Campbell River Project Water Use Plan

Upper Campbell Reservoir Drawdown Zone

Reference: JHTWORKS-3

Revegetation Treatment Report – Year 3

Study Period: 2019

Laich-Kwil-Tach Environmental Assessments Ltd. Partnership and Ecofish Research Ltd.

May 22, 2020

JHTWORKS-3

Upper Campbell Reservoir Drawdown Zone Revegetation Treatment Report – Year 3

Prepared for:

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EXECUTIVE SUMMARY

JHTWORKS-3 is a 10-year program with the primary goal of improving the visual quality and riparian habitat values of high-profile reservoir shoreline areas impacted by fluctuating water levels of the Upper Campbell Reservoir. The program has three phases that will be implemented over the 10-year period: 1) identification/prioritization of sites for revegetation treatment trials (Year 1); 2) planning, trial implementation, and monitoring of revegetation treatment trials (Years 2-6); and 3) implementation of the final Revegetation Treatment Plan at additional sites around the reservoir (Years 7-10). Site identification, development of a treatment and effectiveness monitoring plan, and collection of baseline data (Phase 1) were conducted in Year 1 (2017). In Year 2 (2018; first year of Phase 2 of the program), treatments were implemented at three sites and as-built data were collected. Treatments were implemented as per prescriptions in the Year 1 report; however, in some cases modifications were made based on site conditions and other factors. Lessons learned were identified and were used for planning and treatment implementation for the following year.

This report presents accomplishments of the second year of Phase 2 of the program (2019). Additional treatments were implemented at five sites in this year and as-built data were collected following treatment implementation. In addition, the second year of Phase 2 was the first year of the program in which effectiveness monitoring could be conducted. This was conducted by comparing data on vegetation characteristics between baseline (collected prior to treatment implementation), as-built (collected immediately following treatment implementation), and 2019 surveys.

Revegetation work was implemented at four sites in the spring (March). These are the Old Buttle Lake Boat Launch (JHT-RV02), the Buttle Lake Campground Fan (JHT-RV07), the Karst Creek Boat Launch (JHT-RV08), and the Ralph River Campground (JHT-RV09). Revegetation work was implemented at one site in the fall (October and November) at Rainbow Island Marine Campsite (JHT-RV04). No treatments prescriptions were modified from those described in the Year 1 report in 2019, although one modification developed in 2018 was again implemented in 2019; the hand planting treatment (C2) was reassigned to hand planting in machine loosened circles (C-2i). The spring of 2019 was unusually dry; hence a watering program was implemented by A-Tlegay Fisheries Society crews to increase survival at the sites newly planted in the spring. Effectiveness monitoring results are analysed in detail for areas treated in fall 2018, and at a high level for sites treated in spring 2019.

Two treatments were implemented at JHT-RV02 (Old Buttle Lake Boat Launch) on the partially vegetated islets in the bay in front of the boat launch in March 2019. The treatments conducted on the islets were on relatively steep slopes in the drawdown zone (type C). The treatments implemented were planting native vegetation stakes on prepared rough and loose substrate (C-1ii), and hand planting stakes within excavator-loosened circles (C-2i, modified from the original C-2 identified in 2018 due to hard-pack soil conditions). A control treatment (C-3) area was also established on the island. The C-1ii and C-2i treatment areas were 480 m^2 and 240 m^2 in size, respectively, and both together were planted with a total of 382 stakes of black cottonwood (*Populus balsamifera ssp. trichocarpa*), red-osier dogwood (*Cornus stolonifera*), and Sitka willow (*Salix sitchensis*).

Three treatments were implemented at JHT-RV04 (Rainbow Island Marine Campsite) on steep upland slopes in late October 2019: D-1, D-2, and D-3. This involved stabilizing the slope with modified brush layers and logs, and planting stakes of black cottonwood and Sitka willow. In addition, potted plants (Oregon-grape (*Mahonia aquifolium*), shore pine (*Pinus contorta* var. *contorta*), and Kinnikinnick (*Arctostaphylos uva-ursi*)) were planted in treatment polygon D-3. D-1, D-2, and D-3 treatment areas were 403 m^2, 104 m^2, and 412 m^2 in size, respectively, and in total, 445 plants were planted (367 stakes, 78 potted plants). A control (D-4) treatment area was also established.

Three replicate treatments were implemented in March 2019 at the Buttle Lake Campground Fan (JHT-RV07) in the alluvial fan present at this site. A total of 394 stakes (Sitka willow, black cottonwood, and red-osier dogwood) were planted into stumps (treatment A-1) in the three treatment areas combined. Stakes were planted into decaying stumps either using naturally occurring cavities or by drilling cavities. Where possible, stakes were planted through the stumps into the mineral soil below and filled will soil. The size of the treatment area was 10,347 m^2. A control treatment area (A-3) was also established.

One large treatment was implemented at the Karst Creek Boat Launch (JHT-RV08) into the moderate slope in March 2019. Approximately 210 stakes (black cottonwood, red-osier dogwood, and Sitka willow) were planted by hand (without site preparation) (treatment B-2). The size of the treatment area was 2,430 m^2. A control treatment area (B-3) with similar site characteristics and size was also established.

One treatment was implemented in March 2019 at the Ralph River Campground (JHT-RV09) in the alluvial fan present at this site, taking advantage of the existing stumps protruding from the substate. Stakes of Sitka willow, black cottonwood, and red-osier dogwood were planted into stumps (treatment A-1) using the same methods employed at the Buttle Lake Campground Fan (JHT-RV07). The area planted was 12,035 m^2 in size and a total of 745 stakes were planted. A control treatment area (A-3) was also established.

This report also presents the first year of effectiveness monitoring, in which data from monitoring plots were collected in fall of 2019 and were compared to baseline and as-built dat. Results from treatment areas planted in fall 2018 and spring 2019 are discussed. In addition to data obtained from monitoring plots, a site visit was conducted on October 24, 2019 to provide general qualitative evaluation of treatment areas that had been revegetated along the Buttle Lake shoreline to date. This site visit was conducted by David Polster (of Polster Environmental Services), Patrick Walshe (of Ecofish Research Ltd.), and Zach Everson (of A-Tlegay Fisheries Society). Effectiveness monitoring results suggested that the most successful treatments to date were those in which cuttings (stakes) had been planted into a substrate that had been loosened by an excavator and where either the planting location received afternoon shade or plants were irrigated for at least one dry season after planting. The best growth and survival to date were observed for stakes planted deeply (0.8 m to 1.5 m or more). Treatments that involved planting stakes into stumps with fine textured soils and Sea Soil had high success, likely due to increased moisture retention and nutrients. Treatment areas that were not

watered over spring and early summer had greater losses, especially in locations that were exposed to more sun and had sandy, gravelly, well-drained soil. Differences in success were also noted by species, with black cottonwood and red-osier dogwood exhibiting greatest survival under drought conditions. Observations from the October site visit suggested that high growth and survival were associated with treatments in which stakes were planted through stumps into the substrate below (treatment A-1); however, this may be because the reservoir was unusually low this year and thus these sites were not flooded as usual and were watered instead Treatments that depended on natural regeneration following substrate preparation (B-1i) were observed to be progressing, with both herbaceous plants and some tree seedlings establishing.

There were several lessons learned during 2019 from which recommendations were made for future revegetation work, including proposed work in 2020. These included addressing problems related to limited water and/or high exposure to sun which was documented to affect treatment success. Lessons learned and recommendations were also related to observations on the value of substrate preparation in plant success, including creating mounds and hollows (which provide shade and organic debris accumulation) and adding large coarse woody debris (i.e., stumps) (e.g., JHT-RV03, JHT-RV07, JHT-RV09) which provide shade as well as organics, moisture, and nutrients. Increased consideration of factors that have promoted success to date (e.g., planting depth, soil texture, sun exposure, nutrients, mulch) were recommended, as was additional data collection to improve our understanding of the relative roles of these factors. Similar to 2018, difficulties with site access and or sourcing of materials were also identified.

In 2020, additional treatments will be implemented and effectiveness monitoring will be extended to all treatment areas treated in 2018 and 2019.

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1. INTRODUCTION

As the Campbell River Water Use Planning (WUP) process reached completion in 2012, several concerns remained with respect to the effects of BC Hydro operations on the substrates and vegetation within the reservoir drawdown zone. Among these was the erosion and destabilization of shoreline vegetation of the Upper Campbell Reservoir (Map 1), caused by operational changes in water level and accompanying wind and wave action (BC Hydro 2016). Between 1996 and 2004, the Upper Campbell Reservoir operated under a higher than normal annual water budget. Specifically, the maximum summer operating regime was raised by 0.5 m which caused the removal of substrate and vegetation from an additional 0.5 m band of shoreline around the reservoir equivalent to approximately 440 ha. However, since 2004, reservoir operations have returned to lower summer maximum water levels and these eroded shoreline areas have been left exposed. Given the resultant visual impacts, the WUP Consultative Committee identified the need to improve the aesthetic quality of the exposed shoreline in locations visible from high-use recreation areas. Consequently, the Comptroller of Water Rights issued a *Water Act* Order that required a terms-of-reference be written to "identify, prioritize and revegetate highly visible reservoir perimeter sites within the drawdown zone". To address these priorities, the Upper Campbell Reservoir Drawdown Zone Revegetation Program (JHTWORKS-3) was initiated.

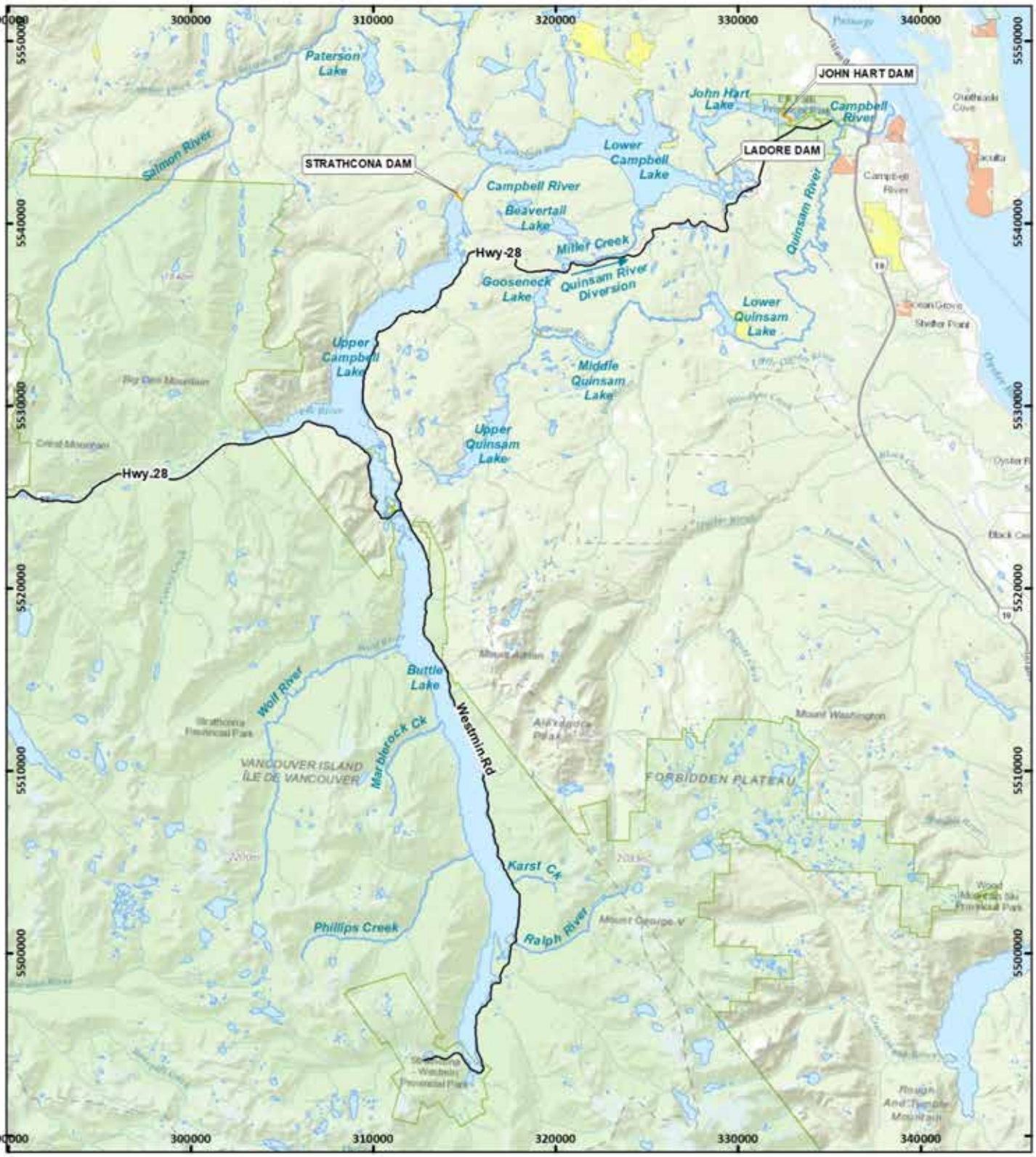
JHTWORKS-3 is a 10-year program with the primary goal of improving the visual quality and riparian habitat values of high-profile reservoir shoreline areas of the Upper Campbell Reservoir impacted by fluctuating water levels. Accomplishment of this goal requires that the natural recolonization of native vegetation communities in the upper drawdown zone of the Upper Campbell Reservoir is actively enhanced (BC Hydro 2016). Additional benefits of this Program are improved Indigenous resource values, wildlife habitat, and likely an increase in shoreline stability.

JHTWORKS-3 has three phases that will be implemented over the 10-year period: 1) identification/prioritization of sites for revegetation treatment trials (Year 1); 2) planning, trial implementation, and monitoring of revegetation treatment trials (Years 2-6); and 3) implementation of the final Revegetation Treatment Plan at additional sites around the reservoir (Years 7-10). In Phase 1, highly visible reservoir perimeter sites within high recreational use areas, that have high potential for revegetation and natural recolonization success, were identified for revegetation treatment. Baseline information on these sites and associated treatment prescriptions are presented in the Year 1 report (Ballin *et al.* 2018a). An effectiveness monitoring program was also developed that outlines the means by which the success of revegetation treatments will be evaluated (Ballin *et al.* 2018b). Years 1, 2 and 3 of JHTWORKS-3 have now been implemented by Laich-Kwil-Tach (LKT) with support from Ecofish Research Ltd. (Ecofish). A summary of the Year 2 revegetation implementation work has been completed (Regehr *et al.* 2019), as well as an updated treatment plan for Year 3 (Woodruff *et al.* 2019).

The objectives of this report are to present the accomplishments of Year 3 (2019), the second year of Phase 2. This includes providing summaries of the revegetation work completed, as well as a watering

program that was initiated based on recommendations from 2018, presenting effectiveness monitoring data for all sites in general and specifically for sites planted in the first year of Phase 2 (2018), describing and discussing important lessons learned that can be incorporated into future revegetation implementation work, and updated budget and schedule information. In addition, appendices of this report provide site-specific restoration profiles as of fall 2019 (Appendix A), results of the as-built surveys conducted for sites treated in 2019 to describe the environmental setting and vegetation presence (Appendix B), effectiveness monitoring results for stem count plots (Appendix C), and photopoint monitoring results (Appendix D). Lessons learned and recommendations for trial implementations for 2020 are included within this report.

Project Area Overview



Legend

- Dam
- Paved Road
- First Nation Reserve
- Recreational Sites
- Parks and Protected Areas

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 2 4 6 8 10 12 km

Scale: 1:300,000

NO.	DATE	REVISION	BY
1	1/22/2019	GIS_JHTMON_ProjectOverview_2019Jan22	GIS
2			
3			
4			
5			

Date Saved: 1/22/2019
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 1

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2. BACKGROUND

Nine revegetation sites were identified for treatment in the Year 1 report (Ballin *et al.* 2018a) (Table 1, Map 2) (one of these, JHT-RV01 was soon after removed). These were classified into four distinct types (labelled A through D), which differ by elevation relative to reservoir operations, slope, substrate, and other environmental factors that affect the optimal types of revegetation treatments that could be implemented (described in Table 2). Specific treatment prescriptions were also identified in the Year 1 report for each treatment site (see Table 3 and Tables 8 through 11 in Ballin *et al.* (2018a) for details on revegetation treatment prescriptions), and control treatment types were included in which no treatment (control) was planned to support the effectiveness monitoring program. In total, 48 treatment areas (equivalent to, and used interchangeably with, mapped 'polygons'), including controls, were identified within the eight revegetation sites (with 2 to 14 treatment areas per site), and a minimum of one permanent monitoring plot was established within each treatment area. Each treatment area can be identified by a uniquely identified permanent monitoring plot that is considered representative of that treatment area, which allows tracking of treatment implementation, environmental condition and vegetation response data associated with each treatment area as needed for effectiveness analysis. Baseline data were primarily collected in 2017 during program development (Ballin *et al.* 2018a), and the effectiveness of revegetation treatments in these treatment areas will be monitored by characterizing vegetation and the environmental setting over time within monitoring plots and treatment areas as per the baseline data collection and effectiveness monitoring plan (Ballin *et al.* 2018b). Some changes to treatment areas have been made based on logistics and site-specific considerations as treatments were implemented, and in some cases alternative treatment areas were defined that could potentially be treated in the future. These deviations from the original plan (Ballin *et al.* 2018a) are described in the annual workplans (Woodruff *et al.* 2018, Woodruff *et al.* 2019) and implementation summary reports (Regehr *et al.* 2019).

The work conducted in 2018 represented the first year of Phase 2 of the JHTWORKS-3 program. Revegetation treatment trials were implemented at a subset of revegetation sites and as-built data were collected as part of the effectiveness monitoring program. Revegetation work was conducted at three sites in late fall (between October and December) in 2018: the Old Buttle Lake Boat Launch (JHT-RV02), Buttle Lake Campground (JHT-RV03), and Buttle Lake Boat Launch (JHT-RV06) (Table 1; Regehr *et al.* 2019) (Map 2). These sites were selected to maximize efficiency for machine access by coordinating with work that was already occurring in the area, and because they provided a good representation of treatment trials that used a variety of the proposed revegetation methods in commonly found types of areas around the reservoir. Treatments at these three sites involved various methods of machine-based substrate preparation (e.g., rough and loose) which would then be allowed to regenerate naturally (JHT-RV02 only) and/or planting stakes of native vegetation including black cottonwood (*Populus balsamifera ssp. trichocarpa*), red-osier dogwood (*Cornus stolonifera*), and Sitka willow (*Salix sitchensis*). In 2018, baseline data were collected for newly identified treatment areas (most baseline data had been collected in 2017) and as-built data were collected following implementation of treatments. Lessons learned that could inform future work were documented (Section 4 of Regehr

et al. 2019), among which were modification of an originally proposed treatment that included no site preparation and hand planting (i.e., C-2) was found to be difficult to implement due to compactness of the substrate. Therefore, this treatment was modified to incorporate site preparation in the form of machine loosened circles and assigned treatment C-2i. Because 2018 was the first year of Phase 2 of the JHTWORKS-3 program, effectiveness monitoring was not conducted.

In 2019, revegetation work was conducted at five revegetation sites, four sites in the spring (JHT-RV02, JHT-RV07, JHT-RV08, and JHT-RV09) and one in the fall (JHTRV04). As-built surveys were conducted following each treatment. The spring of 2019 was unusually dry; hence, a watering program was implemented during the spring and early summer to increase survival at the sites planted in spring. In the fall of 2019, effectiveness monitoring results were documented for areas treated in fall 2018 and spring 2019. Furthermore, repeat stem count data were collected at most plots at which baseline data was collected in fall 2019, and photopoint monitoring data were collected at all plots that had been treated during the Program in spring and at all previously treated areas and in areas in which additional treatments are planned in fall 2019.

Table 1. Sites selected for revegetation trials (reproduced from Ballin *et al.* (2018a)). Revegetation work was conducted at JHT-RV02, JHT-RV03, and JHT-RV06 in 2018 and at JHT-RV02, JHT-RV04, JHT-RV07, JHT-RV08, and JHT-RV09 in 2019.

Site Name	Revegetation Site
JHT-RV02	Old Buttle Lake Boat Launch
JHT-RV03	Buttle Lake Campground
JHT-RV04	Rainbow Island Marine Campsite
JHT-RV05	Driftwood Bay Group Site
JHT-RV06	Buttle Lake Boat Launch
JHT-RV07	Buttle Lake Campground Fan
JHT-RV08	Karst Creek Boat Launch
JHT-RV09	Ralph River Campground

Table 2. Physical and ecological description of the four treatment types (reproduced from Ballin *et al.* (2018a)).

Label	Treatment Type	Description
A	Low slope or alluvial fan	These areas have slopes under 5% and occupy alluvial fans or shallow bays. They are typically well vegetated with herbaceous species at lower elevations (i.e., below 219 m), and with taller shrubs and trees at progressively higher elevations. The primary objective for revegetation of these areas is increasing visibility of lower elevation shallow areas and stumps to reduce the hazard for boaters. This treatment type supports all of the vegetation communities listed in Ballin *et al.* 2018; however, the target area for revegetation is occupied by the lowest two communities - 'spearwort lakeflat' and 'hairgrass - water sedge', as well as the mudflats that occupy lower elevations than these two communities.
B	Moderate slope drawdown	These areas have slopes under 15%. They are typically sparsely vegetated with patches of herbs and patches of deciduous shrubs. This treatment type occupies elevations suitable for the 'tall and short Sitka willow - water sedge' deciduous shrub communities (i.e., 217.8+ m) as well as the upper extent of the drawdown zone that may be capable of succeeding into terrestrial vegetation communities. The primary objective for revegetation is increasing the shrub cover to improve visual quality and riparian habitat, and support vegetation succession, where possible.
C	Steep upper drawdown	These areas have slopes over 15%. They are typically not vegetated to very sparsely vegetated with deciduous shrubs. This treatment type occupies elevations suitable for the 'tall and short Sitka willow - water sedge' deciduous shrub communities (i.e., 217.8+ m) as well as the upper extent of the drawdown zone that may be capable of succeeding into terrestrial vegetation communities. The primary objective for revegetation is increasing the shrub cover to improve visual quality and riparian habitat, and support vegetation succession, where possible.
D	Steep upland forest	These areas have slopes over 45% and are in a perpetual state of erosion. They are typically not vegetated to sparsely vegetated with herbs, low lying shrubs or the odd large Douglas-fir or Pacific dogwood tree that has slid down the slope and remains rooted above. This treatment type occupies elevations above the current and past 'full pool' of the reservoir (i.e., above 221.0 m) and thus are not, nor have ever been inundated by reservoir operations. These elevations are suitable for establishment of 'upland forest' communities. The primary objective for revegetation of these areas is increasing vegetative cover to stabilize the slope, which will help enable vegetation to establish and grow to improve visual quality.

Table 3. Revegetation treatment prescriptions for all treatments implemented in 2019 (control treatments not included). A full list of all treatment prescriptions, along with rationale and risks/challenges, is located in Ballin *et al.* (2018a), and modifications made to this in 2018 are presented in Regehr *et al.* (2019).

Treatment Type	Treatment Location	Treatment	Existing Substrate	Restoration Treatment Details		
				Site Preparation and Planting Treatment	Plant Species and Size	Source of Material
A-1	Low slope shoreline or former alluvial fan (0-10%), 216.5-219.7 m elevation	Fill and plant stump cavities.	Fines/Gravel	Select stumps with appropriate cavities and a surveyed top elevation above 217.8 m. Fill with growing medium and gravel. Plant stumps with tops below 219.8 m with deciduous stakes. Armour with large gravel or cobble. Plant stumps with tops above 219.8 m with flood tolerant forest species (where available). If there are inadequate stumps to plant with terrestrial species, pockets can be drilled out and planted. Plant available planting pockets up to a minimum spacing of 20 cm between plants.	Deciduous stakes: Sitka willow (*Salix sitchensis*), black cottonwood (*Populus trichocarpa*) and red-osier dogwood (*Cornus stolonifera*), 1 meter in length. Forest species may include: western hemlock (*Tsuga heterophylla*), shore pine (*Pinus contorta ssp. contorta*), western white pine (*Pinus monticola*) and grand fir (*Abies grandis*) depending on availability, up to size of 1 gallon pot.	Topsoil imported and gravel/cobble imported or collected. Dormant deciduous stakes harvested by project crew from pre-identified donor sites in the days preceding planting. Forest species will be transplanted from pre-identified and approved location. This may include salvage from WORKS-2 or other maintenance or upgrade projects.
A-3	Low slope shoreline or former alluvial fan (0-10%), 216.5-219.7 m elevation	Control	Fines/Gravel	n/a		
B-2	Moderate slope (5-15%) upper drawdown zone, 217.6-221.0 m elevation	No site preparation. Stake deciduous species by hand.	Gravel/Sand/ Cobble	No site preparation. Stake deciduous species by hand. Plant stakes with 50 cm spacing in rows 2 m apart.	Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.65-1.0 m in length.	Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
B-3	Moderate slope (5-15%) upper drawdown zone, 217.6-221.0 m elevation	Control	Gravel/Sand/ Cobble	n/a		
C-1ii	Steep (>15%) upper drawdown zone, 217.6-221.0 m elevation	Willow and cottonwood stakes planted by machine in trenches.	Gravel/Cobble/ Sand	Create slightly rough and loose topography by creating trenches/ terraces for willow and cottonwood stakes, and provide erosion protection with addition of woody debris and boulders/cobble. Stakes will be 1-2 m in length. Plant stakes with 30 cm spacing in rows 2 m apart. Add leaf litter/mulch as practical.	Sitka willow, black cottonwood and red-osier dogwood. Machine planted stakes will be 1-2 m in length, hand planted stakes will be 0.65-1.0 m in length.	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
C-2	Steep (>15%) upper drawdown zone, 217.6-221.0 m elevation	No site preparation. Stake deciduous species by hand.	Gravel/Cobble/ Sand	No site preparation. Stake deciduous species by hand. Plant stakes with 30 cm spacing in rows 2 m apart.	Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.65-1.0 m in length.	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
C-2i	Steep (>15%) upper drawdown zone, 217.6-221.0 m elevation	Machine loosen circles and stake with deciduous species	Gravel/Cobble/ Sand	Machine loosen circles (0.8 m deep x 1 m diameter) spaced every 2 m. Stake deciduous species by hand in craters, spaced at 0.5 m, 5 to a crater. Alternate method is loosening soil in lines every 2 m up the slope and staking every 0.3 m.	Machine loosen circles (0.8 m deep x 1 m diameter) and space every 2 m. Stake deciduous species by hand in craters, spaced at 0.5 m, 5 to a crater. Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.3-0.7 m in length.	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
C-3	C-3	Control	Gravel/Cobble/ Sand	n/a		

ROW = Right-of-way
LFH = Litter/Fermented/Humic

Table 3. Continued.

Treatment Type	Treatment Location	Treatment	Existing Substrate	Restoration Treatment Details		
				Site Preparation and Planting Treatment	Plant Species and Size	Source of Material
D-1	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Bioengineer slope with cottonwood modified brush layers installed by hand and plant forest species on the created terraces.	Sand/Mineral Soil	Stabilize slope with modified brush layers to create small terraces. Plant terraces with transplanted forest species, if available. Structures will be approximately 2 m long with 2 m spacing between rows horizontally and vertically. Species placement will depend on aspect and expected moisture availability.	Black cottonwood for brush layers. Forest species may include Douglas-fir, shore pine, tall Oregon grape (*Mahonia aquifolium*) and Kinnikinnick (*Arctostaphylus uva-ursi*).	Dormant stakes will be harvested by project crew from donor sites in the days preceding planting. Understory forest species will be harvested by project crew from pre-identified and approved near-by areas. This may include salvage from WORKS-2 or other maintenance or upgrade projects.
D-2	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Cottonwood stakes planted by hand.	Sand/Mineral Soil	Prepare ground for individual stakes as necessary; stakes will be 0.3-0.7 m in length, spaced every 20 cm.	Black cottonwood	Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
D-3	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Stabilize bottom of slope with logs and boulders. Make driftwood benches on the slope[1]. Plant with individual forest plants and cottonwood stakes.	Sand/Mineral Soil	Move logs tight against base of slope and backfill soil. Place 1 log vertically/ parallel to slope every 2 m. Prepare microsites for planting upslope of the logs by loosening soil in pockets. Plant with transplanted forest species, if available. Add leaf litter/mulch as practical. Plant with 70 cm spacing in hollows. In 2019 this was modified to have driftwood benches up the slope that could be placed without a machine.	Deciduous stakes: black cottonwood. Forest species may include: Pacific dogwood, shore pine, Douglas-fir.	Coarse wood will be collected from nearby shoreline accumulations or associated with forestry operations. Forest species will be harvested by project crew from pre-identified and approved near-by areas. This may include salvage from WORKS-2 or other maintenance or upgrade projects. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
D-4	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Control	Sand/Mineral Soil	n/a		

[1]2019 Modification to treatment prescription
ROW = Right-of-way
LFH = Litter/Fermented/Humic

3. ACCOMPLISHMENTS IN 2019

3.1. Revegetation Treatment Trials - Implementation

Revegetation work was implemented in 2019 at five sites. Four were implemented in the spring (March). These are Old Buttle Lake Boat Launch (JHT-RV02), Buttle Lake Campground Fan (JHT-RV07), Karst Creek Boat Launch (JHT-RV08), and Ralph River Campground (JHT-RV09). In the fall (October and November), revegetation work was implemented at Rainbow Island Marine Campsite (JHT-RV04). The sites and the treatment areas within them are mapped, and the restoration treatments and ecological site conditions described, on the site profile maps in Appendix A. A sixth site, Driftwood Bay Group Site (JHT-RV05), had treatments planned for 2019 (Appendix E in Regehr *et al.* 2019 and Woodruff *et al.* 2019); however, machine access to this site was found to be challenging and the substrates hard to penetrate and revegetation work was therefore postponed to provide additional time to reconsider the approach and feasibility. Similar to 2018, stakes used to implement revegetation treatments were cut along Highway 28, adjacent logging roads, and along the shores of Buttle Lake. Potted plants were obtained from Streamside Native Plants in Bowser, British Columbia.

As-built surveys were completed following treatment implementation. These involved conducting a census of planted vegetation, re-measuring the dimensions of treated areas, recording stem counts in vegetation density plots, describing the environmental setting including any substrate modifications, and taking representative photographs at photopoint monitoring locations (as per Ballin *et al.* 2018b). As-built data collected as per the baseline data collection and effectiveness monitoring plan are discussed in more detail in Section 3.2.

In addition to implementing revegetation treatments, a watering program was implemented by A-Tlegay Fisheries Society crews at sites planted in spring of 2019 (JHT-RV02, JHT-RV07, JHT-RV08 and JHT-RV09) to increase survival of planted stock. The lack of rainfall in spring and early summer of 2019 (there was minimal precipitation between early February and June 2019), along with low reservoir water levels, severely restricted the amount of water that plants would receive in spring and summer. Once every two weeks from May 23 to July 3, 2019, plants were watered with ~1 L of water each (evaluated to penetrate ~60 cm into the soil). Approximately 25% of the plants at each site were not watered to provide a control for the watering treatment, and many of these plants died. Details of the watering program and photographs are provided by Everson (2019).

3.1.1. Old Buttle Lake Boat Launch (JHT-RV02)

The Old Buttle Lake Boat Launch treatment site (JHT-RV02) is in a bay with partially vegetated islets that is adjacent to the Buttle Lake Campground area. The site varies in elevation, topography, slope, and exposure, and multiple treatment prescriptions have been identified for the polygons in this site including treatments for moderate and steeper slopes in the drawdown zone (Appendix A).

Original treatment prescriptions for this site were rough and loose (B-1i), willow and cottonwood stakes planted by machine in trenches (C-1ii), and hand planted deciduous stakes (C-2) (Table 12 in Ballin *et al.* 2018a). Stakes were approximately 1 m long, planted to a depth of approximately 80% of

their length. Of these, B-1i and C-1ii were implemented along the shoreline in 2018 and a control (no treatment) was established (treatment C-3; suitable control for both JHT-RV02 and JHT-RV03) (Regehr *et al.* 2019). In 2019, treatment C-1ii was implemented within one polygon on an island (Figure 1), which substantially increased the amount of this treatment over what had been accomplished in 2018 (Appendix A). The planned C-2 treatment was reassigned to C-2i (deciduous stakes planted in machine loosened circles) (Figure 2) due to the presence of compacted and cemented soil, in which cases site preparation by machine is preferred (see Lessons Learned in Regehr *et al.* 2019).

A total of 382 stakes (black cottonwood, red-osier dogwood, and Sitka willow) were planted within the two polygons (C-1ii and C-2i) in 2019 (Table 4), and erosion protection (15 washed stumps and a half load of ~60 cm sized rock from a 20 yard dump truck) was brought into the site and placed within the treatment areas. Specifically, the following two treatment prescriptions were implemented within the islets in the second half of March:

- C-1ii. The substrate was made rough and loose by excavator with loosened substrate in an egg carton pattern, stakes were planted into the prepared substrate, and stumps and rocks were added to stabilize the substrate and create microsites. Creating the egg carton pattern involved digging out hollows 1 to 1.5 m deep with the excavator bucket and depositing soil between the hollows. Stakes of native vegetation were planted into the hollows and sides of the hollows at a variety of elevations and aspects. Stumps were placed into dug holes by excavator and were then backfilled to anchor them, and rocks were placed around the stumps as ballast. Many of the stakes were up to 0.8 m deep. The western most islet was used as a control for the watering program and these stakes were planted 1 m deep with only 0.2 to 0.3 m of their length left above ground. A few scoops of fine textured lake bottom sediment were placed into the hole around the stump.
- C-2i. An excavator was used to loosen soil within which stakes of deciduous species were planted. Soil was loosened in circular craters (0.8 m deep by 1 m in diameter) spaced randomly about 2 m apart within which stakes were planted (five per crater).
- C-3. Control

Table 4. **Size of treatment areas treated in 2019 at JHT-RV02, and number and species of stakes planted within treated areas. Permanent monitoring plots within treatment areas are identified for reference.**

Treatment Type	Permanent Monitoring Plot	Planting Date (2019)	Area (m^2) (approximate)	Species Planted			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
C-1ii	JHT-PRM29	18-20 Mar	480	16	9	170	*195*
C-3	JHT-PRM29[1]	-	123	0	0	0	*0*
C-2i	JHT-PRM28	18-20 Mar	240	18	19	150	*187*

[1]Plot located on border between C-1ii an C-3 treatments

Figure 1. **Machine loosened substrate in C-1ii polygon at JHT-RV02 within the islets (plot JHT-PRM29) on May 1, 2019. Hollow created for rough and loose egg carton pattern.**

Figure 2. Machine loosened substrate staked with native vegetation in C-2i polygon at JHT-RV02 within the islets (plot JHT-PRM28) on May 1, 2019.

3.1.2. Rainbow Island Marine Campsite (JHT-RV04)

The Rainbow Island Marine Campsite treatment site (JHT-RV04) is a high-use walk-in campsite located in a bay with vegetated islets that is part of the Buttle Lake Campground. Revegetation treatments were conducted on steep eroding upland slopes with forest soils bordering the north (south facing) side of the bay (Appendix A). Treatment prescriptions for this site were D-1, D-2, and D-3 (Table 12 in Ballin *et al.* 2018a), which were designed to target the steep upland slopes with primary objectives of slope stabilization. Prescribed treatments involve planting of stakes and/ or planting upland species (forest transplants or nursery stock) following terracing and/or slope stabilization with logs or boulders or modified brush layers/ cottonwood stake fencing (Table 11 in Ballin *et al.* 2018a). No treatments were implemented at this site in 2018. In 2019, revegetation treatments were implemented at four of the six polygons in which treatments were planned and one control (D-4) was established (Appendix A) (Table 5). No machines were used for site preparation as the sandy soils were loose and easy to plant, and because of challenges in transporting a machine to site. Specifically, the following treatment prescriptions were implemented in late October:

- D-1. The slope was stabilized with a combination of 12 modified brush layers, wattle, and driftwood fences, and terraces were prepared into which stakes were planted (Figure 3). Modified brush layers and wattle fences were installed to a depth of approximately 1 m. No soil was added. In total, 94 stakes (1 m long) were planted to a depth of approximately 0.8 m, half Sitka willow and half black cottonwood.

- D-2. 194 black cottonwood stakes (0.75 m long) were planted by hand to a depth of approximately 0.6 m at 0.5 m spacing. No ground preparation conducted.
- D-3. This treatment was modified slightly from Ballin *et al.* (2018a). Instead of moving large logs against the base of the slope, driftwood fences were made along the base of the slope and benched/ terraced up the slope. Logs were moved against the slope, staked in place with live cottonwood and willow stakes, and the native soil was backfilled. For the treatment area associated with JHT-PRM15, wattle fences were installed in addition to driftwood fences (for a total of 19 wattle and driftwood fences) and Sea Soil[1] was added to the terraces to improve survival of potted plants. Microsites were prepared upslope of the fences and 79 stakes of black cottonwood approximately 1 m long were planted to a depth of approximately 7/8 of their total length. Species planted from pots were tall Oregon-grape (*Mahonia aquifolium*), shore pine *(Pinus contorta* var. *contorta*), and Kinnikinnick (*Arctostaphylos uva-ursi*).
- D-4. Control.

Table 5. Size of areas treated in 2019 at JHT-RV04, and number and species of stakes planted within treated areas. Permanent monitoring plots within treatment areas are identified for reference.

Treatment Type	Permanent Monitoring Plot	Planting Date (2019)	Area (m^2) (approximate)	Species Planted			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
D-1	JHT-PRM14	18-31 Oct	403	47	0	47	*94*
D-2	JHT-PRM16	18-31 Oct	104	194	0	0	*194*
D-3	JHT-PRM12	18-31 Oct	216	48	0	0	*102*
D-3	JHT-PRM15	18-31 Oct	196	31	0	0	*55*
D-4	JHT-PRM13	-	246	0	0	0	*0*

[1] Organic growing soil: https://www.seasoil.com/about.html.

Figure 3. **Slope stabilized with driftwood fences and stakes planted into terraces in D-1 treatment area at JHT-RV04 (plot JHT-PRM14) on November 6, 2019.**

Figure 4. **Slope stabilized with a combination of driftwood and wattle fences and stakes planted into terraces in D-3 treatment area at JHT-RV04 (plot JHT-PRM15) on October 28, 2019. Wattle fences are not woven around the stakes, but put on the up-hill side and backfilled with soil.**

3.1.3. Buttle Lake Campground Fan (JHT-RV07)

The Buttle Lake Campground Fan treatment site (JHT-RV07) is an alluvial fan located west of Rainbow Island Marine Campsite. The site is generally well vegetated above 217.6 m in elevation and the target of revegetation treatments (type A; Table 12 in Ballin *et al.* 2018a) are the low slope areas within the alluvial fan, within in which stumps protrude from the mineral soil. No treatments were implemented at this site in 2018. In 2019, revegetation occurred at all three treatment areas identified for this site (Table 6, Figure 5) and a control (A-3) was established (Appendix A). Specifically, the following treatment prescription was implemented in all three treatment areas in late March 2019:

- A-1. A total of 394 stakes (Sitka willow, black cottonwood, and red-osier dogwood) were planted into rotting stumps. Stakes were either planted into natural decay holes or into drilled holes (45 cm long, 4 cm in diameter). Stakes that were planted into decaying stumps were done so with a planting bar that often-allowed planting into the soil below the stumps. The hollow stumps were then filled with soil (which contained native fines and some Sea Soil). Thus, a large proportion of the length of each stake was planted within soil (often 2 to 2.5 m of the stake was in the soil and only 0.3 to 0.5 m was above). Stakes were planted into stumps to bring them to an appropriate elevation relative to water levels (i.e., ~217.8 – ~219.2 m). Some leftover stakes were also planted directly into the ground adjacent to stumps at elevations where stakes were naturally occurring (i.e., over 217.8 m). Stakes planted within stumps were watered approximately once every two weeks between mid-May and the first week of July (total four visits).
- A-3. Control.

Table 6. Size of areas treated in 2019 at JHT-RV07, and number and species of stakes planted within treated areas. Permanent monitoring plots within treatment areas are identified for reference.

Treatment Type	Permanent Monitoring Plot	Planting Date (2019)	Area (m^2) (approximate)	Species Planted			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
A-1	JHT-PRM18, 19, 20	20-25 Mar	10,347	38	14	342	*394*
A-3	JHT-PRM17	-	2,800	0	0	0	*0*

Figure 5. Stakes planted into decaying stumps in A-1 polygon at JHT-RV07 (plot JHT-PRM19) on May 3, 2019. The lateral branches are new growth since the stakes were planted in March.

3.1.4. Karst Creek Boat Launch (JHT-RV08)

The Karst Creek Boat Launch treatment site (JHT-RV08) is a day use area with a new concrete boat launch. Areas on either side of this new boat launch are variably vegetated. Prescribed treatments were of type B given the moderate slope targeted for revegetation (Table 12 in Ballin *et al.* 2018a). No treatments were implemented at this site in 2018. In 2019, revegetation occurred at the single treatment area (B-2) identified for this site (Table 7, Figure 6) and a control (B-3) was established. Specifically, the following treatment prescription was implemented within one treatment area in late March 2019:

- B-2. A total of ~210 stakes (black cottonwood, red-osier dogwood, and Sitka willow), approximately 0.8 m long, were planted by hand approximately 0.6 m deep (without site preparation). Hand planting was possible due to the soils being relatively loose.
- B-3. Control.

Table 7. Size of areas treated in 2019 at JHT-RV08, and number and species of stakes planted within treated areas. Permanent monitoring plots within treatment areas are identified for reference.

Treatment Type	Permanent Monitoring Plot	Planting Date (2019)	Area (m^2) (approximate)	Species Planted			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
B-2i	JHT-PRM40	25-27 Mar	2,430	100	~30	80	*~210*
B-3	JHT-PRM39	-	2,437	0	0	0	*0*

Figure 6. Stakes planted by hand without site preparation in B-2 polygon at JHT-RV08 (plot JHT-PRM40) on May 2, 2019.

3.1.5. Ralph River Campground (JHT-RV09)

The Ralph River Campground treatment site (JHT-RV09) is a well vegetated alluvial fan adjacent to the Ralph River Campground. Conditions were similar to JHT-RV07, and type A was also prescribed at this site given the flat topography and presence of stumps (Table 12 in Ballin *et al.* 2018a). In 2019, revegetation occurred at the single treatment area (Figure 7) and a control (A-3) was established. The single treatment area was newly established in 2019 to better capture the areas where stumps were present. The new treatment area includes the lower portion of the four

previously identified and described treatment areas (identified by JHT-PRM35, 36, 37, 38). A new control was also delineated (identified by plot JHT-PRM60). Specifically, the following treatment prescription was implemented in late March and early April:

- A-1. A total of 725 stakes (black cottonwood, Sitka willow, and red-osier dogwood) were planted into decaying stumps that were hollow or drilled using the methods described in Section 3.1.3. In addition, a few western hemlock trees (*Tsuga heterophylla*) were planted on the highest elevation stumps. A few (~20) stakes were planted directly into the ground adjacent to stumps at ~218.0 m. These stakes were approximately 1 m long and were planted to a depth of approximately 0.8 m.
- A-3. Control

Table 8. Size of areas treated in 2019 at JHT-RV09, and number and species of stakes planted within treated areas. Permanent monitoring plots within treatment areas are identified for reference.

Treatment Type	Permanent Monitoring Plot	Planting Date (2019)	Area (m^2) (approximate)	Species Planted			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
A-1	JHT-PRM61	28-Mar to 5-April	12,035	105	85	555	*745*
A-3	JHT-PRM60	-	7,821	0	0	0	*0*

Figure 7. Stakes planted into decaying stumps in A-1 polygon at JHT-RV09 (plot JHT-PRM61) on October 25, 2019. Example at front of image shows stake that was placed into a hole drilled into the stump.

3.2. Revegetation Treatment Trials - Effectiveness Monitoring

A revegetation effectiveness monitoring program was developed for evaluation of the effectiveness of the revegetation treatments and to enable adaptive modification of prescriptions based on monitoring results (Ballin *et al.* 2018b). Effectiveness monitoring will be ongoing throughout Phase 2 of the revegetation program and involves comparing data on vegetation characteristics at areas where treatments were implemented to baseline data (collected prior to treatment implementation), as-built data (collected immediately following treatment implementation), and data from control sites where no revegetation treatments were implemented. Monitoring results from data collected and compared among locations and time periods are then used to adaptively modify treatments within the program on a yearly basis, thereby maximizing the potential for program success, and to inform future revegetation efforts applied to other areas in the reservoir (in phase three of the program).

3.2.1. Methods

Effectiveness monitoring data were collected following the methods used for the collection of baseline and as-built data (see Ballin *et al.* 2018b). Effectiveness monitoring data collected for sites where treatments were implemented in fall 2018 (i.e., at JHT-RV02, JHT-RV03, and JHT-RV06) have been analysed in this report to evaluate the effectiveness of treatment after one year. Treatments implemented in spring 2019 (at JHT-RV02, JHT-RV07, JHT-RV08, and JHT-RV09) only experienced one growing season (rather than a full year) when monitoring data were collected. Although evaluation

for these treatments is therefore preliminary, high level observations on success to date were nevertheless made to provide potentially valuable information to guide future revegetation work. Data for areas where no treatments have been implemented to date (areas marked as incomplete in Appendix A) are also presented (Appendix C) and can be used to supplement control treatment areas for assessing potential changes in reservoir vegetation in the absence of revegetation efforts.

Data collected for the effectiveness monitoring program in 2019 included as-built data collected for treatment areas treated in spring and fall 2019 soon after treatment and effectiveness monitoring data collected for all sites with treatments. As-built data included: 1) vegetation stem counts within established 50 m^2 (circular 3.99 m radius) monitoring plots (considered representative of that treatment area) (data presented in Appendix B); 2) data describing the ecological and physical environmental setting for the entire treatment area (Appendix B); and 3) photographs from established photopoint monitoring locations (Appendix D). Effectiveness monitoring data included: 1) vegetation stem counts within the established 50 m^2 plots (data presented in Appendix C) in fall 2019; and 2) photopoint monitoring at established photopoint monitoring locations (Appendix D) in spring and fall 2019. Stem count data from 50 m^2 plots allows quantitative evaluation of revegetation success over time and comparisons can be made among plots differing by treatment type and location. Ecological and physical environmental setting data, which include vegetation response, site characteristics, and disturbance factors, allow quantitative and qualitative comparisons of changes in factors contributing to vegetation response (e.g., substrate composition, microtopography), as well as broader evaluation of vegetation success (e.g., estimated percent cover of all species). Photopoint monitoring provides an efficient and effective means of qualitatively evaluating vegetation success and changes to site characteristics over time. Details of the data collection methods (including scheduling) and analysis approach are provided in Ballin *et al.* 2018b.

The baseline data and effectiveness monitoring plan (Ballin *et al.* 2018b) states that two additional types of data will be collected: 1) environmental/climatic data (e.g., precipitation and temperature data), which would allow evaluation of potential weather/climatic impacts on the effectiveness of revegetation treatments; and 2) photograph monitoring with aerial drone imagery, which would allow qualitative or statistical evaluation of the revegetation success and environmental setting. Although photomonitoring using a drone was originally proposed (Ballin *et al.* 2018b), this method has been discarded from annual monitoring following budget re-prioritization. Evaluation of revegetation results relative to environmental/climatic data is being conducted qualitatively for annual monitoring purposes and will be addressed in more detail in the final Project report at the end of the program.

In addition to standardized data collection conducted in 2019 within monitoring plots in accordance with the monitoring program methods, the site visit conducted on October 24, 2019 provided general qualitative evaluation of treatment areas (as a whole) that had been revegetated along the Buttle Lake shoreline to date. This site visit was conducted by David Polster (of Polster Environmental Services), Patrick Walshe (of Ecofish), and Zach Everson (of A-Tlegay Fisheries Society).

3.2.2. Results

Data collected in monitoring plots in fall 2019 are presented in Appendix C. These data are compared to baseline data recorded in 2017 (Appendix F in Ballin *et al.* 2018a) or 2018 (for new plots established at site JHT-RV03 in 2018; Appendix C in Regehr *et al.* 2019), and as-built data recorded in fall of 2018 and spring 2019 immediately after treatment implementation (Appendix D in Regehr *et al.* 2019). Photographs taken from monitoring plots within treatment areas during baseline, as-built, and effectiveness monitoring surveys are presented in Appendix D. Treatment effectiveness monitoring results are preliminary and revegetation success will be more thoroughly evaluated in Year 4.

Effectiveness monitoring results for sites at which treatments were implemented one year ago (fall 2018) (JHT-RV02, JHT-RV03, and JHT-RV06) are presented in the sections below. These sections contain high-level summary tables that present, for each monitoring plot, total stem survival (based on the ratio of alive to dead stems) and stem numbers during baseline, as-built, and monitoring surveys (Appendix C). For sites where treatments experienced only one growing season (i.e., treatments implemented in spring 2019), preliminary monitoring results are discussed in Section 3.2.2.4 and data are presented in Appendix D. Results from the qualitative site assessment conducted on October 24, 2019 are also presented. Some plant mortality is expected in any revegetation program and survival was considered high if 80% of plants survived (standard performance metric used for riparian revegetation evaluation; DFO and MELP 1998).

3.2.2.1. Old Buttle Lake Boat Launch (JHT-RV02)

Two treatment types were implemented at the Old Buttle Lake Boat Launch (JHT-RV02) in fall 2018: treatments C-1ii (substrate made rough and loose and stakes planted; steep slope) and B-1i (substrate made rough and loose and left to seed naturally; moderate slope).

Monitoring data recorded within plots representing rough and loose staked treatment (C-1ii, plots JHT-PRM07 and JHT-PRM08) indicated that the success of plants varied by plot within the C-1ii treatment area. An increase in numbers of stems relative to as-built was documented in one of the two monitoring plots (JHT-PRM07) along with high survival (Table 9). In contrast, success at the other plot within the same treatment area was relatively low (57% survival relative to as-built). However, in both treatment areas, the number of stems in monitoring plots had increased substantially relative to baseline (pre-treatment). Stems within the monitoring plots were primarily planted stems; however, naturally regenerating stems were also counted. It was difficult to distinguish between natural regeneration and planted stems for planted species. Photopoint monitoring results (Appendix D) support the increase in growth relative to baseline for treatment C-1ii (i.e., Figures 2 and 3 in Appendix D).

Results of the October 24 site visit suggested generally poor success for the rough and loose staked treatment (C-1ii) for areas on the mainland at the Old Buttle Lake Boat Launch (JHT-RV02) (for example, at the treatment area represented by JHT-PRM08; Table 9). Based on this visual qualitative assessment, this treatment appeared to have lowest survival of all treatment types assessed. The reason for poor success was evaluated to be lack of water and exposure to sun, given that survival was markedly better at slightly higher elevations close to the trees where plants would be in partial shade (i.e., near plot JHT-PRM07; Table 9). There may also have been a seepage water source adjacent to the trees. At areas that performed poorly, lack of moisture may also have been due to shallow planting depth, given that other sites with the same treatment seem to be doing well (e.g., C-1ii on islet (JHT-PRM29), planted in spring of 2019). Survival of some stakes was linked to drought-tolerance differences among species (e.g., black cottonwood is more drought tolerant than others) and variability in microtopography (e.g., stakes planted in hollows where they were in afternoon shade). High preliminary success observed for treatment C-1ii on the islet (planted in spring 2019) was considered likely due to the planting depth of the stakes because the substrate, which was prepared by an excavator, allowed planting of stakes to a depth of greater than 1 m, and this allowed planting of the majority of the stake underground (7/8 of the stakes were planted underground). In addition, stumps were brought into the site and lake bottom fines and organics were used to backfill stumps which likely increased moisture retention. Further, although the spring of 2019 was very dry, the summer was moister than normal, and the reservoir water levels remained low, which likely supported growth and survival across treatment areas. In general, results from this site to date indicate that stake depth and shade/insolation affect stake success.

Little change was observed in rough and loose treatment B-1i area (plot JHT-PRM09) since the as-built survey was conducted (Table 9). For this treatment, only substrate preparation had occurred, and

the area had been left to regenerate naturally. A decrease in stem numbers since baseline was documented which was likely due to site disturbance incurred during site preparation, and there had been no change since the treatment had been implemented (i.e., no difference in as-built and 2019 stem counts). A reduced stem count relative to baseline was also observed for the control plot (JHT-PRM06/6a); however, this was likely due to high levels of human use or machine damage caused while accessing adjacent areas, although the slight relocation of the plot due to a lost marker made comparison more difficult. Photopoint monitoring results (Appendix D) demonstrate natural regeneration of herbaceous species in the rough and loose treatment (B-1i) monitoring plot (JHT-PRM09) that would have not been captured in the plots that in which only woody vegetation is counted. Photographs also demonstrate the lack of woody vegetation and presence of herbaceous vegetation in the rough and loose treatment (B-1i) polygon (plot JHT-PRM09) (Figure 6 in Appendix D).

The qualitative effectiveness evaluation site visit conducted on October 24, 2019 (Polster 2019) provided additional evidence that the rough and loose treatment (B-1i) implemented in fall 2018 provided the opportunity for colonization of some plant species. In addition to herbaceous species, tree seedlings, including willow and some small seedlings of conifer species, were observed within the treatment area during the site visit. This rough and loose treatment (B-1i) area had been flooded in the winter of 2018-2019 and had not been watered in the spring or summer.

Table 9. Summary of numbers of living stems and percent survival in monitoring plots of revegetation site JHT-RV02 for baseline (prior to treatment), as-built (immediately post-treatment in fall 2018), and 2019.

Treatment		Monitoring Plot	No. of Stems per Plot			2019 Survival of Stems Relative to As-built (%)	2019 Change of Stems Relative to Baseline (%)
Treatment Type	Substrate Preparation and Planting		Baseline[1]	As-built[2]	2019		
C-1ii	substrate prepared, stakes planted	JHT-PRM07	17	42	51	121	200
C-1ii	substrate prepared, stakes planted	JHT-PRM08	4	65	37	57	825
B-1i	substrate prepared, no planting	JHT-PRM09	3	0	4	0	33
C-3	no treatment	JHT-PRM06/06a[3]	15	-	0	-	-100

[1] Baseline data are presented in Appendix F of Ballin *et al.* (2018).

[2] As-built data are presented in Appendix D of Regehr *et al.* (2019).

[3] Plot location changed slightly in spring 2019 and was renamed to 6a due to missing marker.

[4] As-built data are considered equivalent to baseline conditions since no treatment was implemented.

3.2.2.2. Buttle Lake Campground (JHT-RV03)

Three treatments prescriptions were implemented in steep upper drawdown polygons at the Buttle Lake Campground (JHT-RV03) in fall 2018, all of which involved substrate preparation with a machine and stake planting. Treatments C-1ii (substrate made rough and loose and stakes planted) and C-2i (hand planting stakes within excavator-loosened circles) were implemented in steep (>15%

slope) upland forest (217.6 - 221 masl), and treatments D-2i (stakes planted into machine loosened circles) and D-3i (stakes planted into terraces prepared within a modified rough and loose treatment) were implemented in even steeper (>40% slope) and further upland (>221 masl) forest polygons.

Treatments C-1ii and C-2i (JHT- PRM51 and 53) experienced moderate success (numbers of stems in monitoring plots increased since baseline) but had poorest stem survival (~50%) among treatments at this site (Table 10). Photopoint monitoring results (Appendix D) generally support the moderate increase in vegetation cover although stake survival is difficult to discern in the photos (Figures 17 and 19 in Appendix D). A small increase in the number of stems between as-built and 2019 surveys was also documented in the control polygon (treatment C-3; plot JHT-PRM57).

The further upland D type treatments had greater success than the slightly lower elevation C type treatments at this site. Stakes planted into terraces prepared with a modified rough and loose treatment (D-3i) had the highest success of all treatments at this site indicating high success in plant establishment. The number of stems in the representative monitoring plot (JHT- PRM54) almost doubled between as-built and 2019 surveys (Table 10). Survival of stakes planted into machine loosened circles (treatment D-2i) was also high (>80% relative to baseline; plot JHT-PRM52). As also noted for the two C type treatments, is difficult to discern stake survival in photographs at this stage in the monitoring program (Figures 18 and 20 in Appendix D).

The site visit conducted on October 24, 2019, provided an overview of the locations where planting occurred at this site in fall 2018 and linked revegetation success to sun exposure, species planted, and possibly to flooding in winter, and these factors therefore contribute to the difference in success observed by treatment type. Survival of stakes was observed to be greatest in the treatment areas that received shade from the trees immediately to the south (D-3i and D-2i; see Appendix A) (e.g., D-3i and D-2i), whereas survival was lower in locations where sun exposure was greatest (i.e., at C-2i and C-1ii). Even stakes that were 1 m in length and were backfilled by machine did not survive the sunny exposure. However, survival was better at this site than at most of JHT-RV02 which had generally greater exposure to sun. It was also noted that black cottonwood stakes had better survival than willow, especially at higher elevations where the ground would not have been flooded during the winter. The approach taken in 2018 at this site in which a hardened grid of cemented soils was left between dug hollows (treatments C-1ii and D-3i) appeared to have been effective for erosion control, as evident from maintained slope integrity in 2019. It is also of note that the treatments for which survival was greatest were upland treatment types (D type) which are characterized by looser and likely less anoxic soils because they are never flooded. These areas are also more likely to receive seepage from upland areas.

Table 10. Summary of numbers of living stems and percent survival in monitoring plots of revegetation site JHT-RV03 for baseline (prior to treatment in fall 2018), as-built (immediately post-treatment), and 2019.

Treatment		Monitoring Plot	No. of Stems per Plot			2019 Survival of Stems Relative to As-built (%)	2019 Change of Stems Relative to Baseline (%)
Treatment Type	Substrate Preparation and Planting		Baseline[1]	As-built[2]	2019		
C-2i	substrate prepared, stakes planted	JHT-PRM51	10	86	45	52	350
D-2i	substrate prepared, stakes planted	JHT-PRM52	25	79	66	84	164
C-1ii	substrate prepared, stakes planted	JHT-PRM53	5	110	55	50	1000
D-3i	substrate prepared, stakes planted	JHT-PRM54	36	60	117	195	225
C-3	no treatment	JHT-PRM57	-	2	4	133	-

[1] Baseline data are presented in Appendix F of Ballin *et al.* (2018).

[2] As-built data are presented in Appendix D of Regehr *et al.* (2019).

3.2.2.3. Buttle Lake Boat Launch (JHT-RV06)

Treatments B-2i (substrate loosened to 0.8 m depth in craters 1 m wide with stakes spaced at 2 m intervals), C-1ii (substrate loosened and stakes planted), and C-2i (substrate loosened in trenches to 0.8 m depth and stakes planted) were implemented at site JHT-RV06 in fall of 2018. Stem survival was relatively high (over 75%) for both C-type treatments (plots JHT-PRM21 and JHT-PRM22, treatments C-2i and C-1ii, respectively), and stems had increased since baseline (Table 11). Vegetation establishment at these monitoring plots is also evident in photopoint monitoring (Figures 34 and 35 in Appendix D). Little change was observed in the C-type treatment control plots (JHT-PRM23, JHT-PRM24, and JHT-PRM56).

Moderately poor survival (43%) was documented in the monitoring plot for the B-2i treatment area (plot JHT-PRM50), and stem counts had decreased slightly relative to as-built results (Table 11). In contrast, the number of stems in the B-type control plot (JHT-PRM56) had increased slighting relative to the as-built survey.

Observations from the site visit conducted on October 24 also suggested that stakes planted less deeply (i.e., B-2i treatment where stakes were planted into excavator-loosened circles or craters) survived less well than those planted deeply in machine-trenched soil (i.e., treatment C-1ii). Observations also suggested that there were species-specific differences in survival along with differences related to depth of planting. Overall, red-osier dogwood appeared to have higher survival than willow.

Table 11. Summary of numbers of living stems and percent survival in monitoring plots of revegetation site JHT-RV06 for baseline (prior to treatment), as-built (immediately post-treatment in fall 2018), and 2019.

Treatment		Monitoring Plot	No. of Stems per Plot			2019 Survival of Stems Relative to As-built (%)	2019 Change of Stems Relative to Baseline (%)
Treatment Type	Substrate Preparation and Planting		Baseline[1]	As-built[2]	2019		
C-2i	substrate prepared, stakes planted	JHT-PRM21	3	30	24	80	700
C-1ii	substrate prepared, stakes planted	JHT-PRM22	18	67	51	76	183
C-3	no treatment	JHT-PRM23	0	0	0	-	0
C-3	no treatment	JHT-PRM24	19	-	11	-	-42
B-2i	substrate prepared, stakes planted	JHT-PRM50	-	76	33	43	0
B-3	no treatment	JHT-PRM56	-	28	35	125	-

[1] Baseline data are presented in Appendix F of Ballin *et al.* (2018).

[2] As-built data are presented in Appendix D of Regehr *et al.* (2019).

3.2.2.4. Treatments Implemented in Spring 2019

Only one growing season had passed since monitoring data were collected for treatments implemented in spring of 2019. Thus, any evaluation for these treatments is preliminary. Revegetation success will be more thoroughly evaluated in Year 4.

Treatment A-1 (vegetation planted in stumps on lake flats) was implemented at JHT-RV07 in spring 2019. In fall 2019, excellent survival was documented (Appendix C) and qualitative assessment conducted on the October 24, 2019 site visit also suggested that the treatment at this site was highly effective, especially for long stakes planted through hollow stumps into the soil below (stumps were then filled with soil). Stakes planted in this fashion had grown vigorously since spring (1.5 m of growth observed), and even those that had not been watered were growing well. High growth and survival to date was considered likely due to the fines in the backfilled soil (which retained moisture), the addition of nutrient rich Sea Soil, the potential presence of seeps, and the large proportion of stake length planted under the soil. In contrast, the shorter stakes planted into holes drilled into stumps were less successful. Although most of the plants within drilled holes were surviving, they were stunted in comparison to those planted through natural decay holes into the soil below. The difference in success between these two approaches may be due to the opportunity for root expansion provided by the natural decay holes, existing crevices, and decayed fiber (in contrast to holes artificially created by drilling through more solid wood). The shaded base of the stump and the extensive potential for root colonization through a variety of depths may also allow the plants to more easily access moisture through a range of reservoir elevations. In addition, decayed fiber has a higher capacity for moisture retention than does less decomposed wood.

Treatment B-2 (stakes hand-planted without site preparation) implemented at the Karst Creek Boat Launch (JHT-RV08) in spring 2019 had experienced generally good survival by fall 2019. Of the 119 stems counted in the monitoring plot (JHT-PRM40) during as-built surveys in spring 2019, 103

remained in fall 2019 (Appendix C). A similar small decrease in the number of stems counted was also observed in the control monitoring plot between baseline (132 stems; note that as-built survey was not done for the control plot since no treatment was implemented) and the 2019 fall survey (108 stems). The similar pattern in survival between treatment and control for this treatment type suggests that broad scale environmental effects (e.g., differences in environmental conditions in the drawdown zone between years) may account for the observed decrease in stem numbers in the control treatment areas. Several small cottonwoods and willows were recorded in some locations at relatively low elevations along the shoreline during baseline surveys, including within the revegetation site at the Karst Creek Boat Launch (JHT-RV08), whereas most of these were absent in 2019 prior to treatment implementation.

Treatment A-1 (vegetation planted in stumps on lake flats) was also implemented at the Ralph River Campground (JHT-RV09) and similar to preliminary results from the Buttle Lake Campground Fan (JHT-RV07), success to date is high. High survival and a substantial increase in the number of stems was observed since treatment implementation (Appendix C). The increase in the number of stems was due to a combination of planting and natural colonization. As also observed for the Karst Creek Boat Launch (JHT-RV08), the decrease in stems relative to baseline at the monitoring plots in polygons where no treatments have been implemented to date (JHT-PRM35 to JHTPRM38) likely reflects differences in environmental conditions in the drawdown zone between years. Similarly, several small cottonwoods were observed throughout the lakeflats during baseline data collection and most of these were absent in 2019.

3.2.3. Vegetation Change without Treatment

In general, in fall 2019, there was a decrease in stem density since baseline (2017) within monitoring plots representing treatment areas that have not received treatments to date (Appendix C). This may be indicative of the stochastic nature of reservoir operations which can, without intervention, be expected to result in fluctuations in vegetation establishment and success over time.

3.2.4. Summary

Effectiveness monitoring results suggest that the most successful treatments evaluated to date were those in which stakes (cuttings) had been planted deeply into a substrate that had been loosened by an excavator (rough and loose best, loosened craters also good; e.g., C-1ii, C-2i) and where either the planting location received afternoon shade or plants were irrigated for at least one dry season after planting. The best growth and survival to date were observed for stakes planted deeply (0.8 m to 1.5 m or more) with no more than 25% of the stem above ground. This was possible in the hollow stumps, in excavator dug or loosened trenches and hollows, and in soft soils such as are present at Rainbow Island Marine Campsite (JHT-RV04), Buttle Lake Campground Fan (JHT-RV07), and Ralph River Campground (JHT-RV09). Treatments implemented within fine textured soils and with the addition of Sea Soil had higher success, likely due to increased moisture retention and nutrient availability. Treatment areas that were not watered over spring and early summer, during drought conditions, had lower survival, especially in locations that were exposed to more sun and had sandy, gravelly soil that is well drained and thus poor moisture retention. Differences in success were also noted among

species, with black cottonwood and red-osier dogwood exhibiting greatest survival under drought conditions. Although success for treatments that depended solely on natural regeneration following rough and loose substrate preparation (B-1i) were difficult to compare to treatments where planting had occurred because of the short length of time since treatment implementation, revegetation at these treatment areas also appeared to be progressing, with establishment of both herbaceous plants and tree seedlings. Treatment A-1 (stakes planted into stumps) appeared to have highest potential for revegetation success (as evaluated after one growing season) due to high observed survival of planted stakes.

In summary, revegetation success was linked to factors that promote water retention (deep planting, shade, irrigation, fine-textured soil) during the first year of monitoring. However, results could be different when extensive flood conditions are experienced. For example, fine textured soils which enhance moisture retention are beneficial under drought conditions but could be associated with decreased survival during inundation by causing anaerobic conditions.

4. LESSONS LEARNED

There were several lessons learned during 2019 that may be applicable to future revegetation work:

- Moisture was identified as a critical factor in plant success. In general, factors that contribute to moisture were found to be most associated with plant success. These included watering, depth of planting, sun exposure, soil texture, and planting season (elaborated on in the bullets below). Even plants planted in the fall had challenges with survival, especially in well-drained soil and sunny locations.

- The watering program was limited by logistics. Logistical limitations affected the watering program because water had to be hauled to planting sites by truck from Campbell River and at some sites, forestry sprayers need to be carried down a trail and across the shore. When implementing a watering program, it would be more efficient to apply for a water use permit and pump water from the reservoir rather than hauling water from town and packing forestry sprayers to remote sites. Additionally, the quantity of water would then not be as limited, ensuring that the stakes can be adequately watered.

- Depth of planting is important in dry locations with high sun exposure to prevent drying. Stakes that were planted 0.8 m to 1 m or more underground and had a low proportion of total length above ground (12-20 % above ground) had better success than those planted less deeply or with a higher proportion of total length above ground. However, at least 0.20 m of the stake should remain above ground. Deep planting was easier to accomplish in excavated trenches, loosened soil, in hollow stumps, or at locations with soft soil. In A-1 (stump cavity planting) treatments, planting most of the length of long stakes (2.5 m) deep into the ground under stumps, where moisture retention is expected to be high, was believed to be reflected in the high growth rates achieved.

- Moisture retention is aided by fine textured soil which increases plant survival. Backfilling plantings with fine-textured soil was believed to be a key factor for moisture retention and survival.

- High sun exposure is related to poor plant survival. Although many factors affect plant survival, high sun exposure, especially in low water conditions and under sub-optimal soil conditions, has been linked to stake failure. Stakes in shady north-facing locations had better survival, especially when not watered; success could therefore be improved if planting sites are shifted into areas with greater shade.

- Substrate preparation can aid in producing a suitable microclimate for plant establishment. Rough and loose treatments trap organics and fines in hollows and the rough texture serves to provide some shade to establishing plants if they are planted into the hollows or low on the sides. In particular, the 1 to 1.5 m amplitude egg carton style treatment showed evidence of superior organic debris accumulation and high survival even without water and shade. The added stumps also provide some shade as well as organics, moisture, and nutrients as they decompose.

- There are species-specific differences in success for a given set of conditions. Of the species used as stakes, black cottonwood, and to some extent red-osier dogwood, had better success than other species in dry, sunny conditions.

- Planting in the fall may produce superior results than planting in the spring. Plants planted in the fall receive rain during winter which increases their potential for establishment because the available moisture allows them to start establishing roots at the beginning of the growing season (note that the timing of this varies and thus is challenging to plan treatments for). Spring plantings are at risk of drought and low reservoir levels because once the leaves bud out, the plant will tend to put resources into leafing out rather than growing roots. However, conifer seedlings are often hard to source from publicly accessible nurseries (1 gallon pots were available but they are considerably more expensive than smaller plugs); thus conifer-based treatments will likely need to continue to be planted in the spring. In some cases sites are also only accessible in the spring, due to low water levels. Where spring planting is required, a summer watering program may be necessary to make spring planting more successful.

- Soil nutrient content may be an important consideration in plant success. Plantings where Sea Soil was added were found to show superior growth, although other confounding factors also likely contributed to success. Other sources of nutrient additions, such as alfalfa meal, could also be considered if the native soils are poor in nutrient content. Providing plants additional nutrients during planting can help the plants become established which may help them be more resilient to environmental stresses, such as anaerobic conditions associated with flooding, which would contribute to their likelihood of survival in the long-term.

- Stakes planted into holes drilled into stumps were less successful than those planted through decaying stumps into the soil below (treatment A-1). Reduced success of stakes planted into drilled holes is likely because a hole that is deep and wide enough to promote plant survival cannot easily be made with a drill (long drill bit extensions are likely to break). Stakes planted into drilled holes were likely moisture stressed even with watering. This method is likely not a cost-effective revegetation method unless the stump can be drilled right through with a machine or is well decayed and soft so that are larger hole can easily be made.

- Cemented soils can be used for erosion resistance. Recommendations made in 2018 (Sections 3.2 and 4.0 in Regehr *et al.* 2018) to loosen hollows in cemented soils but leaving a hardened grid in between hollows to help resist erosion appeared to function well in 2019 for maintaining slope integrity, which encouraged the establishment of vegetation.

- Stumps and rocks brought into planting locations are beneficial for multiple reasons. Stumps and rocks added to a location increase the diversity of the shoreline and may make it appear more natural. Additionally, stumps increase soil organic content, moisture, soil stability, shade, and microhabitat complexity/diversity, and generate additional habitat for future plant establishment. Rocks are also helpful in erosion control and to anchor stumps. However, placement of these materials needs careful consideration. For example, stumps must be planted deep near the high-water line to prevent them from floating away. Further, stumps and rocks can cause boating hazards and must be strategically placed in consideration of public safety. They can also carry weed seeds, and for this reason the ones brought from other locations were washed with a fire hose before transporting them to site.

- Locating weed-free mulch materials can be challenging. Obtaining weed-free mulch was difficult during 2019 planting. Mulch materials were located in some bays where woody bits, bark, needles, and leaves had accumulated and this was found to be a good mulch source. However, there is a general shortage of suitable mulching material and other sources should be explored. Further, mulch materials can easily float or be washed away, thus topping mulch with mineral soil may be beneficial along with the rough and loose treatment.

- Locating cuttings for planting can be difficult. As also noted in 2018, sourcing cottonwood stakes was a limiting factor in 2019 and additional sources need to be identified. Donor sites should be as close to planting sites as possible to maximize genetic suitability of plants selected as donors to the planting site.

- Challenging site access and conditions causes delay and requires extra time and planning. As also noted in 2018, access and conditions can be challenging for some sites. For example, machine access at the Drifwood Bay Group Site (JHT-RV05) would be difficult and for this reason revegetation work at this site was postponed. In addition to the lack of machine access, the soils at this site are cemented and revegetation work is planned for steep slopes which make any work especially challenging. At some locations, boat access may be more efficient

for moving materials (stakes, soil, mulch, and tools). Thus, it is important to evaluate access and plan for anticipated difficulties.

5. BUDGET AND SCHEDULE SUMMARY

Amounts invoiced for the Project from February to November 2019 are presented by component and task in Table 12.

Table 12. JHTWORKS-3 Phase 2 Budget 2019.

Component	Task	Invoice Total
Administration (LKT)	Administration Fee - LKT	$ 12,535.05
Administration (LKT) Total		*$ 12,535.05*
Project Management (Ecofish)	Project Initiation & Tracking - ERL	*$ 15,215.91*
Project Management (Ecofish) Total		*$ 15,215.91*
Phase 2 (Ecofish)	Treatment Trial Permitting, CEMP & Safety	$ 4,793.91
	Treatment Trial Planning & Scheduling	$ 6,054.81
	Updated Revegetation Treatment Plan Report[1]	$ 26,641.81
	Treatment Trial Implementation	$ 22,925.63
	Baseline & Effectiveness Monitoring	$ 5,580.18
Phase 2 (Ecofish) Total		*$ 65,996.34*
Phase 2 (A-Tlegay)	Treatment Trial Implementation (AFS)	$ 26,964.73
Phase 2 (A-Tlegay) Total		*$ 26,964.73*
Total		**$ 120,712.03**

[1] Work on the Updated Revegetation Treatment Plan Report continued into December; thus, the total cost is not reflected here.

6. RECOMMENDATIONS FOR REVEGETATION TRIALS FOR YEAR 3 OF THE TRIAL PROGRAM (PHASE 2)

Lessons learned during the 2019 implementation of treatment trials have been summarized in this report and will be incorporated into future work plans where relevant. Specific recommendations for future years resulting from these lessons can be divided into treatment implementation, planning, and monitoring recommendations.

Treatment recommendations are:

- Plant stakes deeply with a large proportion of the total length under the ground (only 12% to 20% above ground, but a minimum of 0.2 m) to increase survival, especially in sites with high sun exposure;
- Employ fine textured soils for backfilling when possible to increase moisture retention and plant survival;

- Evaluate the amount of sun exposure prior to selecting a final planting site. A Sun Seeker APP could be used to determine hours of sun exposure/shade and allow comparisons of potential planting locations within sites;
- Make use of substrate texturing to provide a favourable microclimate for plants (e.g., the 1.5 m amplitude egg carton style treatment provides organics and hollows that generate some shade for plants);
- Select species to be planted in relation to location-specific conditions (potentially at fine scales), especially when conditions are sub-optimal (e.g., preferentially plant black cottonwood in dry and sunny conditions);
- Implement a watering program for all treatments - all plantings (regardless of planting season) should be watered for their first summer to optimize survival;
- Continue to take advantage of cemented soils by creating loosened hollows for planting but leaving a hardened grid in between hollows to help resist erosion;
- Experiment with other sources of soil nutrient enrichment (e.g., alfalfa meal) when soil at the site is poor in nutrient content; and
- Plant or seed red alder (*Alnus rubra*) above the high-water mark at additional upland sites identified at JHT-RV04 and JHT-RV05.

Planning recommendations are:

- Evaluate access and conditions challenges ahead of time to inform planning and budgeting;
- Field and budget planning for future years should incorporate sourcing stumps, having them dug up by excavator, moved to planting sites by dump truck, and placed by excavator. Forestry operations can be good sources but depending on the area, the stumps may need to be pressure washed to removed weed-infested soil. However, stumps brought into sites require strategic placement above the high water mark and ballast with soil and rock that considers potential public safety issues (e.g., floating away, causing boating hazard);
- Apply for a water use permit for pumping water from the lake to provide adequate water for a watering program;
- To obtain weed-free mulch, explore options of obtaining chip debris from BC Parks or local forestry operations and experiment with topping mulch with mineral soil to reduce losses of mulch to wave action and floatation;
- Given that site JHT-RV05 is not machine accessible from the road and that soils are cemented, bring in supplies by boat and use modified brush layers and backfill by hand/wheelbarrow to create planting substrate.

Monitoring recommendations are:

- Conduct an analysis (and collect field data as required) of the factors that may be contributing to poor stake survival. This would involve correlating survival and key factors such as planting depth, ratio of total length below and above ground, soil type, species, and sun exposure.

The 2020 treatment trials are planned for the spring and fall in 2020. The as-built surveys will be conducted immediately following completion of the treatment trials. The work plan for 2020 treatment trials, will build on information gained during 2019.

Treatment trials will continue to be implemented for the next three years. As discussed in Ballin *et al.* (2018a), the majority of treatments will be implemented in the first three years of the trial program. Although long term treatment outcomes cannot be monitored within this time frame, the early monitoring results of these revegetation trial prescriptions will inform trials implemented in the later years of the program so they may be adapted to information gained and lessons learned. Thus, outcomes from both revegetation works in 2018-2020, which include experience gained during planting and results from monitoring, will be incorporated into recommendations for future years.

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PROJECT MAPS

290000 300000 310000 320000 330000 340000

5540000 5530000 5520000 5510000 5500000

Strathcona Dam

Lower Campbell Lake

Elk River

JHT-RV05

JHT-RV01

JHT-RV02

JHT-RV06

JHT-RV03

Buttle Lake Boat Launch

Buttle Lake Campground

JHT-RV07

JHT-RV04

Upper Campbell Lake

Wolf River

Marblerock Creek

JHT-RV08

Karst Creek Boat Launch

Karst Creek

Phillips Creek

Ralph River Campground

Ralph River

JHT-RV09

bing

290000 300000 310000 320000 330000 340000

JHTWORKS-3 Revegetation Trial Sites

Upper Campbell Reservoir Candidate Revegetation Sites

Legend

- Candidate Revegetation Sites
- Stream

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 1 2 4 6 8 10 km

Scale: 1:200,000

NO.	DATE	REVISION	BY
1	18/07/2017	1230_JHTWORKS3_Overview_2017Jun14	CGA
2			
3			
4			
5			

Date Saved: 18/07/2017
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 2

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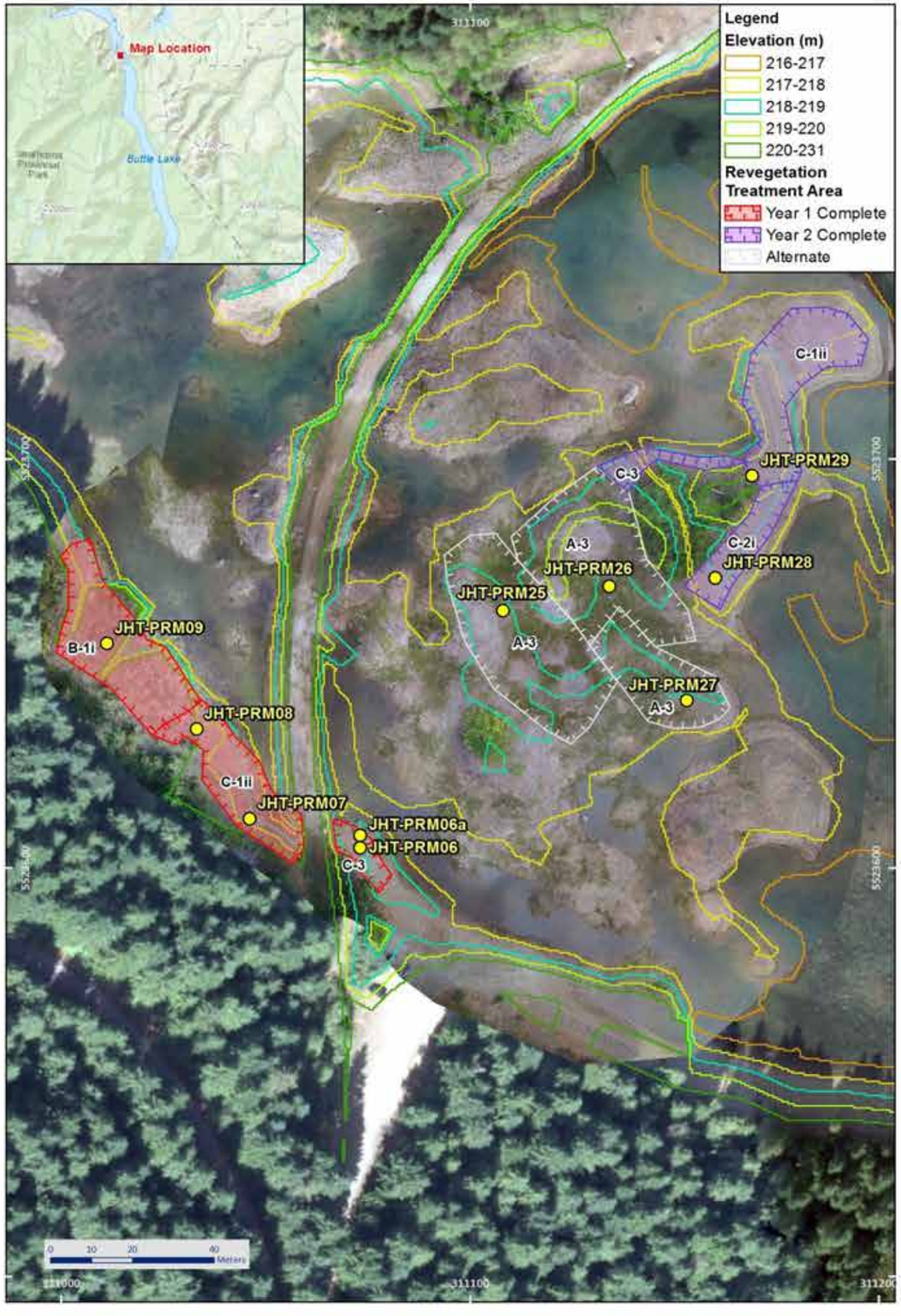
APPENDICES

Appendix A. Site-specific Restoration Profiles Updated to 2019

LIST OF MAPS



Site Description

Old boat launch within a bay with vegetated islets varying in elevation, topography, slope, and exposure. Part of Buttle Lake Campground.

Revegetation Site Attributes

Revegetation Opportunity	
Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - from old boat launch at low water
Known or potential physical works:	JHTWORKS-2 trail and swimming dock installation
Plant species and ecological communities at risk:	None expected
Revegetation Priority	
Visibility:	Highly visible from Driftwood Bay group site (JHT-RV05) and partially visible from Buttle Lake Campground (JHT-RV03) and Westmin Rd.
Public satisfaction:	Abundant area below 219 m; no stumps
Fish and wildlife habitat:	Moderate
Environmental Setting and Disturbance	
Elevation (m):	217-221+
Slope (%):	Majority of highly visible areas 10-33% with flatter areas at elevations 217-218 m
Substrate:	Mix of angular dark and round light gravel and cobble size. Mineral soil on flats.
Natural recruitment:	Natural recruitment occurring (including trees) but constrained by erosion and browsing. North aspect shows better recruitment.
Aspect:	All aspects. East-southeast most visible.
Fetch:	Low - mostly protected in bay
Water availability:	Low on islets, moderate adjacent to upslope forest
Human disturbance:	Moderate adjacent to old boat launch, low on islets
Wildlife disturbance:	Moderate - High (evidence of beaver & geese grazing)
Invasive species:	Moderate

JHTWORKS-3 Revegetation Sites

Old Buttle Boat Launch
JHT-RV02

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-3. Control

B - Moderate Slope Drawdown

PRESCRIPTION

B-1. Complex and/or stabilize substrate (roughen and loosen, terraces). Use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical and available.

i. No planting

C - Steep Upper Drawdown

PRESCRIPTION

C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical and available.

ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).

C-2i. Create excavator loostened circles 0.8 m deep and 1 m diameter, spaced 2 m apart. Stake deciduous species by hand in craters as guided by surveyed elevations (217.8-221.0 m).

C-3. Control

VEGETATION SPECIES

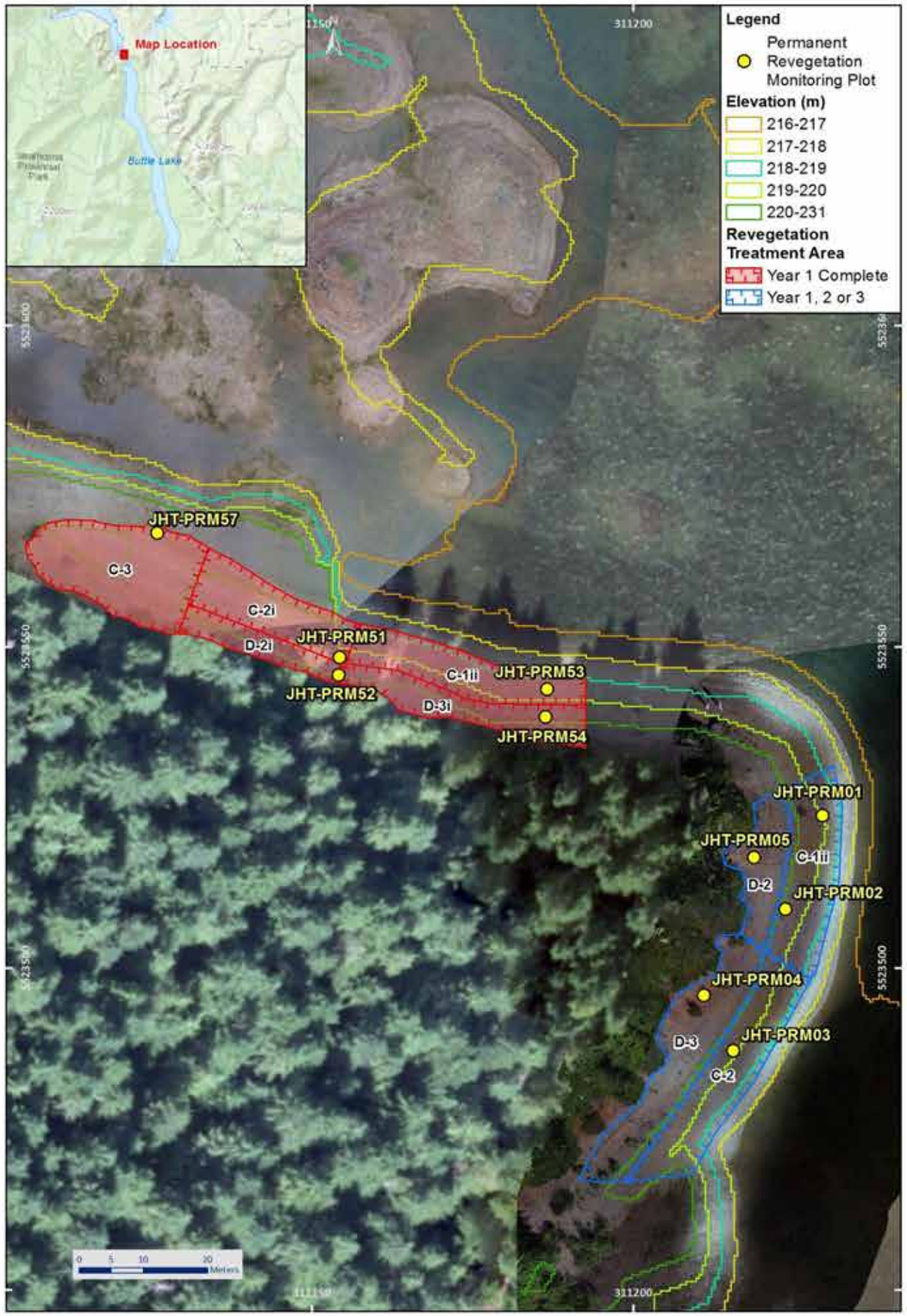
Sitka willow (*Salix sitchensis*)

Black cottonwood (*Populus balsamifera*)

Red-osier dogwood (*Cornus stolonifera*)

ECOFISH RESEARCH

Path: M:\Projects-Active\1230_JHTMON\MXD\Vegetation\Site Profile Sheets\JHTWORKS3_RV02_OldButtleLaunch_3496_20191121.mxd



Site Description

Part of high-use Buttle Lake Campground and linked to beach built from imported sand. Potential revegetation area is adjacent steeper shoreline.

Revegetation Site Attributes

Revegetation Opportunity	
Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - from old boat launch or campground at low water
Known or potential physical works:	JHTWORKS-2 trail and swimming dock installation
Plant species and ecological communities at risk:	None expected
Revegetation Priority	
Visibility:	Highly visible for visitors to Buttle Lake Campground, Buttle Lake boat launch users (JHT-RV06) and boaters in the Narrows. Proposed trail will draw the public to this area for swimming.
Public satisfaction:	Abundant area below 219 m; no stumps
Fish and wildlife habitat:	Moderate - High
Environmental Setting and Disturbance	
Elevation (m):	217-221+
Slope (%):	28-47%
Substrate:	Fines and gravel on flat and lower slopes, with gravel and cobble on steep slopes.
Natural recruitment:	Lower shoreline variably vegetated. Steep slopes adjacent to the beach not vegetated. Recruitment of willow and other trees within southeastern section of bay.
Aspect:	East
Fetch:	Low
Water availability:	Low - Unknown
Human disturbance:	Moderate - walking, boat docking on beach
Wildlife disturbance:	Moderate (evidence of geese & deer grazing)
Invasive species:	Moderate

JHTWORKS-3 Revegetation Sites

Buttle Lake Campground
JHT-RV03

Revegetation Treatment Trials

C - Steep Upper Drawdown

PRESCRIPTION

C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.
ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).
C-2. No site preparation. Stake deciduous species by hand as guided by surveyed elevations (217.8-221.0 m).
C-2i. Create excavator loostened circles 0.8 m deep and 1 m diameter, spaced 2 m apart. Stake deciduous species by hand in craters as guided by surveyed elevations (217.8-221.0 m).
C-3. Control

D - Steep Upland Forest

PRESCRIPTION

D-2. Stake cottonwood by hand
D-2i. Create excavator loosened circles 0.8 m deep and 1 m diameter, spaced 2 m apart. Stake black cottonwood by hand in craters.
D-3. Stabilize bottom of slope with logs and boulders. Add leaf litter/mulch as practical. Stake with cottonwood. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) if available.
D-3i. Stabilize bootom of slope with boulders and stumps along full pool line (220.5 m). Also create and plant excavator loosened circles similar to D-2i.

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Forest species may include:
Shore pine (*Pinus contorta ssp. contorta*)
Western white pine (*Pinus monticola*)
Douglas-fir (*Pseudotsuga menziesii*)
Pacific dogwood (*Cornus nuttali*)
Tall Oregon grape (*Mahonia aquifolium*)
Kinnikinnick (*Arctostaphylus uva-ursi*)

ECOFISH RESEARCH

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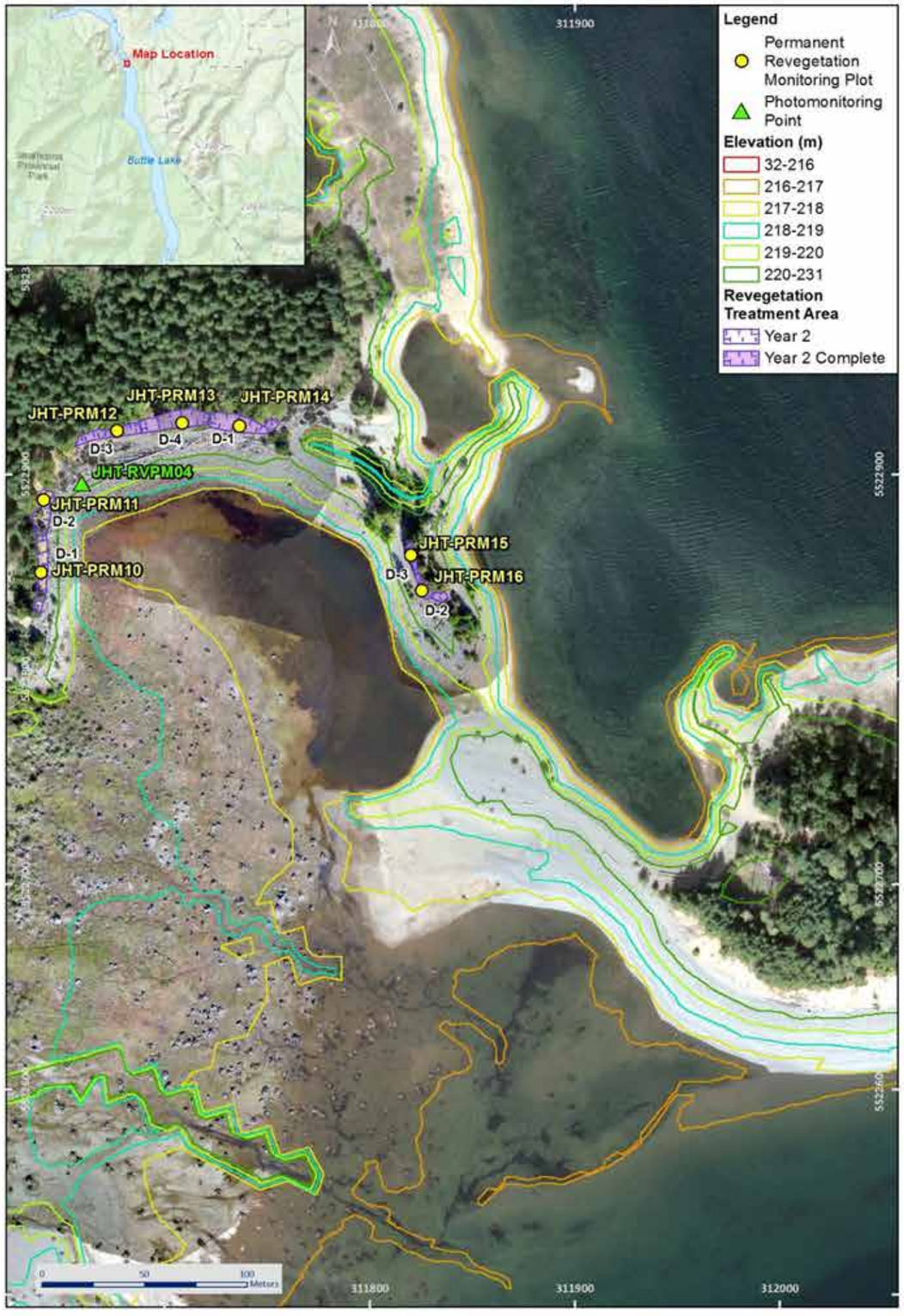

Site Description

High-use site, walk-in campground at Rainbow Island, that provides views up the narrows and to JHT-RV07. The area is comprised of flat areas that are variably vegetated and extensive unvegetated steep slopes including drawdown area and upland eroding forest soils.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Fair - a barge may be required if the existing walking trail is too narrow
Known or potential physical works:	Unknown
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for recreational users walking the beach trail, camping on the island, using the Buttle Lake boat launch (JHT-RV06) and boating in the Narrows
Public satisfaction:	The shoreline slopes to below 219 m. Some areas associated with steep unvegetated shoreline
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Steep upland slopes 47-60%
Substrate:	Gravel and sand in drawdown zone, eroded forest soils upslope.
Natural recruitment:	Recruitment impeded by erosion/deposition and high solar exposure/water deficits. Conifers growing at top of upper drawdown on east aspects. Higher recruitment observed with lower slope.
Aspect:	Variable with a large portion of the site's unvegetated area facing southeast and exposed to a long fetch.
Fetch:	None for upslope areas. High in drawdown.
Water availability:	Low for upslope forest
Human disturbance:	Flat areas heavily used, low on steep upland slopes.
Wildlife disturbance:	Low
Invasive species:	Moderate (high on suitable sites)

JHTWORKS-3 Revegetation Sites

Rainbow Island Marine Site
JHT-RV04

Revegetation Treatment Trials

D - Steep Upland Forest

PRESCRIPTION

D-1. Bioengineer slope with cottonwood modified brush layers installed by hand. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) or other source if available, on the created terraces.
D-2. Stake cottonwood by hand
D-3. Stabilize bottom of slope with logs and boulders. Add leaf litter/mulch as practical. Stake with cottonwood. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) if available.
D-4. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Forest species may include:
Douglas-fir (*Pseudotsuga menziesii*)
Pacific dogwood (*Cornus nuttali*)
Tall Oregon grape (*Mahonia aquifolium*)
Kinnikinnick (*Arctostaphylus uva-ursi*)

ECOFISH RESEARCH

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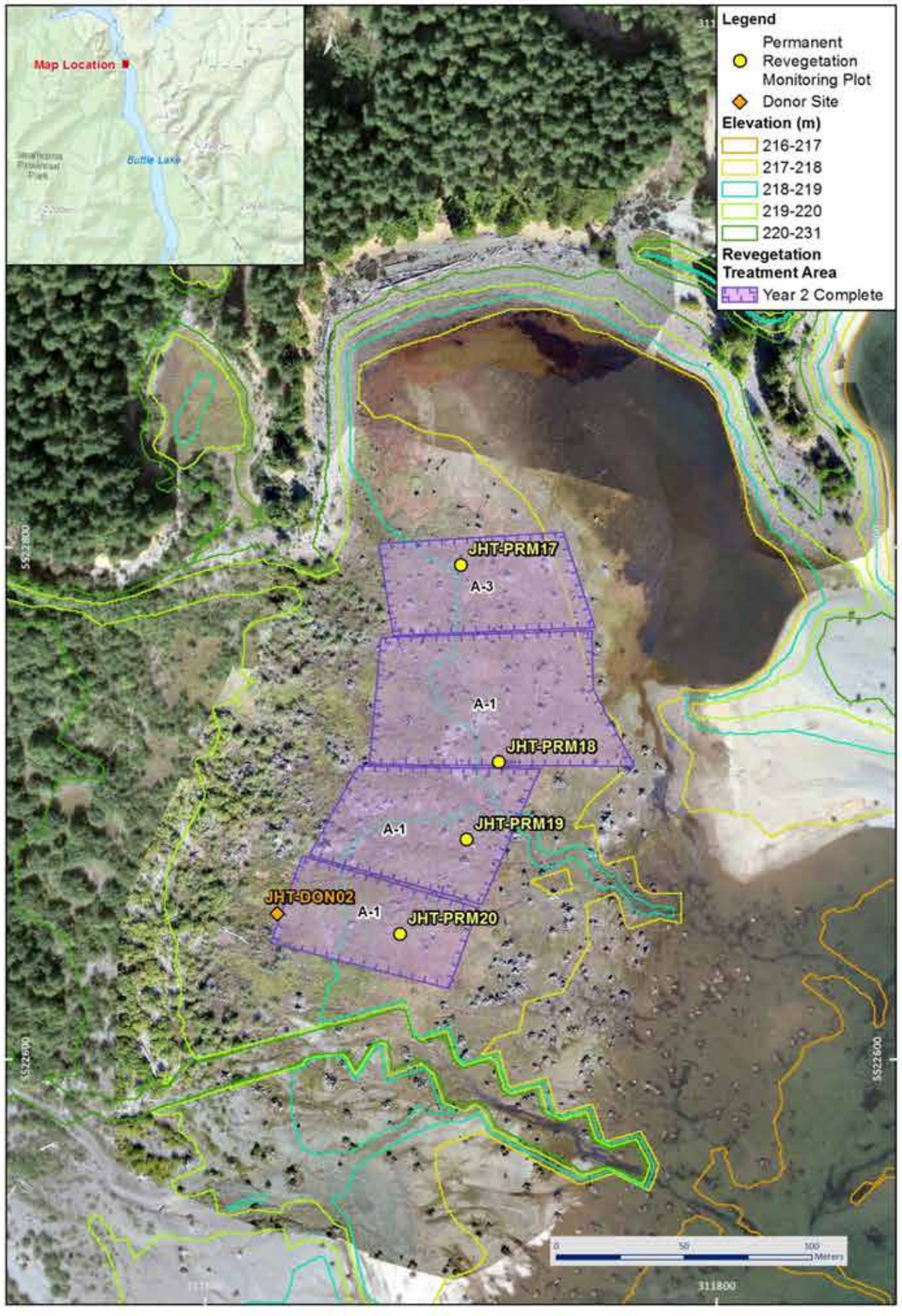

Site Description

Alluvial fan with stumps west of Rainbow Island. Generally very well vegetated above 217.6 m.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Fair - a barge may be required if the existing walking trail is too narrow
Known or potential physical works:	None
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Visible from Rainbow Island (JHT-RV04) and boaters on Buttle Lake.
Public satisfaction:	Extensive low gradient area below 219 m; many stumps present
Fish and wildlife habitat:	High

Environmental Setting and Disturbance

Elevation (m):	217-219+
Slope (%):	1%
Substrate:	Mineral soil, some stumps
Natural recruitment:	High recruitment of vegetation communities typical of the elevation band.
Aspect:	East
Fetch:	Low - disipated by slope
Water availability:	Good - upslope stream and forest and reservoir
Human disturbance:	Low - Nil
Wildlife disturbance:	Moderate
Invasive species:	Low

JHTWORKS-3 Revegetation Sites

Buttle Lake Fan
JHT-RV07

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-1. Select stumps with a top height over 217.8 m, as guided by surveyed elevations, and fill with soil and plant. Plant stumps with tops below 219.8 m with deciduous stakes. Plant stumps with tops above 219.8 m with flood tolerant forest species (where available). Armour with large gravel or cobble.

A-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*)
Forest species may include:
Western hemlock (*Tsuga heterophylla*)
Western redcedar (*Thuja plicata*)
Shore pine (*Pinus contorta ssp. contorta*)
Salal (*Gaultheria shallon*)

ECOFISH RESEARCH

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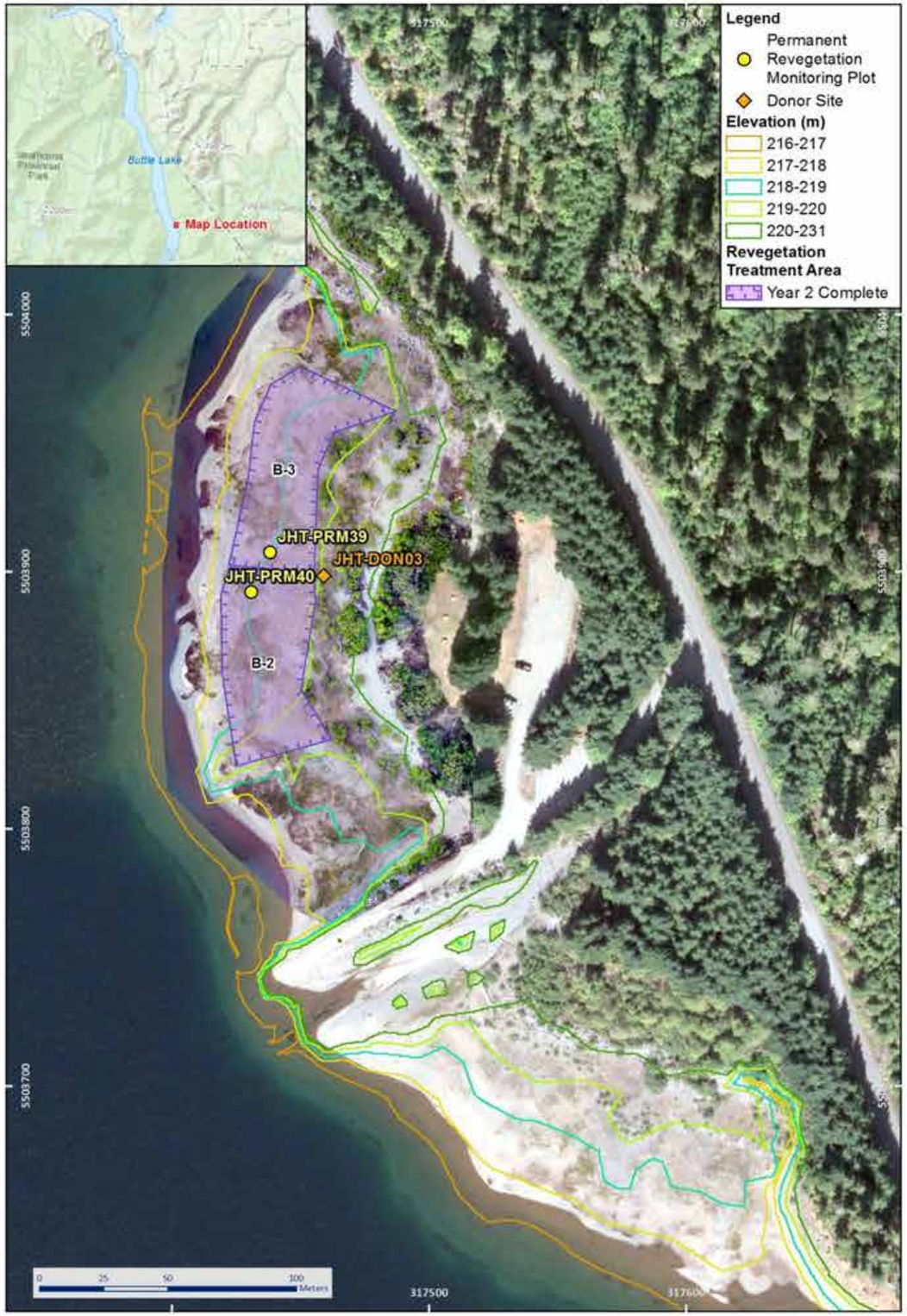

Site Description

Concrete boat launch with variably vegetated areas on either side. Day use area.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Excellent - boat launch
Known or potential physical works:	JHTWORKS-2 boat launch upgrade
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for boat launch users and boaters on Buttle Lake.
Public satisfaction:	Extensive area below 219 m; stumps have been mostly removed
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Majority <6%
Substrate:	Gravel with pockets of mineral soil.
Natural recruitment:	North beach adjacent to creek better vegetated than south.
Aspect:	West (northwest to southwest)
Fetch:	High
Water availability:	Unknown, some subsurface flow from Karst Creek
Human disturbance:	Moderate (to high) - vehicle tracks, trampling, campfires
Wildlife disturbance:	Low
Invasive species:	Low

JHTWORKS-3 Revegetation Sites

Karst Creek Boat Launch
JHT-RV08

Revegetation Treatment Trials

B - Moderate Slope Drawdown

PRESCRIPTION

B-2. No site preparation. Stake deciduous species by hand as guided by surveyed elevations (217.8-221 m).

B-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)

Sitka willow (*Salix sitchensis*)

Red-osier dogwood (*Cornus stolonifera*)

ECOFISH RESEARCH

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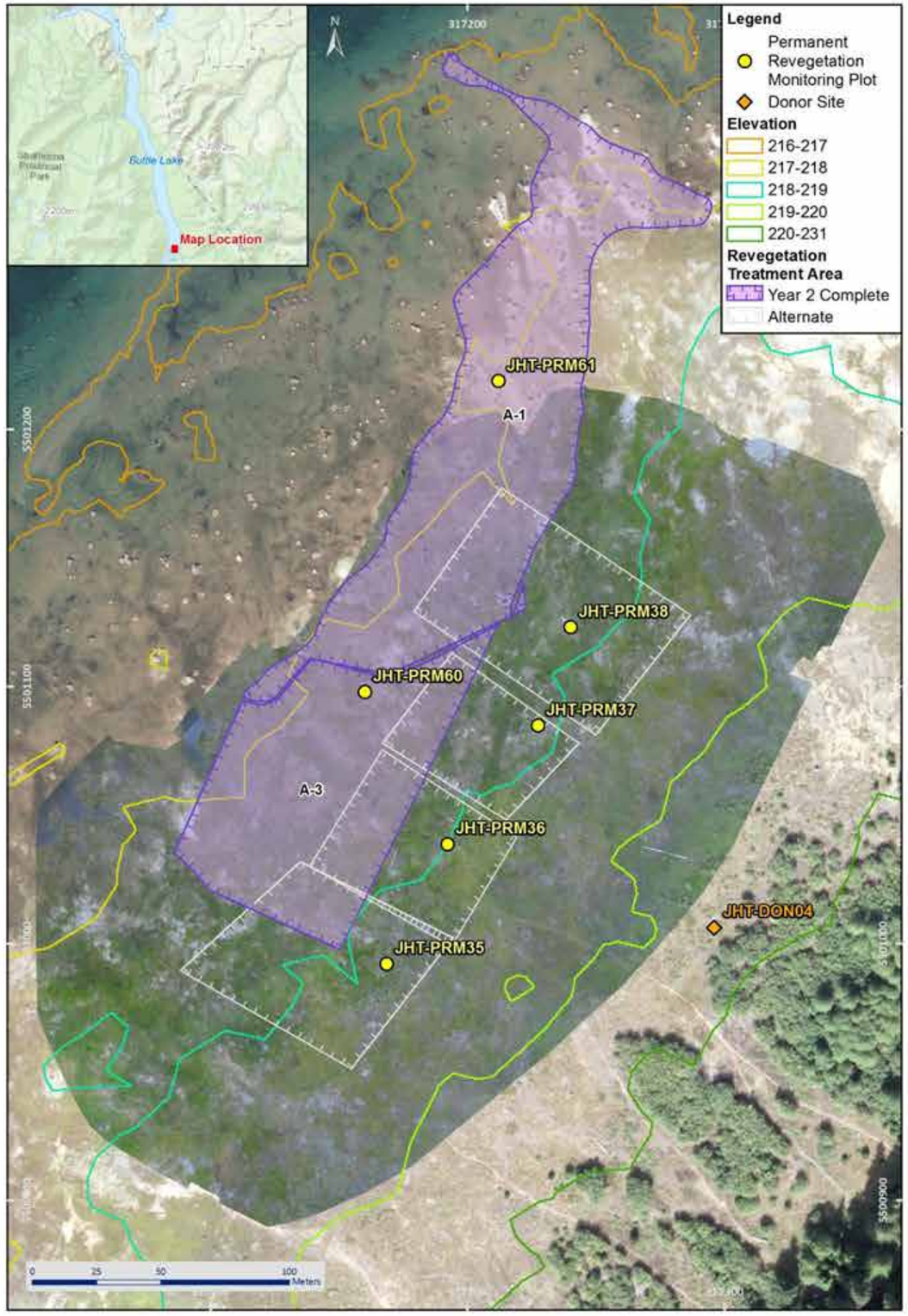

Site Description

Well vegetated expansive alluvial fan adjacent to the Ralph River Campground.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - may require temporary road to access lower elevations
Known or potential physical works:	JHTWORKS-2 trail to swimming area
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for visitors to Ralph River Campground
Public satisfaction:	Extensive area below 219 m; some stumps have been removed while those remaining are at lower elevations
Fish and wildlife habitat:	Moderate - High

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	<2%
Substrate:	Mineral soil
Natural recruitment:	High recruitment of vegetation communities typical of elevation bands.
Aspect:	West (northwest to southwest)
Fetch:	High but effect dispersed by slope
Water availability:	Good; higher at north end by Ralph River
Human disturbance:	Low (to moderate) - trampling, campground
Wildlife disturbance:	Moderate - High (evidence of deer, elk, geese grazing)
Invasive species:	Low - Moderate

JHTWORKS-3 Revegetation Sites

Ralph River Campground
JHT-RV09

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-1. Select stumps with a top height over 217.8 m, as guided by surveyed elevations, and fill with soil and plant. Plant stumps with tops below 219.8 m with deciduous stakes. Plant stumps with tops above 219.8 m with flood

A-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*)
Forest species may include:
Western hemlock (*Tsuga heterophylla*)
Western redcedar (*Thuja plicata*)
Douglas-fir (*Pseudotsuga menziesii*)

ECOFISH RESEARCH

Path: M:\Projects-Active\1230_JHTMON\MXD\Vegetation\Site Profile Sheets\JHTWORKS3_RV09_RalfRiver_3496_20191121.mxd

Appendix B. As-built Site Description Data for Sites Treated in Spring and Fall 2019

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Table 1. Revegetation Treatment and Permanent Monitoring Plot locations, elevations, and dates surveyed.

Treatment Area	Permanent Monitoring Plot	Treatment Type[1]	UTMs (Zone 10U)		Approximate Polygon Elevation (m)	Survey Date
			Easting	Northing		
Old Buttle Lake Boat Launch (JHT-RV02)	JHT-PRM28	C-2i	311160	5523671	218.0	2019-05-01
	JHT-PRM29	C-1ii, C-3[2]	311169	5523696	217.8	2019-05-01
Rainbow Island Marine Campsite (JHT-RV04)	JHT-PRM12	D-3	311677	5522921	224	2019-11-06
	JHT-PRM14	D-1	311736	5522924	223	2019-11-06
	JHT-PRM15	D-3	311820	5522861	223	2019-10-28
	JHT-PRM16	D-2	311825	5522843	223	2019-10-28
Buttle Lake Campground Fan (JHT-RV07)	JHT-PRM18, 19, 20	A-1	311715	5522716	218.5	2019-05-03
Karst Creek Boat Launch (JHT-RV08)	JHT-PRM40	B-2	317431	5503892	218.2	2019-05-02
Ralph River Campground (JHT-RV09)	JHT-PRM61	A-1	317192	5501039	217.8	2019-05-02

[1]As-built data only collected for treatments that involved active restoration, and was not collected for control treatments; treatment data collected for the entire treated area.

[2]Plot located on boundary between two treatment areas.

Table 2. Revegetation Treament vegetation response - structural stage and percent vegetation cover by layer.

Treatment Area	Permanent Monitoring Plot	Treatment Type	Structural Stage[1]	Total Vegetation Cover by Layer (%)				
				A[3]	B1	B2	C	D
Old Buttle Lake Boat Launch (JHT-RV02)	JHT-PRM28	C-2i	3a	0%	1-5%	1-5%	5-25%	0%
	JHT-PRM29	C-1ii, C-3	3a	0%	0%	1-5%	<1%	<1%
Rainbow Island Marine Campsite (JHT-RV04)	JHT-PRM12	D-3	1a	1-5%	0%	5-25%	0%	0%
	JHT-PRM14	D-1	1a	1-5%	0%	0%	0%	1-5%
	JHT-PRM15	D-3	1a	0%	0%	0%	0%	5-25%
	JHT-PRM16	D-2	1a	0%	1-5%	1-5%	1-5%	1-5%
Buttle Lake Campground Fan (JHT-RV07)	JHT-PRM18, 19, 20	A-1	2a	0%	0%	1-5%	>75%	5-25%
Karst Creek Boat Launch (JHT-RV08)	JHT-PRM40	B-2	3a	0%	1-5%	1-5%	25-50%	0%
Ralph River Campground (JHT-RV09)	JHT-PRM36	A-1	2a	0%	0%	<1%	<1%	<1%

[1] Structural stage categories: 1a = sparse, 2a= forb dominated, 3a= low shrub

[2] Vegetation layers: A=tree, B1=tall shrub, B2=short shrub, C=herb, D=moss, lichen and seedling

[3] An increase in A layer vegetation was recorded in the new treatment area location due to the soft edge of the upland forest being included in the treatment area in some locations

Table 3. Revegetation Treament Area environmental setting - aspect, slope, exposure, and substrate.

Treatment Area	Permanent Monitoring Plot	Treatment Type	Aspect (°)	Slope (%)	Exposure	Surface Substrate[1]						
						Cobble	Large Gravel	Small Gravel	Fines	Mineral Soil	Wood	Organic Matter
Old Buttle Lake Boat Launch (JHT-RV02)	JHT-PRM28	C-2i	95	22	full sun		SD	D	SD	SD		
	JHT-PRM29	C-1ii, C-3	85	23	full sun	SD	SD	D	SD			
Rainbow Island Marine Campsite (JHT-RV04)	JHT-PRM12	D-3	120	60	full sun		T		SD	D	T	
	JHT-PRM14	D-1	178	56	full sun		SD		SD	D	SD	
	JHT-PRM15	D-3	239	60	full sun			SD	SD	D	SD	
	JHT-PRM16	D-2	237	47	full shade				D	D	SD	
Buttle Lake Campground Fan (JHT-RV07)	JHT-PRM18, 19, 20	A-1	90	1	full sun			SD	D	T	T	T
Karst Creek Boat Launch (JHT-RV08)	JHT-PRM40	B-2	220	4	full sun	T	T	SD	D	T	T	
Ralph River Campground (JHT-RV09)	JHT-PRM36	A-1	290	1	full sun				D	T	T	T

[1] D = dominate, SD = subdominant, T = trace

Table 4. Revegetation Treament Area environmental setting - microtopography, surface shape, soil moisture, water source.

Treatment Area	Permanent Monitoring Plot	Treatment Type	Microtopography	Surface Shape	Soil Moisture	Water Source
Old Buttle Lake Boat Launch (JHT-RV02)	JHT-PRM28	C-2i	mounded	convex	subxeric	rain, flood
	JHT-PRM29	C-1ii, C-3	mounded	straight	submesic	rain, flood
Rainbow Island Marine Campsite (JHT-RV04)	JHT-PRM12	D-3	smooth	straight	very xeric	precipitation, seepage (upslope runoff)
	JHT-PRM14	D-1	smooth	straight	very xeric	precipitation/ seepage (upslope runoff)
	JHT-PRM15	D-3	smooth	straight	very xeric	precipitation, seepage (upslope runoff)
	JHT-PRM16	D-2	smooth	straight	very xeric	precipitation, seepage (upslope runoff)
Buttle Lake Campground Fan (JHT-RV07)	JHT-PRM18, 19, 20	A-1	smooth	straight	hygric	rain/flood
Karst Creek Boat Launch (JHT-RV08)	JHT-PRM40	B-2	undulating	straight	subhygric	rain/flood
Ralph River Campground (JHT-RV09)	JHT-PRM36	A-1	smooth	straight	submesic	rain/flood

Table 5. Revegetation Treament Area environmental setting and disturbance factors.

Treatment Area	Permanent Monitoring Plot	Treatment Type	Fetch[1]	Erosion[1]	Deposition[1]	Wood debris[1]	Wildlife, Disease or Insect Damage[1]	Human Disturbances[1]	Invasive Species[1]	Other Site Disturbances[1]
Old Buttle Lake Boat Launch (JHT-RV02)	JHT-PRM28	C-2i	L	M	L	L	L	M	L	L
	JHT-PRM29	C-1ii, C-3	N	M	L	L	N	M	N	N
Rainbow Island Marine Campsite (JHT-RV04)	JHT-PRM12	D-3	N	M	M	L	N	M	N	
	JHT-PRM14	D-1	N	H	H	L	N	M	N	N
	JHT-PRM15	D-3	N	M	M	L	N	M	N	N
	JHT-PRM16	D-2	N	H	M	L	N	M	L	N
Buttle Lake Campground Fan (JHT-RV07)	JHT-PRM18, 19, 20	A-1	M	L	M	H	N	M	L	N
Karst Creek Boat Launch (JHT-RV08)	JHT-PRM40	B-2	H	M	L	L	N	M	N	N
Ralph River Campground (JHT-RV09)	JHT-PRM36	A-1	M	L	L	M	N	M	N	N

[1]H = high, M = moderate, L = low, N = none

Table 6. Measured abundance of tree species in permanent monitoring plots.

Treatment Area	Permanent Monitoring Plot	Treatment Type	black cottonwood (*Populus balsamifera ssp. trichocarpa*)	shore pine (*Pinus contorta var. contorta*)	*All tree species*
Old Buttle Lake Boat Launch (JHT-RV02)	JHT-PRM28	C-2	2	3	*5*
	JHT-PRM29	C-1ii, C-3	21	0	*21*
Rainbow Island Marine Campsite (RV04)	JHT-PRM12	D-3	11	0	*11*
	JHT-PRM13	D-4	0	0	*0*
	JHT-PRM14	D-1	16	0	*16*
	JHT-PRM15	D-3	21	4	*25*
	JHT-PRM16	D-2	78	0	*78*
Buttle Lake Campground Fan (JHT-RV07)	JHT-PRM17	A-1	0	0	*0*
	JHT-PRM18	A-1	2	0	*2*
	JHT-PRM19	A-1	1	0	*1*
	JHT-PRM20	A-1	0	0	*0*
Karst Creek Boat Launch (JHT-RV08)	JHT-PRM40	B-2	0	0	*0*
Ralph River Campground (JHT-RV09)	JHT-PRM35	A-1	0	0	*0*
	JHT-PRM36	A-1	0	0	*0*
	JHT-PRM37	A-1	0	0	*0*
	JHT-PRM38	A-1	0	0	*0*
	JHT-PRM60	A-3	0	0	*0*
	JHT-PRM61	A-1	0	0	*0*

Table 7. Measured abundance of shrub species in permanent revegetation monitoring plots.

Treatment Area	Permanent Monitoring Plot	Treatment Type	red-osier dogwood (*Cornus stolonifera*)	Kinnikinnick (*Arctostaphylos uva-ursi*)	red huckleberry (*Vaccinium parvifolium*)	salal (*Gaultheria shallon*)	tall Oregon-grape (*Mahonia aquifolium*)	trailing blackberry (*Rubus ursinus*)	willow (*Salix sp.*)	Scotch broom (*Cytisus scoparius*)**	*All shrub species*
Old Buttle Lake Boat Launch (JHT-RV02)	JHT-PRM28	C-2	1	0	0	0	0	0	14	0	*1*
	JHT-PRM29	C-1ii, C-3	0	0	0	0	0	0	20	0	*0*
Rainbow Island Marine Campsite (RV04)	JHT-PRM12	D-3	0	1	1	0	6	0	0	0	*8*
	JHT-PRM13	D-4	0	0	0	0	0	0	0	3	*0*
	JHT-PRM14	D-1	0	0	0	0	0	0	15	0	*0*
	JHT-PRM15	D-3	0	2	0	3	6	0	0	0	*11*
	JHT-PRM16	D-2	0	0	0	0	0	2	0	0	*2*
Buttle Lake Campground Fan (JHT-RV07)	JHT-PRM17	A-1	0	0	0	0	0	0	165	0	*0*
	JHT-PRM18	A-1	1	0	0	0	0	0	81	0	*1*
	JHT-PRM19	A-1	0	0	0	0	0	0	58	0	*0*
	JHT-PRM20	A-1	0	0	0	0	0	0	18	0	*0*
Karst Creek Boat Launch (JHT-RV08)	JHT-PRM40	B-2	4	0	0	0	0	0	115	0	*4*
Ralph River Campground (JHT-RV09)	JHT-PRM35	A-1	0	0	0	0	0	0	15	0	*0*
	JHT-PRM36	A-1	0	0	0	0	0	0	17	0	*0*
	JHT-PRM37	A-1	0	0	0	0	0	0	65	0	*0*
	JHT-PRM38	A-1	0	0	0	0	0	0	0	0	*0*
	JHT-PRM60	A3	0	0	0	0	0	0	0	0	*0*
	JHT-PRM61	A-1	0	0	0	0	0	0	1	0	*0*

**Invasive species

Appendix C. Monitoring Data from Permanent Revegetation Monitoring Plots 2017–2019

LIST OF TABLES

Table 1. Location of permanent monitoring plots monitored between 2017 to 2019.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	UTM (Zone 10U)	
				Easting	Northing
Old Buttle Lake Boat Launch (JHT-RV02)	Fall 2018	JHT-PRM06a	C-3	311073	5523608
		JHT-PRM07	C-1ii	311046	5523612
		JHT-PRM08	C-1ii	311033	5523634
		JHT-PRM09	B-1i	311011	5523655
	Not Treated	JHT-PRM25	A-3	311108	5523663
		JHT-PRM26	A-3	311134	5523669
		JHT-PRM27	A-3	311153	5523641
	Spring 2019	JHT-PRM28	C-2i	311160	5523671
		JHT-PRM29	C-1ii, C-3[1]	311169	5523696
Buttle Lake Campground (JHT-RV03)	Not Treated	JHT-PRM01	C-1ii	311229	5523524
		JHT-PRM02	C1ii	311224	5523509
		JHT-PRM03	C-2	311216	5523487
		JHT-PRM04	D-2	311211	5523496
		JHT-PRM05	D-3	311219	5523517
	Fall 2018	JHT-PRM51	C-2i	311150	5523550
		JHT-PRM52	D-2i	311148	5523547
		JHT-PRM53	C-1ii	311192	5523542
		JHT-PRM54	C-1ii	311189	5523543
		JHT-PRM57	C-3	311123	5523563
Rainbow Island Marine Campsite (JHT-RV04)	Not Treated	JHT-PRM10	D-1	311640	5522852
		JHT-PRM11	D-2	311641	5522888
	Fall 2019	JHT-PRM12	D-3	311677	5522921
		JHT-PRM13	D-4	311708	5522925
		JHT-PRM14	D-1	311736	5522924
		JHT-PRM15	D-3	311820	5522861
		JHT-PRM16	D-2	311825	5522843
Driftwood Bay Group Site (JHT-RV05)	Not Treated	JHT-PRM30	B-3	311462	5523904
		JHT-PRM31	B-1ii	311481	5523941
		JHT-PRM32	B-2i	311494	5523969
		JHT-PRM33	C-1ii	311470	5524036
		JHT-PRM34	C-1ii	311416	5524180

[1] Plot on boundary of two treatment areas.

Table 1. Continued.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	UTM (Zone 10U)	
				Easting	Northing
Buttle Lake Boat Launch (JHT-RV06)	Fall 2018	JHT-PRM21	C-2i	312034	5523143
		JHT-PRM22	C-1ii	312071	5523109
		JHT-PRM23	C-3	312103	5523088
		JHT-PRM24	C-3	312151	5523042
	Not Treated	JHT-PRM41	C-3	311775	5523489
		JHT-PRM42	C-1ii	311764	5523479
		JHT-PRM43	C-1ii	311810	5523397
		JHT-PRM44	C-3	311840	5523356
		JHT-PRM45	C-1ii	311866	5523315
		JHT-PRM46	D-4	311876	5523316
		JHT-PRM47	C-2	311901	5523275
		JHT-PRM48	D-1	311922	5523291
		JHT-PRM49	C-1ii	311911	5523309
	Fall 2018	JHT-PRM50	B-3	311987	5523202
		JHT-PRM56	B-2i	311995	5523243
Buttle Lake Campground Fan (JHT-RV07)	Spring 2019	JHT-PRM17	A-3	311700	5522793
		JHT-PRM18	A-1	311715	5522716
		JHT-PRM19	A-1	311702	5522686
		JHT-PRM20	A-1	311676	5522649
Karst Creek Boat Launch (JHT-RV08)	Spring 2019	JHT-PRM39	B-3	317438	5503908
		JHT-PRM40	B-2	317431	5503892
Ralph River Campground (JHT-RV09)	Not Treated	JHT-PRM35	A-1	317168	5500992
		JHT-PRM36	A-1	317192	5501039
		JHT-PRM37	A-1	317227	5501085
		JHT-PRM38	A-1	317240	5501123
	Spring 2019	JHT-PRM60	A-3	317160	5501098
		JHT-PRM61	A-1	317212	5501219

[1] Plot on boundary of two treatment areas.

Table 2. Measured abundance of tree species in permanent monitoring plots collected in fall 2019.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red alder (*Alnus rubra*)	Douglas-fir (*Pseudotsuga menziesii*)	western redcedar (*Thuja plicata*)	lodgepole pine (*Pinus contorta var. latifolia*)	shore pine (*Pinus contorta var. contorta*)	western hemlock (*Tsuga heterophylla*)	western white pine (*Pinus monticola*)	*Total # of trees/ plot*
Old Buttle Lake Boat Launch (JHT-RV02)	Fall 2018	JHT-PRM06a	C-3	0	0	0	0	0	0	0	0	*0*
		JHT-PRM07	C-1ii	0	1	0	0	0	0	0	0	*1*
		JHT-PRM08	C-1ii	0	0	0	0	0	0	0	0	*0*
		JHT-PRM09	B-1i	0	0	0	0	0	0	0	0	*0*
	Not Treated	JHT-PRM25	A-3	0	0	0	0	0	0	0	0	*0*
		JHT-PRM26	A-3	0	0	0	0	0	0	0	0	*0*
		JHT-PRM27	A-3	0	0	0	0	0	0	0	0	*0*
	Spring 2019	JHT-PRM28	C-2i	2	0	0	0	0	0	0	3	*5*
		JHT-PRM29	C-1ii, C-3	20	0	0	0	0	0	0	0	*20*
Buttle Lake Campground (JHT-RV03)	Not Treated	JHT-PRM01	C-1ii	0	0	0	0	0	0	0	0	*0*
		JHT-PRM02	C1ii	0	0	0	0	0	0	0	0	*0*
		JHT-PRM03	C-2	0	0	0	0	0	0	0	0	*0*
		JHT-PRM04	D-2	0	0	1	0	1	0	1	0	*3*
		JHT-PRM05	D-3	0	0	0	0	0	0	0	0	*0*
	Fall 2018	JHT-PRM51	C-2i	3	0	0	0	0	0	1	0	*4*
		JHT-PRM52	D-2i	6	0	0	0	0	0	1	2	*9*
		JHT-PRM53	C-1ii	2	0	0	0	0	0	0	0	*2*
		JHT-PRM54	C-1ii	6	0	0	2	0	1	3	0	*12*
		JHT-PRM57	C-3	1	0	0	0	0	0	0	0	*1*
Rainbow Island Marine Campsite (RV04)	Not Treated	JHT-PRM10	D-1	0	0	3	0	0	0	0	2	*5*
		JHT-PRM11	D-2	0	0	0	0	0	0	0	0	*0*
	Fall 2019	JHT-PRM12	D-3	11	0	0	0	0	0	0	0	*11*
		JHT-PRM13	D-4	0	0	0	0	0	0	0	0	*0*
		JHT-PRM14	D-1	16	0	0	0	0	0	0	0	*16*
		JHT-PRM15	D-3	21	0	0	0	0	4	0	0	*25*
		JHT-PRM16	D-2	78	0	0	0	0	0	0	0	*78*

Table 2. Continued.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red alder (*Alnus rubra*)	Douglas-fir (*Pseudotsuga menziesii*)	western redcedar (*Thuja plicata*)	lodgepole pine (*Pinus contorta var. latifolia*)	shore pine (*Pinus contorta var. contorta*)	western hemlock (*Tsuga heterophylla*)	western white pine (*Pinus monticola*)	*Total # of trees/ plot*
Buttle Lake Boat Launch (JHT-RV06)	Fall 2018	JHT-PRM21	C-2i	0	0	0	0	0	0	0	0	*0*
		JHT-PRM22	C-1ii	0	0	0	0	0	0	0	0	*0*
		JHT-PRM23	C-3	0	0	0	0	0	0	0	0	*0*
		JHT-PRM24	C-3	0	0	0	0	0	0	0	0	*0*
	Not Treated	JHT-PRM45	C-1ii	0	0	0	0	0	0	0	0	*0*
		JHT-PRM46	D-4	0	0	3	0	0	0	0	1	*4*
		JHT-PRM47	C-2	0	0	0	0	0	0	0	0	*0*
		JHT-PRM48	D-1	0	0	1	0	0	0	1	0	*2*
		JHT-PRM49	C-1ii	0	0	0	0	0	0	0	0	*0*
	Fall 2018	JHT-PRM50	B-3	0	0	0	0	0	0	0	0	*0*
		JHT-PRM56	B-2i	0	6	0	0	0	0	0	0	*6*
Buttle Lake Campground Fan (JHT-RV07)	Spring 2019	JHT-PRM17	A-3	1	0	0	0	0	0	0	0	*1*
		JHT-PRM18	A-1	7	0	0	0	0	0	0	0	*7*
		JHT-PRM19	A-1	3	0	0	0	0	0	0	0	*3*
		JHT-PRM20	A-1	0	0	0	0	0	0	0	0	*0*
Karst Creek Boat Launch (JHT-RV08)	Spring 2019	JHT-PRM39	B-3	0	0	0	0	0	0	0	0	*0*
		JHT-PRM40	B-2	0	0	0	0	0	0	0	0	*0*
Ralph River Campground (JHT-RV09)[1]	Not Treated	JHT-PRM35	A-1	0	0	0	0	0	0	0	0	*0*
		JHT-PRM36	A-1	0	0	0	0	0	0	0	0	*0*
		JHT-PRM37	A-1	0	0	0	0	0	0	0	0	*0*
		JHT-PRM38	A-1	0	0	0	0	0	0	0	0	*0*
	Spring 2019	JHT-PRM60	A-3	0	0	0	0	0	0	0	0	*0*
		JHT-PRM61	A-1	0	0	0	0	0	0	0	0	*0*

[1] This is also fall 2019 as-built data

[2] Invasive species

Table 3. Measured abundance of shrub species in permanent monitoring plots collected in fall 2019.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	Oregon-grape (*Mahonia sp.*)	hardhack (*Spiraea douglasii*)	Kinnikinnick (*Arctostaphylos uva-ursi*)	Pacific ninebark (*Physocarpus capitatus*)	red huckleberry (*Vaccinium parvifolium*)	red-flowering currant (*Ribes sanguineum*)	red-osier dogwood (*Cornus stolonifera*)	salmonberry (*Rubus spectabilis*)	thimbleberry (*Rubus parviflorus*)	Red Raspberry (*Rubus idaeus*)	trailing blackberry (*Rubus ursinus*)	Raspberry family (*Rubus sp.*)	salal (*Gaultheria shallon*)	willow (*Salix sp.*)	Scotch broom (*Cytisus scoparius*)[1]	Himalayan blackberry (*Rubus armeniacus*)[1]	*Total # of shrubs/ plot*
Old Buttle Lake Boat Launch (JHT-RV02)	Fall 2018	JHT-PRM06a	C-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
		JHT-PRM07	C-1ii	0	0	0	0	0	0	3	0	0	0	0	0	0	47	0	0	*50*
		JHT-PRM08	C-1ii	0	0	0	0	0	0	1	0	0	0	0	0	0	36	0	0	*37*
		JHT-PRM09	B-1i	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	*4*
	Not Treated	JHT-PRM25	A-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
		JHT-PRM26	A-3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	*2*
		JHT-PRM27	A-3	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	*38*
	Spring 2019	JHT-PRM28	C-2i	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	0	*13*
		JHT-PRM29	C-1ii, C-3	0	0	0	0	0	0	3	0	0	0	0	0	0	30	0	0	*33*
Buttle Lake Campground (JHT-RV03)	Not Treated	JHT-PRM01	C-1ii	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	*1*
		JHT-PRM02	C1ii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
		JHT-PRM03	C-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
		JHT-PRM04	D-2	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*39*
		JHT-PRM05	D-3	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	*6*
	Fall 2018	JHT-PRM51	C-2i	0	0	0	0	0	0	6	0	5	0	0	0	0	30	0	0	*41*
		JHT-PRM52	D-2i	2	0	0	0	7	0	6	0	0	0	6	0	6	30	0	0	*57*
		JHT-PRM53	C-1ii	0	0	0	0	0	0	5	0	0	0	0	0	0	48	0	0	*53*
		JHT-PRM54	C-1ii	0	0	0	0	8	0	0	0	0	0	0	0	76	21	0	0	*105*
		JHT-PRM57	C-3	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	*3*
Rainbow Island Marine Campsite (RV04)	Not Treated	JHT-PRM10	D-1	0	0	0	0	1	0	0	0	0	0	3	0	0	0	2	0	*6*
		JHT-PRM11	D-2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	2	0	*5*
	Fall 2019	JHT-PRM12	D-3	6	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	*8*
		JHT-PRM13	D-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	*3*
		JHT-PRM14	D-1	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	*15*
		JHT-PRM15	D-3	6	0	2	0	0	0	0	0	0	0	0	0	3	0	0	0	*11*
		JHT-PRM16	D-2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	*2*

Table 3. Continued.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	Oregon-grape (*Mahonia sp.*)	hardhack (*Spiraea douglasii*)	Kinnikinnick (*Arctostaphylos uva-ursi*)	Pacific ninebark (*Physocarpus capitatus*)	red huckleberry (*Vaccinium parvifolium*)	red-flowering currant (*Ribes sanguineum*)	red-osier dogwood (*Cornus stolonifera*)	salmonberry (*Rubus spectabilis*)	thimbleberry (*Rubus parviflorus*)	Red Raspberry (*Rubus idaeus*)	trailing blackberry (*Rubus ursinus*)	Raspberry family (*Rubus sp.*)	salal (*Gaultheria shallon*)	willow (*Salix sp.*)	Scotch broom (*Cytisus scoparius*)[1]	Himalayan blackberry (*Rubus armeniacus*)[1]	*Total # of shrubs/ plot*
Buttle Lake Boat Launch (JHT-RV06)	Fall 2018	JHT-PRM21	C-2i	0	0	0	0	0	0	8	0	0	0	0	0	0	16	0	0	*24*
		JHT-PRM22	C-1ii	0	0	0	0	0	0	5	0	0	0	0	0	0	46	0	0	*51*
		JHT-PRM23	C-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
		JHT-PRM24	C-3	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	*11*
	Not Treated	JHT-PRM45	C-1ii	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
		JHT-PRM46	D-4	0	0	0	0	4	4	3	3	11	0	1	0	23	0	0	0	*49*
		JHT-PRM47	C-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
		JHT-PRM48	D-1	0	0	0	0	1	0	1	0	0	0	0	0	0	2	0	0	*4*
		JHT-PRM49	C-1ii	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	*1*
	Fall 2018	JHT-PRM50	B-3	0	0	0	0	0	0	14	0	0	0	0	0	0	19	0	0	*33*
		JHT-PRM56	B-2i	0	0	0	0	0	0	0	7	0	0	0	0	0	21	0	1	*29*
Buttle Lake Campground Fan (JHT-RV07)	Spring 2019	JHT-PRM17	A-3	0	2	0	0	0	0	0	0	0	0	0	1	0	188	0	0	*191*
		JHT-PRM18	A-1	0	2	0	0	0	0	1	0	0	4	0	0	0	164	0	0	*171*
		JHT-PRM19	A-1	0	32	0	4	0	0	0	0	0	0	0	0	0	65	0	0	*101*
		JHT-PRM20	A-1	0	27	0	2	0	0	0	0	0	0	0	0	0	42	0	0	*71*
Karst Creek Boat Launch (JHT-RV08)	Spring 2019	JHT-PRM39	B-3	0	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	*108*
		JHT-PRM40	B-2	0	0	0	0	0	0	1	0	0	0	0	0	0	102	0	0	*103*
Ralph River Campground (JHT-RV09)[1]	Not Treated	JHT-PRM35	A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	91	0	0	*91*
		JHT-PRM36	A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	*14*
		JHT-PRM37	A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0	*33*
		JHT-PRM38	A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	0	*58*
	Spring 2019	JHT-PRM60	A-3	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	*7*
		JHT-PRM61	A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	*4*

[1] This is also fall 2019 as-built data

[2] Invasive species

Table 4. Survival of plants (change in number of stems) in permanent monitoring plots 2017-2019.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	Stems per Plot								Treatment Survival (%)	Change from Baseline (%)
				Fall 2017		Fall 2018		Spring 2019		Fall 2019			
				Live Stems	Dead Stems	Live Stems	Dead Stems	Live Stems	Dead Stems	Live Stems	Dead Stems		
Old Buttle Lake Boat Launch (JHT-RV02)	Fall 2018	JHT-PRM06/06a	C-3	15	0			0	0	0	0	-	-100
		JHT-PRM07	C-1ii	17	4	42	0	0	0	51	18	121	200
		JHT-PRM08	C-1ii	4	1	65	0	0	0	37	28	57	825
		JHT-PRM09	B-1i	3	0	0	0	0	0	4	0	-	33
	Not Treated	JHT-PRM25	A-3	4	2					0	0	-	-100
		JHT-PRM26	A-3	4	0					2	0	-	-50
		JHT-PRM27	A3	61	2					38	2	-	-38
	Spring 2019	JHT-PRM28	C-2	4	1			20	8	18	8	-	350
		JHT-PRM29	C-1ii, C-3	47	0			41	6	53	5	-	13
Buttle Lake Campground (JHT-RV03)	Not Treated	JHT-PRM01	C-1ii	1	0					1	0	-	0
		JHT-PRM02	C-1ii	0	0					0	0	-	0
		JHT-PRM03	C-2	0	0					0	0	-	0
		JHT-PRM04	D-3	83	44					42	1	-	-49
		JHT-PRM05	D-2	15	13					6	0	-	-60
	Fall 2018	JHT-PRM51	C-2i	10[1]	0[1]	86	0	0	0	45	28	52	350
		JHT-PRM52	D-2i	25[1]	1[1]	79	1	0	0	66	12	84	164
		JHT-PRM53	C-1ii	5[1]	0[1]	110	42	0	0	55	28	50	1,000
		JHT-PRM54	D-3i	36[1]	0[1]	60	0	0	0	117	7	195	225
		JHT-PRM57	C-3			3	0	3	0	4	0	133	-
Rainbow Island Marine Campsite (JHT-RV04)	Not Treated	JHT-PRM10	D-1	15	0					11	1	-	-27
		JHT-PRM11	D-2	4	0					5	0	-	25
	Fall 2019	JHT-PRM12	D-3	5	0					19	0	-	280
		JHT-PRM13	D-4	2	0					3	0	-	50
		JHT-PRM14	D-1	1	0					31	0	-	3,000
		JHT-PRM15	D-3	1	0					36	0	-	3,500
		JHT-PRM16	D-2	9	5					80	0	-	789

[1] Baseline collected on November 7, 2018.

Table 4. Continued.

Treatment Area	Treatment Season	Permanent Monitoring Plot	Treatment Type	Stems per Plot								Treatment Survival (%)	Change from Baseline (%)
				Fall 2017		Fall 2018		Spring 2019		Fall 2019			
				Live Stems	Dead Stems	Live Stems	Dead Stems	Live Stems	Dead Stems	Live Stems	Dead Stems		
Buttle Lake Boat Launch (JHT-RV06)	Fall 2018	JHT-PRM21	C-2i	3	0	30	0	0	0	24	4	80	700
		JHT-PRM22	C-1ii	18	0	67	0	52	0	51	7	76	183
		JHT-PRM23	C-3	0	0	0	0	0	0	0	0	-	0
		JHT-PRM24	C-3	19	2					11	0	-	-42
	Not Treated	JHT-PRM41	C-3	19	0							-	-
		JHT-PRM42	C-1ii	16	0							-	-
		JHT-PRM43	C-1ii	0	0							-	-
		JHT-PRM44	C-3	0	0							-	-
		JHT-PRM45	C-1ii	1	0					1	0	-	0
		JHT-PRM46	D-4	83	1					53	0	-	-36
		JHT-PRM47	C-2	0	0					0	0	-	0
		JHT-PRM48	D-1	6	2					1	0	-	-83
		JHT-PRM49	C-1ii	1	0					1	0	-	0
	Fall 2018	JHT-PRM50	B-2i			76	0	0	0	33	4	43	0
		JHT-PRM56	B-3			28	1	0	0	35	0	125	0
Buttle Lake Campground Fan (JHT-RV07)	Spring 2019	JHT-PRM17	A-1	264	26			165	0	192	0	116	-27
		JHT-PRM18	A-1	156	26			84	0	178	0	212	14
		JHT-PRM19	A-1	61	2			59	0	104	0	176	70
		JHT-PRM20	A-1	6	0			18	0	71	0	394	1,083
Karst Creek Boat Launch (JHT-RV08)	Spring 2019	JHT-PRM39	B-3	132	5					108	0	-	-18
		JHT-PRM40	B-2	70	2			119	4	103	1	87	47
Ralph River Campground (JHT-RV09)	Not Treated	JHT-PRM35	A-1	135	6			15	0	91	0	607	-33
		JHT-PRM36	A-1	18	0			17	0	14	0	82	-22
		JHT-PRM37	A-1	62	1			65	0	33	1	51	-47
		JHT-PRM38	A-1	49	1			91	0	58	0	64	18
	Spring 2019	JHT-PRM60	A-3					0	0	7	0	-	-
		JHT-PRM61	A-1					1	0	4	0	400	-

[1] Baseline collected on November 7, 2018.

Appendix D. Photomonitoring Data by Treatment Area

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1. OLD BUTTLE LAKE BOAT LAUNCH (JHT-RV02)

1.1. JHT-PRM06/PRM06a

Figure 1. Photopoint monitoring comparison for JHT-PRM06/06a.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking south through plot centre (pin missing) on 03-May-2019 (monitoring).

c) Looking north through plot centre (pin replaced and renamed JHT-PRM06a) on 06-Nov-2019 (monitoring).

1.2. JHT-PRM07

Figure 2. Photopoint monitoring comparison for JHT-PRM07.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking northwest through plot centre 28-Dec-2018 (as-built).

c) Looking south through plot centre on 30-May-2019 (monitoring).

d) Looking north through plot centre on 28-Oct-2019 (monitoring).

Figure 2. Continued.

e) Looking west from plot centre on 12-Sep-2017 (baseline).

f) Looking west from plot centre 28-Nov-2018 (as-built).

g) Looking west from plot centre on 30-May-2019 (monitoring).

h) Looking west from plot centre on 28-Oct-2019 (monitoring).

1.3. JHT-PRM08

Figure 3. Photopoint monitoring comparison for JHT-PRM08.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking north through plot centre on 28-Nov-2018 (as-built).

c) Looking north on 01-May-2019 (monitoring).

d) Looking north through plot centre on 28-Oct-2019 (monitoring).

Figure 3. Continued.

e) Looking east (74 degrees) on 12-Sep-2017 (baseline).

f) Looking east on 28-Nov-2018 (as-built).

g) Looking east on 01-May-2019 (monitoring).

h) Looking east on 28-Oct-2019 (monitoring).

1.4. JHT-PRM09

Figure 4. Photopoint monitoring comparison for JHT-PRM09.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking northwest through plot centre on 28-Nov-2018 (as-built).

c) Looking south through plot centre on 01-May-2019 (monitoring).

d) Looking north through plot centre (at blue tape) on 28-Oct-2019 (monitoring).

1.5. JHT-PRM25

Figure 5. Photopoint monitoring comparison for JHT-PRM25.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

1.6. JHT-PRM26

Figure 6. Photopoint monitoring comparison for JHT-PRM26.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

1.7. JHT-PRM27

Figure 7. Photopoint monitoring comparison for JHT-PRM27.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

1.8. JHT-PRM28

Figure 8. Photopoint monitoring comparison for JHT-PRM28.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 01-May-2019 (as-built).

c) Looking north through plot centre on 06-Nov-2019 (monitoring).

1.9. JHT-PRM29

Figure 9. Photopoint monitoring comparison for JHT-PRM29.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 01-May-2019 (as-built).

c) Looking north through plot centre on 06-Nov-2019 (monitoring).

2. BUTTLE LAKE CAMPGROUND (JHT-RV03)

2.1. JHT-PRM01

Figure 10. Photopoint monitoring comparison for JHT-PRM01.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

2.2. JHT-PRM02

Figure 11. Photopoint monitoring comparison for JHT-PRM02.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

2.3. JHT-PRM03

Figure 12. Photopoint monitoring comparison for JHT-PRM03.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

2.4. JHT-PRM04

Figure 13. Photopoint monitoring comparison for JHT-PRM04.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

2.5. JHT-PRM05

Figure 14. Photopoint monitoring comparison for JHT-PRM05.

a) Looking north through plot centre on 12-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

2.6. JHT-PRM51

Figure 15. Photopoint monitoring comparison for JHT-PRM51.

a) Looking north through plot centre on 07-Nov-2018 (baseline).

b) Looking north through plot centre on 28-Nov-2018 (as-built).

c) Looking north through plot centre on 01-May-2019 (monitoring).

d) Looking north through plot centre on 08-Nov-2019 (monitoring).

2.7. JHT-PRM52

Figure 16. Photopoint monitoring comparison for JHT-PRM53.

a) Looking south through plot centre on 07-Nov-2018 (baseline).

b) Looking south through plot centre on 06- Dec-2018 (as-built).

c) Looking south through plot centre on 01-May-2019 (monitoring).

d) Looking north through plot centre on 08-Nov-2019 (monitoring).

2.8. JHT-PRM53

Figure 17. Photopoint monitoring comparison for JHT-PRM53.

a) Looking north through plot centre on 07-Nov-2018 (baseline).

b) Looking north through plot centre 09-Nov-2018 (as-built).

c) Looking south through plot centre on 01-May-2019 (monitoriong).

d) Looking north through plot centre on 06-Nov-2019 (monitoring).

2.9. JHT-PRM54

Figure 18. Photopoint monitoring comparison for JHT-PRM54.

a) Looking south through plot centre on 07-Nov-2018 (baseline).

b) Looking south through plot centre on 06-Dec-2018 (as-built).

c) Looking south through plot centre on 01-May-2019 (monitoring).

d) Looking north through plot centre on 08-Nov-2019 (monitoring).

2.10. JHT-PRM57

Figure 19. Photopoint monitoring comparison for JHT-PRM57.

a) Looking north through plot centre on 28-Nov-2018 (as-built).

b) Looking south through plot centre on 03-May-2019 (monitoring).

c) Looking north through plot centre on 06-Nov-2019 (monitoring).

3. RAINBOW ISLAND MARINE CAMPSITE (JHT-RV04)

3.1. JHT-PRM10

Figure 20. Photopoint monitoring comparison for JHT-PRM10.

a) Looking north through plot centre on 13-Sept-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (monitoring).

3.2. JHT-PRM11

Figure 21. Photopoint monitoring comparison for JHT-PRM11.

a) Looking north through plot centre on 13-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (as-built).

3.3. JHT-PRM12

Figure 22. Photopoint monitoring comparison for JHT-PRM12.

a) Looking north through plot centre on 13-Sept-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (as-built).

3.4. JHT-PRM13

Figure 23. Photopoint monitoring comparison for JHT-PRM13.

a) Looking north through plot centre on 13-Sept-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (as-built).

3.5. JHT-PRM14

Figure 24. Photopoint monitoring comparison for JHT-PRM14.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 06-Nov-2019 (as-built).

3.6. JHT-PRM15

Figure 25. Photopoint monitoring comparison for JHT-PRM15.

a) Looking north through plot centre on 13-Sept-2017 (baseline).

b) Looking north through plot centre on 28-Oct-2019 (as-built).

3.7. JHT-PRM16

Figure 26. Photopoint monitoring comparison for JHT-PRM16.

a) Looking north through plot centre on 13-Sept-2017 (baseline).

b) Looking north through plot centre on 28-Oct-2019 (as-built).

4. DRIFTWOOD GROUP SITE (JHT-RV05)

4.1. JHT-PRM30

Figure 27. Photopoint monitoring comparison for JHT-PRM30.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

4.2. JHT-PRM31

Figure 28. Photopoint monitoring comparison for JHT-PRM31.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

4.3. JHT-PRM32

Figure 29. Photopoint monitoring comparison for JHT-PRM32.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

4.4. JHT-PRM33

Figure 30. Photopoint monitoring comparison for JHT-PRM33.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

4.5. JHT-PRM34

Figure 31. Photopoint monitoring comparison for JHT-PRM34.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

5. BUTTLE LAKE BOAT LAUNCH (JHT-RV06 SHORELINE)

5.1. JHT-PRM21

Figure 32. Photopoint monitoring comparison for JHT-PRM21.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 21-Nov-2018 (as-built).

c) Looking north through plot centre on 03-May-2019 (monitoring).

d) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.2. JHT-PRM22

Figure 33. Photopoint monitoring comparison for JHT-PRM22.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 21-Nov-2018 (as-built).

c) Looking north through plot centre on 03-May-2019 (monitoring).

d) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.3. JHT-PRM23

Figure 34. Photopoint monitoring comparison for JHT-PRM23.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north from plot centre on 21-Nov-2018 (as-built).

c) Looking north through plot centre on 03-May-2019 (monitoring).

d) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.4. JHT-PRM24

Figure 35. Photopoint monitoring comparison for JHT-PRM24.

a) Looking north through plot centre on 14-Sep-2017 (baseline).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.5. JHT-PRM41

Figure 36. Photopoint monitoring comparison for JHT-PRM41.

a) Looking north through plot centre on 28-Sep-2017 (baseline).

5.6. JHT-PRM42

Figure 37. Photopoint monitoring comparison for JHT-PRM42.

a) Looking north through plot centre on 28-Sep-2017 (baseline).

5.7. JHT-PRM43

Figure 38. Photopoint monitoring comparison for JHT-PRM43.

a) Looking north through plot centre on 28-Sep-2017 (baseline).

5.8. JHT-PRM44

Figure 39. Photopoint monitoring comparison for JHT-PRM44.

a) Looking north through plot centre on 28-Sep-2017 (baseline).

5.9. JHT-PRM45

Figure 40. Photopoint monitoring comparison for JHT-PRM45.

a) Looking north through plot centre on 28 Sep-2017 (baseline).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.10. JHT-PRM46

Figure 41. Photopoint monitoring comparison for JHT-PRM46.

a) **Looking north through plot centre on 28-Sep-2017 (baseline).**

b) **Looking north through plot centre on 25-Oct-2019 (monitoring).**

5.11. JHT-PRM47

Figure 42. Photopoint monitoring comparison for JHT-PRM47.

a) Looking north through plot centre on 28-Sep-2017 (baseline).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.12. JHT-PRM48

Figure 43. Photopoint monitoring comparison for JHT-PRM48.

a) Looking north through plot centre on 28-Sep-2017 (baseline).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.13. JHT-PRM49

Figure 44. Photopoint monitoring comparison for JHT-PRM49.

a) Looking north through plot centre on 28-Sep-2017 (baseline).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).

5.14. JHT-PRM50

Figure 45. Photopoint monitoring comparison for JHT-PRM50.

a) **Looking north through plot centre on 07-Nov-2018 (as-built).**

b) **Looking north through plot centre on 03-May-2019 (monitoring).**

c) **Looking north through plot centre on 25-Oct-2019 (monitoring).**

5.15. JHT-PRM56

Figure 46. Photopoint monitoring comparison for JHT-PRM56.

a) Looking north through plot centre on 21-Nov-2018 (as-built).

b) Looking north through plot centre on 03-May-2019 (monitoring).

c) Looking north through plot centre on 25-Oct-2019 (monitoring).

6. BUTTLE LAKE CAMPGROUND FAN (JHT-RV07)

6.1. JHT-PRM17

Figure 47. Photopoint monitoring comparison for JHT-PRM17.

a) Looking north through plot centre on 13-Sep-2017 (baseline).

b) Looking north through plot centre on 03-May-2019 (as-built).

c) Looking north through plot centre on 28-Oct-2019 (monitoring).

6.2. JHT-PRM18

Figure 48. Photopoint monitoring comparison for JHT-PRM18.

a) Looking north through plot centre on 13-Sep-2017 (baseline).

b) Looking north through plot centre on 03-May-2019 (as-built).

c) Looking north through plot centre on 28-Oct-2019 (monitoring).

6.3. JHT-PRM19

Figure 49. Photopoint monitoring comparison for JHT-PRM19.

a) Looking north through plot centre on 03-May-2019 (as-built).

b) Looking north through plot centre on 28-Oct-2019 (monitoring).

6.4. JHT-PRM20

Figure 50. Photopoint monitoring comparison for JHT-PRM20.

a) Looking north through plot centre on 13-Sep-2017 (baseline).

c) Looking north through plot centre on 28-Oct-2019 (monitoring).

c) Looking north through plot centre on 03-May-2019 (as-built).

7. KARST CREEK BOAT LAUNCH (JHT-RV08)

7.1. JHT-PRM39

Figure 51. Photopoint monitoring comparison for JHT-PRM39.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).

7.2. JHT-PRM40

Figure 52. Photopoint monitoring comparison for JHT-PRM40.

a) **Looking north through plot centre on 15-Sep-2017 (baseline).**

b) **Looking north through plot centre on 02-May-2019 (as-built).**

c) **Looking north through plot centre on 25-Oct-2019 (monitoring).**

8. RALPH RIVER CAMPGOUND (JHT-RV09)

8.1. JHT-PRM35

Figure 53. Photopoint monitoring comparison for JHT-PRM35.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

b) Looking north through plot centre on 02-May-2019 (as-built).

c) Looking north through plot centre on 25-Oct-2019 (monitoring).

8.2. JHT-PRM36

Figure 54. Photopoint monitoring comparison for JHT-PRM36.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

b) Looking north through plot centre on 02-May-2019 (as-built).

c) Looking north through plot centre on 25-Oct-2019 (monitoring).

8.3. JHT-PRM37

Figure 55. Photopoint monitoring comparison for JHT-PRM37.

b) Looking north through plot centre on 15-Sep-2017 (baseline).

b) Looking north through plot centre on 02-May-2019 (as-built).

c) Looking north through plot centre on 25-Oct-2019 (monitoring).

8.4. JHT-PRM38

Figure 56. Photopoint monitoring comparison for JHT-PRM38.

a) Looking north through plot centre on 15-Sep-2017 (baseline).

b) Looking north through plot centre on 02-May-2019 (as-built).

c) Looking north through plot centre on 25-Oct-2019 (monitoring).

8.5. JHT-PRM60

Figure 57. Photopoint monitoring comparison for JHT-PRM60.

a) Looking north through plot centre on 02-May-2019 (as-built).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).

8.6. JHT-PRM61

Figure 58. Photopoint monitoring comparison for JHT-PRM61.

a) Looking north through plot centre on 02-May-2019 (as-built).

b) Looking north through plot centre on 25-Oct-2019 (monitoring).