17.8	0.89	FR11	sparkle orange	No	89001040642322
BDR-DSSN02B	7-Apr-22	Downstream	BT	200	161	39.9	0.96	FR5	sparkle purple	No	89001040642289
BDR-DSSN02B	7-Apr-22	Downstream	BT	220	172	52.1	1.02	FR2	sparkle purple	No	89001040642273
BDR-DSSN02B	7-Apr-22	Downstream	BT	220	177	54.7	0.99		sparkle purple	No	89001040642262
BDR-DSSN02B	7-Apr-22	Downstream	BT	230	191	60.2	0.86	FR6	sparkle purple	No	89001040642319
BDR-DSSN02B	7-Apr-22	Downstream	BT	260	178	54.7	0.97	FR3	sparkle purple	No	89001040642336
BDR-DSSN02B	7-Apr-22	Downstream	BT	260	198	81.3	1.05	FR4	sparkle purple	No	89001040642354

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Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DSSN02B	7-Apr-22	Downstream	MW	300	250	180.3	1.15	SC9		No	89001040642283
BDR-DSSN02B	7-Apr-22	Downstream	MW	310	306	365.5	1.28	SC10		No	89001040642340
BDR-DSSN03	6-Apr-22	Downstream	BT	100	113				red	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	100						No	
BDR-DSSN03	6-Apr-22	Downstream	BT	110	112				yellow	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	110	124				yellow	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	120	138				yellow	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	120						No	
BDR-DSSN03	6-Apr-22	Downstream	BT	130	116				red	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	130	143				yellow	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	130	168				orange	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	130						No	
BDR-DSSN03	6-Apr-22	Downstream	BT	150	142				yellow	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	150	148				yellow	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	150	164				orange	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	150						No	
BDR-DSSN03	6-Apr-22	Downstream	BT	160	161				orange	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	160						No	
BDR-DSSN03	6-Apr-22	Downstream	BT	170	137				yellow	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	200	275				white	Yes	89001031378548
BDR-DSSN03	6-Apr-22	Downstream	BT	205	257				white	Yes	89001038120913
BDR-DSSN03	6-Apr-22	Downstream	BT	210	214				pink	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	290	289				white	No	
BDR-DSSN03	6-Apr-22	Downstream	BT	330	379				white	No	
BDR-DSSN03	7-Apr-22	Downstream	BT	100						No	
BDR-DSSN03	7-Apr-22	Downstream	BT	110						No	
BDR-DSSN03	7-Apr-22	Downstream	BT	125	131	22.8	1.01	FR2		No	89001040642316
BDR-DSSN03	7-Apr-22	Downstream	BT	130						No	
BDR-DSSN03	7-Apr-22	Downstream	BT	140					pink	No	
BDR-DSSN03	7-Apr-22	Downstream	BT	150	137	27.3	1.06	FR9		No	89001040642342

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Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DSSN03	7-Apr-22	Downstream	BT	150	138	25.7	0.98	FR6		No	89001040642306
BDR-DSSN03	7-Apr-22	Downstream	BT	150						No	
BDR-DSSN03	7-Apr-22	Downstream	BT	160	162	41.4	0.97	FR7	orange	No	89001040642259
BDR-DSSN03	7-Apr-22	Downstream	BT	160						No	
BDR-DSSN03	7-Apr-22	Downstream	BT	180	173	44.9	0.87	FR3	orange	No	89001040642291
BDR-DSSN03	7-Apr-22	Downstream	BT	180	209	94.7	1.04	FR10		No	89001040642290
BDR-DSSN03	7-Apr-22	Downstream	BT	180						No	
BDR-DSSN03	7-Apr-22	Downstream	BT	200						No	
BDR-DSSN03	7-Apr-22	Downstream	BT	310	280	203.4	0.93	FR8		No	89001040642297
BDR-DSSN03	7-Apr-22	Downstream	BT	320					white	No	
BDR-DSSN03	7-Apr-22	Downstream	BT		117	15.9	0.99	FR4		No	89001040642302
BDR-DSSN03	7-Apr-22	Downstream	BT		125	19.6	1.00	FR4		No	89001040642344
BDR-DSSN03	7-Apr-22	Downstream	MW	220	246	150.1	1.01	SC11		No	89001040642258
BDR-DSSN03	7-Apr-22	Downstream	MW	320						No	
BDR-DSSN03	7-Apr-22	Downstream	RB/CT	190	190	56.8	0.83	SC1		No	89001040642310
BDR-DSSN04	6-Apr-22	Downstream	BT	90	132				sparkle orange	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	100	115				sparkle blue	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	100	119				sparkle blue	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	110	128				sparkle orange	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	115						No	
BDR-DSSN04	6-Apr-22	Downstream	BT	120	125				sparkle orange	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	120	140				sparkle orange	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	130	125				sparkle orange	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	130	165				sparkle yellow	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	130	175				sparkle yellow	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	150	135				sparkle orange	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	160	190				sparkle yellow	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	170						No	
BDR-DSSN04	6-Apr-22	Downstream	BT	180	195				sparkle yellow	No	
BDR-DSSN04	6-Apr-22	Downstream	BT	200	234				sparkle white	Yes	89001032067189

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Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DSSN04	6-Apr-22	Downstream	BT	280	310				sparkle pink	Yes	89001006773381
BDR-DSSN04	7-Apr-22	Downstream	BT	105	105	12	1.04	FR8		No	89001040642338
BDR-DSSN04	7-Apr-22	Downstream	BT	110	129	22	1.02	FR5		No	89001040642308
BDR-DSSN04	7-Apr-22	Downstream	BT	110	142	27	0.94	FR6		No	89001040642303
BDR-DSSN04	7-Apr-22	Downstream	BT	120	119	19	1.13	FR4		No	89001040642264
BDR-DSSN04	7-Apr-22	Downstream	BT	130	133	23	0.98	FR9		No	89001040642295
BDR-DSSN04	7-Apr-22	Downstream	BT	160						No	
BDR-DSSN04	7-Apr-22	Downstream	BT	210	195	54	0.73	FR3	yellow	No	89001040642257
BDR-DSSN04	7-Apr-22	Downstream	BT	220	216	111	1.10	FR1		No	89001040642339
BDR-DSSN04	7-Apr-22	Downstream	BT	240	246	129	0.87	FR7	sparkle white	No	89001040642294
BDR-DSSN04	7-Apr-22	Downstream	BT	290	311	305	1.01	FR10	sparkle pink	Yes	89001032067189
BDR-DSSN04	7-Apr-22	Downstream	BT	290						No	
BDR-DSSN04	7-Apr-22	Downstream	NFC							No	
BDR-DSSN04	7-Apr-22	Downstream	RB/CT	200	181	61	1.03	SC2		No	89001040642279
BDR-DSSN05	6-Apr-22	Downstream	BT	70						No	
BDR-DSSN05	6-Apr-22	Downstream	BT	80						No	
BDR-DSSN05	6-Apr-22	Downstream	BT	110						No	
BDR-DSSN05	6-Apr-22	Downstream	BT	130	135				orange	No	
BDR-DSSN05	6-Apr-22	Downstream	BT	140						No	
BDR-DSSN05	6-Apr-22	Downstream	BT	160	175				orange	No	
BDR-DSSN05	6-Apr-22	Downstream	BT	160						No	
BDR-DSSN05	6-Apr-22	Downstream	BT	170	187				orange	No	
BDR-DSSN05	6-Apr-22	Downstream	BT	190	200				orange	No	
BDR-DSSN05	6-Apr-22	Downstream	BT	190	275				white	Yes	89001038120955
BDR-DSSN05	6-Apr-22	Downstream	BT	200	230				pink	No	
BDR-DSSN05	7-Apr-22	Downstream	BT	100	113	15	1.04	FR2		No	89001040642284
BDR-DSSN05	7-Apr-22	Downstream	BT	130					orange	No	
BDR-DSSN05	7-Apr-22	Downstream	BT	135	130	21	0.96	FR4	yellow	No	89001040642333
BDR-DSSN05	7-Apr-22	Downstream	BT	135	138	27	1.03	FR5		No	89001040642350
BDR-DSSN05	7-Apr-22	Downstream	BT	160	176	51	0.94	FR3	orange	No	89001040642330

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Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DSSN05	7-Apr-22	Downstream	BT	160	225	97	0.85	FR7		No	89001040642314
BDR-DSSN05	7-Apr-22	Downstream	BT	180					pink	No	
BDR-DSSN05	7-Apr-22	Downstream	BT	195	218	93	0.90	FR1		No	89001040642293
BDR-DSSN05	7-Apr-22	Downstream	BT	200						No	
BDR-DSSN05	7-Apr-22	Downstream	BT	230						No	
BDR-DSSN05	7-Apr-22	Downstream	BT	265	213	93	0.96	FR6		No	89001040642332
BDR-DSSN05	7-Apr-22	Downstream	MW	220						No	
BDR-DSSN05	7-Apr-22	Downstream	NFC							No	
BDR-DVSN01	4-Apr-22	Diversion	BT	120	130				yellow	No	
BDR-DVSN01	4-Apr-22	Diversion	BT	130	140				yellow	No	
BDR-DVSN01	4-Apr-22	Diversion	BT	130	145				yellow	No	
BDR-DVSN01	4-Apr-22	Diversion	BT	150	124				yellow	No	
BDR-DVSN01	4-Apr-22	Diversion	BT	150						No	
BDR-DVSN01	4-Apr-22	Diversion	BT	200	245				white	No	
BDR-DVSN01	4-Apr-22	Diversion	BT	200						No	
BDR-DVSN01	4-Apr-22	Diversion	BT	250						No	
BDR-DVSN01	4-Apr-22	Diversion	MW	130						No	
BDR-DVSN01	5-Apr-22	Diversion	BT	90	129	20.1	0.94	FR7	yellow	No	89001040642301
BDR-DVSN01	5-Apr-22	Diversion	BT	110	115	13.8	0.91	FR15		No	89001040642334
BDR-DVSN01	5-Apr-22	Diversion	BT	110	123	17.9	0.96	FR14		No	89001040642326
BDR-DVSN01	5-Apr-22	Diversion	BT	110	139	26.9	1.00	FR10		No	89001040642261
BDR-DVSN01	5-Apr-22	Diversion	BT	110						No	
BDR-DVSN01	5-Apr-22	Diversion	BT	120	129	20.6	0.96	FR13		No	89001040642355
BDR-DVSN01	5-Apr-22	Diversion	BT	130	124	21.7	1.14	FR6		No	89001040642347
BDR-DVSN01	5-Apr-22	Diversion	BT	140	186	60.9	0.95	FR8		No	89001040642335
BDR-DVSN01	5-Apr-22	Diversion	BT	150	249	137.6	0.89	FR4		Yes	89001039049944
BDR-DVSN01	5-Apr-22	Diversion	BT	155	130	22.2	1.01	FR12		No	89001040642324
BDR-DVSN01	5-Apr-22	Diversion	BT	160	153	34.8	0.97	FR5		No	89001040642323
BDR-DVSN01	5-Apr-22	Diversion	BT	170	180	56.7	0.97	FR3		No	89001040612286
BDR-DVSN01	5-Apr-22	Diversion	BT	200	196	66.3	0.88	FR11		No	89001040642348

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Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DVSN01	5-Apr-22	Diversion	BT	230						No	
BDR-DVSN01	5-Apr-22	Diversion	BT	240	200	80.1	1.00	FR1		No	89001040642265
BDR-DVSN01	5-Apr-22	Diversion	BT	240	251	153.3	0.97	FR2		No	89001040642287
BDR-DVSN01	5-Apr-22	Diversion	BT	250						No	
BDR-DVSN01	5-Apr-22	Diversion	NFC							No	
BDR-DVSN02	4-Apr-22	Diversion	BT	110	116				sparkle blue	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	140	135				sparkle orange	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	150	145				sparkle orange	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	150	148				sparkle orange	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	150	171				sparkle yellow	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	200	190				sparkle yellow	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	200	235				sparkle white	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	230	200				sparkle yellow	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	250	255				sparkle pink	No	
BDR-DVSN02	4-Apr-22	Diversion	BT	250						No	
BDR-DVSN02	4-Apr-22	Diversion	BT	350						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	80	129	20.3	0.95	FR2		No	89001040642320
BDR-DVSN02	5-Apr-22	Diversion	BT	80						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	100	124	18.4	0.97	FR1		No	89001040642309
BDR-DVSN02	5-Apr-22	Diversion	BT	100						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	110						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	120						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	130					sparkle blue	No	
BDR-DVSN02	5-Apr-22	Diversion	BT	140						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	150	172	47	0.92	FR3	sparkle yellow	No	89001040642312
BDR-DVSN02	5-Apr-22	Diversion	BT	150	190	67.6	0.99	FR4	sparkle yellow	No	89001040642292
BDR-DVSN02	5-Apr-22	Diversion	BT	160						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	190						No	
BDR-DVSN02	5-Apr-22	Diversion	BT	200					sparkle pink	No	
BDR-DVSN02	5-Apr-22	Diversion	BT	210	194	66.7	0.91	FR6	sparkle yellow	No	89001040642307

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Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DVSN02	5-Apr-22	Diversion	BT	240	253	144.7	0.89	FR5		Yes	89001032067114
BDR-DVSN02	5-Apr-22	Diversion	BT	280					sparkle white	No	
BDR-DVSN02	5-Apr-22	Diversion	BT	295	256	155.1	0.92	FR7	sparkle pink	No	89001040642315
BDR-DVSN02	5-Apr-22	Diversion	BT	300						No	
BDR-DVSN03	4-Apr-22	Diversion	BT	100						No	
BDR-DVSN03	4-Apr-22	Diversion	BT	110	127				yellow	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	110	144				yellow	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	110						No	
BDR-DVSN03	4-Apr-22	Diversion	BT	120	149				yellow	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	125						No	
BDR-DVSN03	4-Apr-22	Diversion	BT	135						No	
BDR-DVSN03	4-Apr-22	Diversion	BT	140						No	
BDR-DVSN03	4-Apr-22	Diversion	BT	165						No	
BDR-DVSN03	4-Apr-22	Diversion	BT	200	213				white	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	200	253				pink	Yes	89001032067138
BDR-DVSN03	4-Apr-22	Diversion	BT	220	230				white	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	225	239				white	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	240	265				pink	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	250	259				pink	Yes	89001006335383
BDR-DVSN03	4-Apr-22	Diversion	BT	290	279				pink	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	310	330				pink	No	
BDR-DVSN03	4-Apr-22	Diversion	BT	350						No	
BDR-DVSN03	4-Apr-22	Diversion	BT		183				orange	No	
BDR-DVSN03	4-Apr-22	Diversion	BT		230				white	No	
BDR-DVSN03	4-Apr-22	Diversion	BT		241				pink	No	
BDR-DVSN03	4-Apr-22	Diversion	BT		250				pink	No	
BDR-DVSN03	5-Apr-22	Diversion	BT	110	147	33.4	1.05	FR1		No	89001040642298
BDR-DVSN03	5-Apr-22	Diversion	BT	120	124	19.4	1.02	FR3		No	89001040642349
BDR-DVSN03	5-Apr-22	Diversion	BT	150	156	36.4	0.96	FR4		No	89001040642268
BDR-DVSN03	5-Apr-22	Diversion	BT	150						No	

[1] BT = Bull Trout, RB/CT = Cutthroat Trout, MW = Mountain Whitefish, NFC = No Fish Caught, and NFO = No Fish Observed.

[2] FR = Fin Ray and SC = Scale Sample.

Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DVSN03	5-Apr-22	Diversion	BT	160						No	
BDR-DVSN03	5-Apr-22	Diversion	BT	190	185	56.8	0.90	FR5		No	89001040642275
BDR-DVSN03	5-Apr-22	Diversion	BT	220	260	172.5	0.98	FR2	pink	Yes	89001006335383
BDR-DVSN03	5-Apr-22	Diversion	BT	240	212	95.2	1.00	FR8		Yes	89001039049927
BDR-DVSN03	5-Apr-22	Diversion	BT	250	231	116.2	0.94	FR6	white	No	89001040642269
BDR-DVSN03	5-Apr-22	Diversion	BT	260						No	
BDR-DVSN03	5-Apr-22	Diversion	BT	275	253	162.1	1.00	FR9		No	89001040642353
BDR-DVSN03	5-Apr-22	Diversion	BT	280	250	158.9	1.02	FR7		No	89001040642278
BDR-DVSN03	5-Apr-22	Diversion	BT	300					pink	No	
BDR-DVSN03	5-Apr-22	Diversion	BT	310	337	340.7	0.89	FR10		No	89001040642263
BDR-DVSN03	5-Apr-22	Diversion	BT							No	
BDR-DVSN04	4-Apr-22	Diversion	BT	100						No	
BDR-DVSN04	4-Apr-22	Diversion	BT	110	99				blue sparkle	No	
BDR-DVSN04	4-Apr-22	Diversion	BT	130	151				orange sparkle	No	
BDR-DVSN04	4-Apr-22	Diversion	BT	140	171				purple sparkle	No	
BDR-DVSN04	4-Apr-22	Diversion	BT	150	206				red sparkle	No	
BDR-DVSN04	4-Apr-22	Diversion	BT	270	260				green sparkle	No	
BDR-DVSN04	4-Apr-22	Diversion	BT	340	357				green sparkle	No	
BDR-DVSN04	5-Apr-22	Diversion	BT	80						No	
BDR-DVSN04	5-Apr-22	Diversion	BT	100						No	
BDR-DVSN04	5-Apr-22	Diversion	BT	102	85	6.4	1.04	FR5		No	89001040642313
BDR-DVSN04	5-Apr-22	Diversion	BT	105	100	9.5	0.95	FR1	sparkle blue	No	
BDR-DVSN04	5-Apr-22	Diversion	BT	120						No	
BDR-DVSN04	5-Apr-22	Diversion	BT	130	135	23.5	0.96	FR3		No	89001040642327
BDR-DVSN04	5-Apr-22	Diversion	BT	130	172	47.5	0.93	FR2	sparkle purple	No	89001040642318
BDR-DVSN04	5-Apr-22	Diversion	BT	168						No	
BDR-DVSN04	5-Apr-22	Diversion	BT	220	227	113.7	0.97	FR4		Yes	89001006696326
BDR-DVSN05	4-Apr-22	Diversion	BT	280						No	
BDR-DVSN05	4-Apr-22	Diversion	BT	290						No	
BDR-DVSN05	5-Apr-22	Diversion	BT	110						No	

[1] BT = Bull Trout, RB/CT = Cutthroat Trout, MW = Mountain Whitefish, NFC = No Fish Caught, and NFO = No Fish Observed.

[2] FR = Fin Ray and SC = Scale Sample.

Table 1. Continued.

Site	Date	Location	Species[1]	Estimated Length (mm)	Length (mm)	Weight (g)	Condition Factor (K)	Aging Structure & Sample Number[2]	Tag Colour	Recapture (Yes/No)	PIT Tag #
BDR-DVSN05	5-Apr-22	Diversion	BT	290	269	223	1.15	FR1		No	89001040642299
BDR-DVSN05	5-Apr-22	Diversion	BT	290						No	

[1] BT = Bull Trout, RB/CT = Cutthroat Trout, MW = Mountain Whitefish, NFC = No Fish Caught, and NFO = No Fish Observed.

[2] FR = Fin Ray and SC = Scale Sample.

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Table 1. Summary of angling sites in Boulder Creek in fall 2023.

Site	Habitat Type	Date	Water Temp. (°C)	Site Length (m)	Stream Wetted Width	Average Angled Width (m)	Overall Site Area (m²)	Fished Area (m²)	Estimated Fishable Area (%)
BDR-DSAG01	Cascade	03-Oct	6.1	40.0	11.0	9.0	440	360.0	81.8
		13-Sep	9.7	12.0	16.0	3.0	192	36.0	18.8
		21-Oct	6.0	40.0	11.0	9.0	440	360.0	81.8
BDR-DSAG02	Cascade	03-Oct	6.0	20.0	15.0	10.0	300	200.0	66.7
		13-Sep	9.7	10.0	11.1	3.0	111	30.0	27.0
		21-Oct	6.0	20.0	15.0	10.0	300	200.0	66.7
BDR-DSAG06	Cascade	03-Oct	5.7	25.5	11.0	11.0	281	280.5	100.0
		13-Sep	9.5	23.0	11.2	5.0	258	115.0	44.6
		21-Oct	5.9	25.5	11.0	11.0	281	280.5	100.0
BDR-DVAG01	Cascade/Pool	03-Oct	6.0	62.0	9.1	5.0	564	310.0	54.9
		13-Sep	8.0	27.0	7.2	6.0	194	162.0	83.3
		21-Oct	6.8	62.0	9.1	5.0	564	310.0	54.9
BDR-DVAG03	Run	03-Oct	5.2	27.0	7.0	6.0	189	162.0	85.7
		13-Sep	8.5	62.0	9.1	5.0	564	310.0	54.9
		21-Oct	6.8	28.0	7.0	6.0	196	168.0	85.7
BDR-DVAG05	Cascade	03-Oct	6.8	50.0	9.0	5.0	450	250.0	55.6
		13-Sep	9.0	47.0	9.0	5.0	423	235.0	55.6
		21-Oct	6.7	50.0	9.0	5.0	450	250.0	55.6
BDR-TRAG01	Run	03-Oct	5.2	38.0	8.0	6.0	304	228.0	75.0
		13-Sep	6.5	38.0	8.0	6.0	304	228.0	75.0
		21-Oct	5.6	38.0	8.0	6.0	304	228.0	75.0

Table 2. Summary of angling sites in Lillooet River in fall 2023.

Site	Habitat Type	Date	Water Temp. (°C)	Site Length (m)	Stream Wetted Width	Average Angled Width (m)	Overall Site Area (m²)	Fished Area (m²)	Estimated Fishable Area (%)
ULL-DSAG05	Run	14-Sep	5.6	48.0	31.0	3.0	1,488	144.0	9.7
		20-Oct	4.7	15.0	31.0	2.5	465	37.5	8.1
		05-Oct	6.6	37.0	30.0	2.5	1,110	92.5	8.3
ULL-DSAG08	Riffle/Pool	05-Oct	7.4	67.0	27.0	3.0	1,809	201.0	11.1
		14-Sep	6.5	67.0	28.1	4.0	1,883	268.0	14.2
		20-Oct	4.5	62.0	29.0	1.5	1,798	93.0	5.2
ULL-DSAG10	Riffle/Pool	05-Oct	5.8	21.0	29.0	4.0	609	84.0	13.8
		14-Sep	4.2	25.0	25.0	4.0	625	100.0	16.0
		20-Oct	4.7	20.0	30.0	2.5	600	50.0	8.3
ULL-DVAG15	Cascade	05-Oct	7.4	39.0	13.5	3.5	527	136.5	25.9
		14-Sep	5.0	41.0	15.2	4.0	623	164.0	26.3
		20-Oct	6.5	20.0	14.0	2.0	280	40.0	14.3
ULL-DVAG16	Step/Pool	05-Oct	8.3	10.9	11.0	3.0	120	32.7	27.3
		14-Sep	6.3	62.0	18.5	10.0	1,147	620.0	54.1
		20-Oct	7.0	67.0	12.0	2.5	804	167.5	20.8
ULL-TRAG01	Step/Pool	05-Oct	5.7	22.0	42.0	5.0	924	110.0	11.9
		14-Sep	3.7	25.0	43.0	20.0	1,075	500.0	46.5
		20-Oct	4.7	17.0	43.0	1.0	731	17.0	2.3

Table 3. Summary of angling sites in North Creek in fall 2023.

Site[1]	Habitat Type	Date	Water Temp. (°C)	Site Length (m)	Stream Wetted Width	Average Angled Width (m)	Overall Site Area (m²)	Fished Area (m²)	Estimated Fishable Area (%)
NTH-DSAG01	Riffle/Pool	04-Oct	9.0	22.0	11.0	5.0	242	110.0	45.5
		15-Sep	9.5	54.0	10.0	4.0	540	216.0	40.0
		22-Oct	6.0	22.0	11.0	5.0	242	110.0	45.5
NTH-DSAG05	Cascade/Pool	04-Oct	8.8	27.0	11.5	5.5	311	148.5	47.8
		15-Sep	9.0	24.0	7.6	4.0	182	96.0	52.6
		22-Oct	5.7	27.0	11.5	5.5	311	148.5	47.8
NTH-DSAG06	Run	04-Oct	8.4	55.0	9.5	9.5	523	522.5	100.0
		15-Sep	9.0	62.0	8.0	5.0	496	310.0	62.5
		22-Oct	5.6	55.0	10.0	9.5	550	522.5	95.0
NTH-DVAG04	Cascade/Pool	04-Oct	8.4	32.0	11.5	10.5	368	336.0	91.3
		15-Sep	8.5	33.0	8.7	7.0	287	231.0	80.5
		22-Oct	5.6	32.0	11.0	10.0	352	320.0	90.9
NTH-DVAG05	Cascade/Pool	04-Oct	8.3	35.0	9.5	9.5	333	332.5	100.0
		15-Sep	7.5	22.0	9.0	7.0	198	154.0	77.8
		22-Oct	5.5	35.0	9.0	9.5	315	332.5	105.6
NTH-DVAG06	Cascade/Pool	04-Oct	8.3	55.0	7.5	7.5	413	412.5	100.0
		15-Sep	7.5	50.0	12.2	8.0	610	400.0	65.6
		22-Oct	5.5	55.0	8.0	7.5	440	412.5	93.8

[1] Site labels for North Creek are historic. No downstream or diversion exist.

Table 4. Summary of all fish captured during angling in Boulder Creek in fall 2023.

Date	Reach	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	DNA Sample #	PIT Tag #
Diversion	13-Sep	BDR-DVAG01	BT	302	391	1.42	n/c	FC-01	989001045508755
	13-Sep	BDR-DVAG05	BT	240	154	1.11	n/c	FC-01	989001045508710
			BT	274	210	1.02	n/c		989001032067181
			BT	228	125	1.05	n/c	FC-02	989001045508761
			BT	182	63	1.05	n/c	FC-03	989001043508717
			BT	296	269	1.04	n/c		989001038120898
		BDR-DVAG03	BT	440	880	1.03	n/c	FC-01	989001045508722
			BT	235	121	0.93	n/c	FC-02	989001045508752
			BT	222	117	1.07	n/c	FC-04	989001045508801
			BT	291	254	1.03	n/c	FC-03	989001045508732
			BT	295	272	1.06	n/c	FC-05	989001045508751
	21-Oct	BDR-DVAG01	BT	208	89	0.99	n/c	FC-01	989001040643282
		BDR-DVAG05	BT	242	143	1.01	n/c		989001045508710
			BT	270	207	1.05	n/c		989001045508774
		BDR-DVAG03	BT	229	116	0.97	n/c	FC-01	989001039049693
			BT	304	270	0.96	n/c		989001032067178
	03-Oct	BDR-DVAG01	BT	289	224	0.93	n/c		989001039049957
			BT	268	182	0.95	n/c	FC-03	989001045508790
			BT	335	367	0.98	n/c		989001038120925
			BT	364	438	0.91	n/c	FC-04	989001045508737
			BT	315	394	1.26	n/c	FC-01	989001045508776
			BT	139	26	0.97	n/c	FC-02	NA
		BDR-DVAG05	BT	270	209	1.06	n/c	FC-01	989001045508774
		BDR-DVAG03	BT	235	126	0.97	n/c	FC-02	989001045508788
			BT	229	125	1.04	n/c	FC-03	989001045508791
			BT	304	220	0.78	n/c		98900145508751
			BT	305	256	0.90	n/c	FC-01	98900145508793
			BT	305	268	0.94	n/c		989001032067178
			BT	290	247	1.01	n/c	FC-04	989001045508756

BT= Bull Trout, CT= Cutthroat Trout, NFC= No fish caught.
n/c= not collected

Table 4. Continued.

Date	Reach	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	DNA Sample #	PIT Tag #
Tailrace	13-Sep	BDR-TRAG01	BT	224	111	0.99	n/c	FC-03	989001045508807
			BT	264	189	1.03	n/c		989001040642332
			BT	265	196	1.05	n/c		989001040642293
			BT	278	194	0.90	n/c		989001039049937
			BT	281	216	0.97	n/c	FC-04	989001045508750
			BT	317	313	0.98	n/c		989001032067194
			BT	466	1012	1.00	n/c	FC-01	989001045508798
			BT	510	1423	1.07	n/c	FC-02	989001045508803
	21-Oct	BDR-TRAG01	BT	280	203	0.92	n/c	FC-02	989001040642469
			BT	210	97	1.05	n/c	FC-01	989001040642470
			BT	270	183	0.93	n/c		989001039049937
			BT	277	217	1.02	n/c		989001040642348
	03-Oct	BDR-TRAG01	BT	163	169	3.90	n/c	FC-01	989001040642332
			BT	165	156	3.47	n/c	FC-02	989001045508734
Downstream	13-Sep	BDR-DSAG01	NFC				n/c		
		BDR-DSAG02	BT	504	1208	0.94	n/c	FC-01	989001045508747
		BDR-DSAG06	BT	262	169	0.94	n/c	FC-01	989001045508714
	21-Oct	BDR-DSAG01	NFC				n/c		
		BDR-DSAG02	BT	250	147	0.94	n/c		989001032067137
		BDR-DSAG06	BT	222	105	0.96	n/c		989001045508807
	03-Oct	BDR-DSAG01	BT	530	1600	1.07	n/c	FC-01	989001045508749
			BT	601	2000	0.92	n/c	FC-02	989001045508799
		BDR-DSAG02	BT	213	30	0.31	n/c	FC-02	989001045508682□
			BT	424	716	0.94	n/c	FC-01	989001045508675
		BDR-DSAG06	BT	475	917	0.86	n/c	FC-01	989001045508736
			BT	455	929	0.99	n/c	FC-02	989001045508698
			BT	260	152	0.86	n/c	FC-03	989001045508731

BT= Bull Trout, CT= Cutthroat Trout, NFC= No fish caught.
n/c= not collected

Table 5. Summary of all fish captured during angling in Lillooet River in fall 2023.

Reach	Date	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	DNA Sample #	PIT Tag #
Diversion	14-Sep	ULL-DVAG15	BT	225	119	1.04	n/c	FC-01	989001045508794
		ULL-DVAG16	NFC				n/c		
	20-Oct	ULL-DVAG15	NFC				n/c		
		ULL-DVAG16	CT	204	85	1.00	n/c	FC-01	NA
	05-Oct	ULL-DVAG15	NFC				n/c		
		ULL-DVAG16	BT	220	110	1.03	n/c	FC-01	989001045508642
Tailrace	14-Sep	ULL-TRAG01	BT	234	115	0.90	n/c	FC-01	989001045508758
	20-Oct	ULL-TRAG01	NFC				n/c		
	05-Oct	ULL-TRAG01	BT	226	105	0.91	n/c	FC-01	989001045508649
Downstream	14-Sep	ULL-DSAG08	BT	368	480	0.96	n/c	FC-02	989001045508746
			CT	157	37	0.96	n/c	FC-01	989001045508724
		ULL-DSAG10	BT	324	320	0.94	n/c	FC-01	989001045508795
		ULL-DSAG05	BT	374	500	0.96	n/c	FC-01	989001045508719
	20-Oct	ULL-DSAG08	BT	330	333	0.93	n/c	FC-01	989001045508787
		ULL-DSAG10	NFC				n/c		
		ULL-DSAG05	BT	213	91	0.94	n/c	FC-01	989001045508730
	05-Oct	ULL-DSAG08	NFC				n/c		
		ULL-DSAG10	NFC				n/c		
		ULL-DSAG05	NFC				n/c		

BT= Bull Trout, CT= Cutthroat Trout, NFC= No fish caught.
n/c= not collected

Table 6. Summary of all fish captured during angling in North Creek in fall 2023.

Date	Reach	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	DNA Sample #	PIT Tag #
Diversion	15-Sep	NTH-DVAG06	BT	312	338	1.11	n/c	FC-03	989001045508782
			BT	256	161	0.96	n/c	FC-01	989001045508740
			BT	332	342	0.93	n/c	FC-02	989001045508777
		NTH-DVAG05	BT	282	230	1.03	n/c	FC-04	989001045508723
			BT	207	93	1.05	n/c	FC-05	989001045508786
			BT	406	666	1.00	n/c	FC-01	989001045508720
			BT	316	292	0.93	n/c	FC-02	989001045508739
			BT	360	430	0.92	n/c		989001038120914
			BT	308	283	0.97	n/c	FC-03	989001045508709
			BT	182	59	0.98	n/c	FC-06	989001045508726
		NTH-DVAG04	BT	288	231	0.97	n/c	FC-02	989001045508763
			BT	420	745	1.01	n/c	FC-01	989001045508773
			BT	320	309	0.94	n/c		989001039050017
			BT	300	276	1.02	n/c	FC-03	989001045508713
			BT	206	81	0.93	n/c	FC-04	989001045508805
Diversion	22-Oct	NTH-DVAG06	BT	275	213	1.02	n/c		989001040643335
			BT	230	118	0.97	n/c		989001045508729
			BT	454	922	0.99	n/c		989001040642505
		NTH-DVAG05	BT	274	199	0.97	n/c		989001039049560
			BT	312	273	0.90	n/c		989001039049755
		NTH-DVAG04	BT	252	159	0.99	n/c		989001045508690
	04-Oct	NTH-DVAG06	BT	364	481	1.00	n/c	FC-01	989001045508631
			BT	352	410	0.94	n/c	FC-02	989001045508648
			BT	503	1266	0.99	n/c	FC-03	989001045508781
		NTH-DVAG05	BT	380	511	0.93	n/c		989001039050090
			BT	258	159	0.93	n/c	FC-05	989001045508690
			BT	424	685	0.90	n/c	FC-02	989001045508708
			BT	461	848	0.87	n/c	FC-01	989001045508745
			BT	444	835	0.95	n/c	FC-03	989001045508796
			BT	374	519	0.99	n/c	FC-04	989001045508685
			BT	472	1007	0.96	n/c	FC-06	989001045508636
			BT	469	1020	0.99	n/c	FC-07	989001045508625
			BT	520	1560	1.11	n/c	FC-08	989001045508699
		NTH-DVAG04	BT	268	192	1.00	n/c	FC-02	989001045508681
			BT	357	390	0.86	n/c	FC-01	989001045508609

BT= Bull Trout, CT= Cutthroat Trout, NFC= No fish caught.
n/c= not collected

Table 6. Continued.

Date	Reach	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	DNA Sample #	PIT Tag #
Downstream	15-Sep	NTH-DSAG06	BT	200	71	0.89	n/c		989001045508779
			BT	424	781	1.02	n/c	FC-01	989001045508765
			BT	449	791	0.87	n/c	FC-02	989001045508769
			BT	188	71	1.07	n/c		989001045508775
		NTH-DSAG05	BT	390	599	1.01	n/c		989001039049938
			BT	246	162	1.09	n/c		9989001045508712
			BT	422	751	1.00	n/c		989001045508753
			BT	196	85	1.13	n/c		989001045508792
			BT	544	1572	0.98	n/c		989001045508757
			BT	438	754	0.90	n/c		989001045508797
			BT	358	498	1.09	n/c		989001045508759
			BT	273	208	1.02	n/c		989001045508784
		NTH-DSAG01	NFC				n/c		
	22-Oct	NTH-DSAG06	BT	292	217	0.87	n/c		989001045508666
			BT	294	230	0.91	n/c		989001045508763
		NTH-DSAG05	NFC				n/c		
		NTH-DSAG01	BT	189	69	1.02	n/c		989001040643336
	04-Oct	NTH-DSAG06	BT	409	692	1.01	n/c	FC-02	989001045508691
			BT	353	422	0.96	n/c	FC-01	989001045508643
			BT	424	721	0.95	n/c	FC-03	989001045508678
			BT	432	769	0.95	n/c	FC-04	989001045508688
		NTH-DSAG05	BT	458	867	0.90	n/c	FC-01	989001045508715
			BT	286	232	0.99	n/c	FC-01	989001045508666
			BT	231	127	1.03	n/c	FC-03	989001045508806
		NTH-DSAG01	NFC				n/c		

BT= Bull Trout, CT= Cutthroat Trout, NFC= No fish caught.
n/c= not collected

Appendix Q. Incidental Wildlife Observations

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Table 1. Incidental wildlife sightings: Mammals.

Species		Date	Time	UTM Coordinates (10U)		Location	Sighting or Sign	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing							
American Black Bear	*Ursus americanus*	23-Jul-2022	15:00:00	482225	5602561	ULL FSR 24 km	Sighting		1	FL	U	Unknown
		23-Jul-2022	_	493296	5598106	ULL FSR 12 km	Sighting		1	LI	U	Unknown
Grey Wolf	*Canis lupus*	15-Sep-2022	11:00:00	471374	5608440	ULL FSR 38km	Sighting	mother with 2 pups	1	FL	F	Adult
		15-Sep-2022	11:00:00	471374	5608440	ULL FSR 38km	Sighting	2 pups with mother	2	FL	U	Juevenile
Grizzly Bear	*Ursus arctos*	24-Jul-2022	16:00:00	468476	5611583	ULL powerhouse	Sighting		1	FD	U	Juvenile
		24-Jul-2022	7:00:00	471154	5609327	BDR powerhouse gate	Sighting		1	FL	U	Unknown
		29-Jul-2022	7:00:00	471745	5610545	BDR Cabins	Sighting	Large Grizzly	1	FL	U	Adult
Moose	*Alces americanus*	1-Oct-2022	8:00:00	490539	5599087	ULL FSR 15km	Sighting		2	FD	M	Adult
		15-Dec-2022	20:00:00	480548	5603177	ULL FSR 26km	Sighting	sleeping on the road	1	LI	M	Unknown
Mule Deer	*Odocoileus hemionus*	25-Sep-2022	7:00:00	470268	5610011	ULL FSR 40km powerlines	Sighting	feeding under powerlines	1	FD	M	Unknown
		25-Sep-2022	7:00:00	470268	5610011	ULL FSR 40km powerlines	Sighting	feeding under powerlines	2	FD	F	Unknown
		30-Sep-2022	16:30:00	469331	5610412	ULL FSR 41.2 km	Sighting		4	TF	F	Adult
		30-Sep-2022	16:30:00	469331	5610412	ULL FSR 41.2 km	Sighting		2	TF	M	Adult
Red Fox	*Vulpes vulpes*	23-Jul-2022	7:00:00	470955	5609336	ULL FSR 39 km	Sighting		2	FL	U	Unknown

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 2. Incidental wildlife sightings: Avian.

Species		Date	Time	UTM Coordinates (10U)		Location	Sighting or Sign	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing							
Bald Eagle	*Haliaeetus leucocephalus*	15-Dec-2022	9:30:00	469346	5610403	ULL FSR 41km	Sighting	sitting on a stump, fishing	1	FD	U	Unknown

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

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Figure 3. Vegetated screen along the transmission line at ULH MAMCM01, assessed on July 27, 2023.

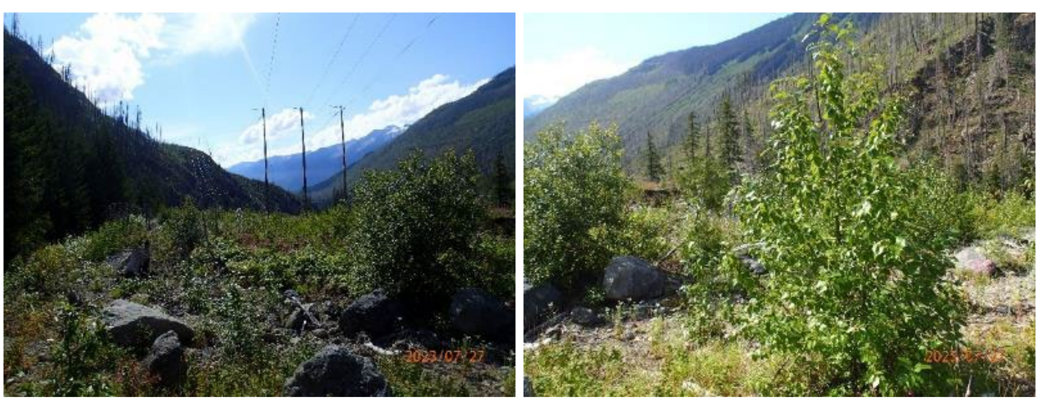

Table 1. Vegetated screen monitoring summary at ULH-MAMCM01.

General comment:	Some sections with low heights, good natural regeneration; recovering from the Boulder Creek wildfire. On a trajectory to meet 5 m height requirement.
Species:	Grizzly Bear
Screen widths (m):	15, 10, 7
Average screen width (m):	11
Screen heights (m):	5, 3, 6
Average screen height (m):	5
% Screen coverages:	40, 30, 35
Average % screen coverage:	35

2. ULH-MAMCM02

Figure 4. Vegetated screen along the transmission line at ULH-MAMCM02 (at the top of the hill in the photo), assessed on June 14, 2018.

Figure 5. Vegetated screen along the transmission line at ULH-MAMCM02 (at the top of the hill in the photo), assessed on August 24, 2020.

Figure 6. Vegetated screen along the transmission line at ULH-MAMCM02 (at the top of the hill in the photo), assessed on July 27, 2023.

Table 2. Vegetated screen monitoring summary at ULH-MAMCM02. Note that the screen could not be measured due to height of the site above the road.

General comment:	This site is very high above the road. Vegetation is slow to recover from the Boulder Creek fire. The site is high above the road; thus, the screen is not considered to be critical as wildlife are less likely to be visible from the road and traffic along the road is less likely to disturb wildlife than if the transmission line RoW was closer to the road. Further monitoring is not recommended.
Species:	Grizzly Bear
Average screen width (m):	-
Average screen height (m):	-
Average % coverage:	-

3. ULH-MAMCM04B

Figure 7. Vegetated screen along the transmission line at ULH-MAMCM04B (river right of the creek), assessed on June 14, 2018.

Figure 8. Vegetated screen along the transmission line at ULH-MAMCM04B (river right of the creek), assessed on August 24, 2020.

Figure 9. Vegetated screen along the transmission line at ULH MAMCM04B (river right of the creek), assessed on July 27, 2023.

Table 3. Vegetated screen monitoring summary at ULH-MAMCM04B.

General comment:	Excellent natural regeneration; vegetation is growing through the wood chips; increased vegetation along the road; vegetation is on track to meet the height requirement.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	10, 15, 5
Average screen width (m):	10
Screen heights (m):	2, 4, 4
Average screen height (m):	3
% Screen coverages:	30, 20, 5
Average % screen coverage:	18

4. ULH-MAMCM06

Figure 10. Vegetated screen along the transmission line at ULH-MAMCM06, assessed on June 14, 2018.

Figure 11. Vegetated screen along the transmission line at ULH-MAMCM06, assessed on August 24, 2020.

Figure 12. Vegetated screen along the transmission line at ULH-MAMCM06, assessed on July 27, 2023.

Table 4. Vegetated screen monitoring summary at ULH-MAMCM06.

General comment:	Excellent regeneration; dense vegetation with good cover.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	30, 30, 25
Average screen width (m):	28
Screen heights (m):	6, 7, 4
Average screen height (m):	6
% Screen coverages:	90, 95, 85
Average % screen coverage:	90

5. ULH-MAMCM08

Figure 13. Vegetated screen along the transmission line at ULH-MAMCM08, assessed on June 14, 2018.

Figure 14. Vegetated screen along the transmission line at ULH-MAMCM08, assessed on August 24, 2020.

Figure 15. Vegetated screen along the transmission line at ULH-MAMCM08, assessed on July 27, 2023.

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Table 5. Vegetated screen monitoring summary at ULH-MAMCM08.

General comment:	Abundant dense vegetation continues to regenerate naturally.
Species:	Mule Deer
Screen widths (m):	20, 25, 20
Average screen width (m):	22
Screen heights (m):	6, 5, 4
Average screen height (m):	5
% Screen coverages:	90, 80, 60
Average % screen coverage:	77

6. ULH-MAMCM09

Figure 16. Vegetated screen along the transmission line at ULH-MAMCM09, assessed on June 14, 2018.

Figure 17. Vegetated screen along the transmission line at ULH-MAMCM09, assessed on August 24, 2020.

Figure 18. Vegetated screen along the transmission line at ULH-MAMCM09, assessed on July 27, 2023.

Table 6. Vegetated screen monitoring summary at ULH-MAMCM09.

General comment:	Some vegetation has grown tall, but there is limited growth in rocky areas. Height and coverage have increased since 2020. Overall, vegetation is on track to reach the height requirement.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	10, 5, 9
Average screen width (m):	8
Screen heights (m):	5, 2, 1.5
Average screen height (m):	3
% Screen coverages:	30, 10, 25
Average % screen coverage:	22

7. ULH-MAMCM10

Figure 19. Vegetated screen along the transmission line at ULH-MAMCM10, assessed on June 14, 2018.

Figure 20. Vegetated screen along the transmission line at ULH-MAMCM10, assessed on August 24, 2020.

Figure 21. Vegetated screen along the transmission line at ULH-MAMCM10, assessed on July 27, 2023.

Table 7. Vegetated screen monitoring summary at ULH-MAMCM10.

General comment:	Good natural regeneration. Vegetation is expected to fill in and reach heights of 5 m.
Species:	Mule Deer
Screen widths (m):	15, 15, 12
Average screen width (m):	14
Screen heights (m):	5, 4, 2
Average screen height (m):	4
% Screen coverages:	30, 10, 25
Average % screen coverage:	22

8. ULH-MAMCM12

Figure 22. Vegetated screen along the transmission line at ULH-MAMCM12, assessed on June 14, 2018.

Figure 23. Vegetated screen along the transmission line at ULH-MAMCM12, assessed on August 24, 2020.

Figure 24. Vegetated screen along the transmission line at ULH-MAMCM12, assessed on July 27, 2023.

Table 8. Vegetated screen monitoring summary at ULH-MAMCM12.

General comment:	This site was disturbed in 2020; many alders and willows were cut down. Good natural revegetation with increased cover since 2020.
Species:	Moose
Screen widths (m):	30, 15, 8
Average screen width (m):	18
Screen heights (m):	5, 3, 2
Average screen height (m):	3
% Screen coverages:	60, 15, 40
Average % screen coverage:	38

9. ULH-MAMCM14

Figure 25. Vegetated screen along the transmission line at ULH-MAMCM14, assessed on June 6, 2018.

Figure 26. Vegetated screen along the transmission line at ULH-MAMCM14, assessed on August 24, 2020.

Figure 27. Vegetated screen along the transmission line at ULH-MAMCM14, assessed on July 28, 2023.

Table 9. Vegetated screen monitoring summary at ULH-MAMCM14.

General comment:	Abundant natural regeneration with dense bushes. Dense vegetation along the road.
Species:	Grizzly Bear and Moose
Road deactivated:	Yes
Screen widths (m):	15, 15, 20
Average screen width (m):	17
Screen heights (m):	8, 6, 5
Average screen height (m):	5
% Screen coverages:	100, 100, 100
Average % screen coverage:	100

10. ULH-MAMCM17

Figure 28. Vegetated screen along the transmission line at ULH-MAMCM17, assessed on June 6, 2018.

Figure 29. Vegetated screen along the transmission line at ULH-MAMCM17, assessed on August 24, 2020.

Figure 30. Vegetated screen along the transmission line at ULH-MAMCM17, assessed on July 28, 2023.

Table 10. Vegetated screen monitoring summary at ULH-MAMCM17.

General comment:	Abundant natural regeneration; dense vegetation along the road.
Species:	Grizzly Bear
Screen widths (m):	15, 8, 15
Average screen width (m):	13
Screen heights (m):	8, 6, 5
Average screen height (m):	6
% Screen coverages:	100, 90, 90
Average % screen coverage:	93

11. ULH-MAMCM19

Figure 31. Vegetated screen along the transmission line at ULH-MAMCM19, assessed on June 6, 2018.

Figure 32. Vegetated screen along the transmission line at ULH-MAMCM19, assessed on August 25, 2020.

Figure 33. Vegetated screen along the transmission line at ULH-MAMCM19, assessed on July 28, 2023.

Table 11. Vegetated screen monitoring summary at ULH-MAMCM19.

General comment:	Excellent regeneration; dense vegetation; the tower access road appears to be inactive.
Species:	Grizzly Bear
Screen widths (m): **Average screen width (m):**	20, 35, 40 32
Screen heights (m): **Average screen height (m):**	7, 6, 5 6
% Screen coverages: **Average % screen coverage:**	80, 60, 20 53

12. ULH-MAMCM21

Figure 34. Vegetated screen along the transmission line at ULH-MAMCM21, assessed on June 19, 2018.

Figure 35. Vegetated screen along the transmission line at ULH-MAMCM21, assessed on August 25, 2020.

Figure 36. Vegetated screen along the transmission line at ULH-MAMCM21, assessed on July 28, 2023.

Table 12. Vegetated screen monitoring summary at ULH-MAMCM21.

General comment:	This site was noticeably disturbed in 2020 when trees that were approximately 2-3 m in height were cut down. In 2023, significant growth was observed with excellent regeneration along the road and dense shrubs.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	25, 20, 15
Average screen width (m):	20
Screen heights (m):	6, 5, 3
Average screen height (m):	5
% Screen coverages:	75, 60, 80
Average % screen coverage:	72

13. ULH-MAMCM22

Figure 37. Vegetated screen along the transmission line at ULH-MAMCM22, assessed on June 19, 2018.

Figure 38. Vegetated screen along the transmission line at ULH-MAMCM22, assessed on August 25, 2020.

Figure 39. Vegetated screen along the transmission line at ULH-MAMCM22, assessed on July 28, 2023.

Table 13. Vegetated screen monitoring summary at ULH-MAMCM22.

General comment:	This site was noticeably disturbed in 2020; all shrubs that were approximately 2-3 m in height in 2018 were cut down. In 2023 good regeneration with increased vegetation height and dense shrubs were observed. The site is on a trajectory to meet the 5 m height requirement.
Species:	Grizzly Bear
Screen widths (m):	10, 20, 12
Average screen width (m):	14
Screen heights (m):	5, 3, 2
Average screen height (m):	3
% Screen coverages:	40, 70, 45
Average % screen coverage:	62

14. ULH-MAMCM23

Figure 40. Vegetated screen along the transmission line at ULH-MAMCM23, assessed on June 19, 2018.

Figure 41. Vegetated screen along the transmission line at ULH-MAMCM23, assessed on August 25, 2020.

Figure 42. Vegetated screen along the transmission line at ULH-MAMCM23, assessed July 28, 2023.

Table 14. Vegetated screen monitoring summary at ULH-MAMCM23.

General comment:	Roadside vegetation has grown tall; dense shrubs; excellent regeneration.
Species:	Grizzly Bear
Screen widths (m):	20, 15, 25
Average screen width (m):	20
Screen heights (m):	5, 4, 5
Average screen height (m):	5
% Screen coverages:	100, 80, 40
Average % screen coverage:	73

15. ULH-MAMCM24

Figure 43. Vegetated screen along the transmission line at ULH-MAMCM24, assessed on June 19, 2018.

Figure 44. Vegetated screen along the transmission line at ULH-MAMCM24, assessed on August 25, 2020.

Figure 45. Vegetated screen along the transmission line at ULH-MAMCM24, assessed on July 28, 2023.

Table 15. Vegetated screen monitoring summary at ULH-MAMCM24.

General comment:	Roadside vegetation has grown tall; dense shrubs; excellent regeneration.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	15, 20, 10
Average screen width (m):	15
Screen heights (m):	5, 3, 7
Average screen height (m):	5
% Screen coverages:	50, 75, 80
Average % screen coverage:	68

16. ULH-MAMCM26

Figure 46. Vegetated screen along the transmission line at ULH-MAMCM26, assessed on June 19, 2018.

Figure 47. Vegetated screen along the transmission line at ULH-MAMCM26, assessed on August 25, 2020.

Figure 48. Vegetated screen along the transmission line at ULH-MAMCM26, assessed on July 28, 2023.

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Table 16. Vegetated screen monitoring summary at ULH-MAMCM26.

General comment:	Excellent regeneration along with the road; dense shrubs.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	50, 50, 45
Average screen width (m):	47
Screen heights (m):	5, 6, 4
Average screen height (m):	5
% Screen coverages:	95, 60, 50
Average % screen coverage:	68

17. ULH-MAMCM27

Figure 49. Vegetated screen along the transmission line at ULH-MAMCM27, assessed on June 21, 2018.

Figure 50. Vegetated screen along the transmission line at ULH-MAMCM27, assessed on August 25, 2020.

Figure 51. Vegetated screen along the transmission line at ULH-MAMCM27, assessed on July 27, 2023.

Table 17. Vegetated screen monitoring summary at ULH-MAMCM27.

General comment:	Abundant natural regeneration; vegetation; good mix of conifers and deciduous trees.
Species:	Grizzly Bear
Screen widths (m):	60, 65, 45
Average screen width (m):	57
Screen heights (m):	7, 3, 5
Average screen height (m):	5
% Screen coverages:	90, 100, 85
Average % screen coverage:	93

18. ULH-MAMCM28

Figure 52. Vegetated screen along the transmission line at ULH-MAMCM28, assessed on June 21, 2018.

Figure 53. Vegetated screen along the transmission line at ULH-MAMCM28, assessed on August 25, 2020.

Figure 54. Vegetated screen along the transmission line at ULH-MAMCM28, assessed on July 27, 2023.

Table 18. Vegetated screen monitoring summary at ULH-MAMCM28.

General comment:	Excellent natural regeneration. Good growth along the road; dense vegetation.
Species:	Grizzly Bear
Screen widths (m): **Average screen width (m):**	60, 50, 40 50
Screen heights (m): **Average screen height (m):**	6, 3, 5 5
% Screen coverages: **Average % screen coverage:**	50, 30, 35 38

Appendix S. Riparian Revegetation Permanent Monitoring Site Photographs

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Figure 19. View north through ULL-PRM06 plot centre from 3 m south of plot centre on September 07, 2018.

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Figure 25. View north through ULL-PRM08 plot centre from 3 m south of plot centre on September 06, 2018.

Figure 26. View north through ULL-PRM08 plot centre from 3 m south of plot centre on September 02, 2020.

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Figure 28. View north through ULL-PRM09 plot centre from 3 m south of plot centre on September 06, 2018.

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Figure 31. View north through ULL-PRM10 plot centre from 3 m south of plot centre on September 06, 2018.

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2. ULL-PRM01

Figure 7. Representative site photo taken at 154° from ULL-PRM01 on September 07, 2018.

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Figure 9. Representative site photo taken at 154° from ULL-PRM01 on September 01, 2020.

Figure 10. Representative site photo taken 270° from ULL-PRM01 plot centre on September 01, 2020.

Figure 11. Representative site photo taken at 154° from ULL-PRM01 on September 05, 2023.

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3. ULL-PRM02

Figure 13. Representative site photo taken at 64° from ULL-PRM02 on September 07, 2018.

Figure 14. Looking upstream at the dam from ULL-PRM02 on September 07, 2018.

Figure 15. Representative site photo taken at 64° from ULL-PRM02 on September 01, 2020.

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4. ULL-PRM03

Figure 19. Representative site photo taken at 144° from ULL-PRM03 on September 06, 2018.

Figure 20. Representative site photo taken 270° from ULL-PRM03 plot centre on September 06, 2018.

Figure 21. Representative site photo taken at 144° from ULL-PRM03 on September 01, 2020.

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5. ULL-PRM04

Figure 25. Representative site photo taken at 164° from ULL-PRM04 on September 07, 2018.

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Figure 31. Representative site photo taken at 312° from ULL-PRM05 on September 07, 2018.

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7. ULL-PRM06

Figure 37. Representative site photo taken at 104° from ULL-PRM06 on September 06, 2018.

Figure 38. Representative site photo taken 90° from ULL-PRM06 plot centre on September 06, 2018.

8. ULL-PRM06

Figure 39. Representative site photo taken at 104° from ULL-PRM06 on September 06, 2018.

Figure 40. Representative site photo taken 90° from ULL-PRM06 plot centre on September 06, 2018.

Figure 41. Representative site photo taken at 104° from ULL-PRM06 on August 30, 2023.

Figure 42. Representative site photo taken 90° from ULL-PRM06 plot centre on August 30, 2023.

9. ULL-PRM07

Figure 43. Representative site photo taken at 270° from ULL-PRM07 on September 06, 2018.

Figure 44. Representative site photo taken 90° from ULL-PRM07 plot centre on September 06, 2018.

Figure 45. Representative site photo taken at 270° from ULL-PRM07 on September 02, 2020.

Figure 46. Representative site photo taken 90° from ULL-PRM07 plot centre on September 02, 2020.

Figure 47. Representative site photo taken at 270° from ULL-PRM07 on August 30, 2023.

Figure 48. Representative site photo taken 90° from ULL-PRM07 plot centre on August 30, 2023.

10. ULL-PRM08

Figure 49. Representative site photo taken at 222° from ULL-PRM08 on September 06, 2018.

Figure 50. Representative site photo taken 90° from ULL-PRM08 plot centre on September 06, 2018.

Figure 51. Representative site photo taken at 222° from ULL-PRM08 on September 02, 2020.

Figure 52. Representative site photo taken 90° from ULL-PRM08 plot centre on September 02, 2020.

Figure 53. Representative site photo taken at 222° from ULL-PRM08 on August 30, 2023.

Figure 54. Representative site photo taken 90° from ULL-PRM08 plot centre on August 30, 2023.

11. ULL-PRM09

Figure 55. Representative site photo taken at 222° from ULL-PRM09 on September 06, 2018

Figure 56. Representative site photo taken from edge of stream at ULL-PRM09 on September 06, 2018.

Figure 57. Representative site photo taken at 222° from ULL-PRM09 on September 02, 2020.

Figure 58. Representative site photo taken from edge of stream at ULL-PRM09 on September 02, 2020.

Figure 59. Representative site photo taken at 222° from ULL-PRM09 on August 30, 2023.

Figure 60. Representative site photo taken from edge of stream at ULL-PRM09 on August 30, 2023.

12. ULL-PRM10

Figure 61. Representative site photo taken at 86° from ULL-PRM10 on September 06, 2018.

Figure 62. Representative site photo taken 180° from ULL-PRM10 plot centre on September 06, 2018.

Figure 63. Representative site photo taken at 86° from ULL-PRM10 on September 02, 2020.

Figure 64. Representative site photo taken 180° from ULL-PRM10 plot centre on September 02, 2020.

Figure 65. Representative site photo taken at 86° from ULL-PRM10 on August 30, 2023.

Figure 66. Representative site photo taken 180° from ULL-PRM10 plot centre on August 30, 2023.

13. ULL-PRM11

Figure 67. Representative site photo taken at 88° from ULL-PRM11 on September 06, 2018.

Figure 68. Representative site photo taken 270° from ULL-PRM11 plot centre on September 06, 2018.

Figure 69. Representative site photo taken at 88° from ULL-PRM11 on September 02, 2020.

Figure 70. Representative site photo taken 270° from ULL-PRM11 plot centre on September 02, 2020.

Figure 71. Representative site photo taken at 88° from ULL-PRM11 on August 30, 2023.

Figure 72. Representative site photo taken 270° from ULL-PRM11 plot centre on August 30, 2023.