Planting Plan for the Little Qualicum River Estuary Regional Conservation Area

FINAL

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by

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1.0 Introduction

Streamside Native Plants Inc. (Streamside) was retained by the British Columbia Conservation Foundation (BCCF) to develop a planting plan for the Little Qualicum River Estuary Regional Conservation Area (LQRERCA), with funding provided by the Pacific Salmon Foundation's (PSF) Community Salmon Program.

The primary purpose of the revegetation efforts is to stabilize the spit, limiting erosion from high river flow and tide action, and improve broader riparian functions for the benefit of fish habitat values (e.g., providing shade to constructed rearing channel). The purpose of this planting plan is to provide guidance for ongoing revegetation efforts at the LQRERCA, including recommendations for which native plant species should be included and where they should be installed. A pilot program is proposed to further test and evaluate different planting approaches and guide plant species selection for various LQRERCA sub-areas.

An overview of preferred planting site preparation and planting techniques for LQRERCA revegetation efforts is included; it is based on general best practices and further informed by past experience gained by BCCF/Qualicum Beach Streamkeeper Society (QBSS). In addition, maintenance (or "after-care") approaches and recommendations for monitoring are provided.

2.0 Previous Plantings

Revegetation efforts in the LQRERCA have been undertaken over the past several decades, with the most substantive planting activities carried out in the last 10 years. In 2014, BCCF/QBSS planted native shrubs and trees within exclosures on the spit immediately south of a fish habitat enhancement channel constructed by Fisheries and Oceans Canada (DFO). Supplemental plantings followed in 2016. In 2019/20, BCCF/QBSS undertook additional plantings in an area surrounding the Mill Pond, following construction of a secondary channel connecting this pond to the adjacent river channel.

A total of 19 different native plant species, including trees/shrubs (n=15), forbs/perennials (n=3), and grasses (n=1) were planted during these various planting efforts (BCCF 2023a). A summary of where these various species were planted and the relative success of these plantings is provided below in **Table 1**.

Table 1 references four different sub-areas within the LQRERCA (as introduced in BCCF 2023b; see **Figure 1**), including:

- Spit and Island within Constructed Rearing Channel (S/CI)
- South of the Constructed Rearing Channel (SCC)
- Mill Site (MS)
- Mill Pond and Island (MP/I)

Table 1 also provides summarized results from a plant inventory undertaken by BCCF and QBSS volunteers on July 9, 2003, documenting previous BCCF/QBSS plantings from 2014-2020, along with naturally occurring plants in the LQRERCA (BCCF, 2023b).

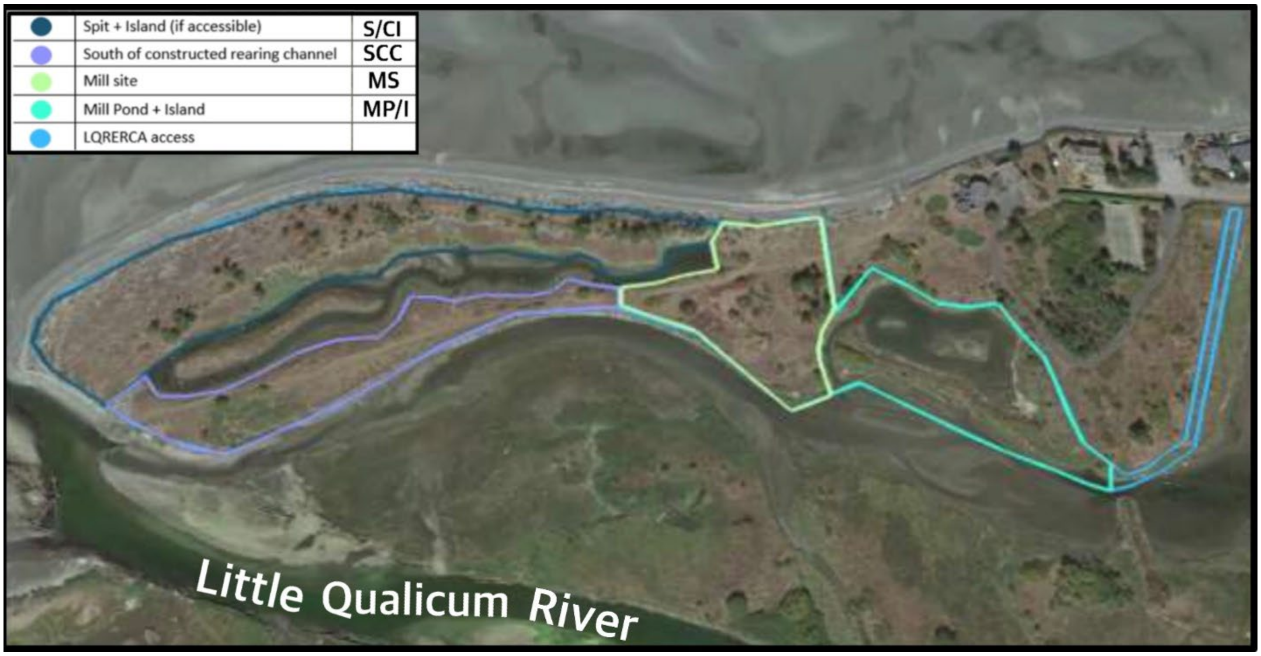

Figure 1 LQRERCA Sub-areas

As summarized in **Table 1** and consistent with past monitoring results that evaluated survivorship and vigour (BCCF 2023a and 2023b), the most successful plantings installed during the period of 2014-2020 were as follows:

Trees

Deciduous

- Black hawthorn (*Craetagus douglasii*)
- Pacific crabapple (*Malus fusca*)

Coniferous

- Douglas fir (*Pseudotsuga menziesii)*
- Shore pine (*Picea sitchensis*)

Shrubs

- Common snowberry (*Symphoricarpos albus*)
- Nootka rose (*Rosa nutkana*)
- Red flowering currant (*Ribes sanguineum*)
- Scouler's willow (*Salix scouleriana*)
- Thimbleberry (*Rubus parviflorus*)

Grasses

- Dune grass (*Elymus mollis*)

* Note: Although not highlighted as "most successful" in **Table 1** based on previous monitoring efforts, more recent evaluation by QBSS members indicates that ¾ of the originally planted Douglas fir still persist in the LQRERCA (Daryl Erickson, QBSS, pers. com. September 19, 2024).

All of these various species are considered typical of marine shorelines in British Columbia and are also known to have some degree of salt- and drought-tolerance.

Table 1 Planted and Naturally Occurring Plants

		Year of Planting				Sub-areas (pl/nat occur)				Characteristics		
Common Name	**Botanical Name**	2014	2016	2019	2020	S/CI	SCC	MS	MP/I	MS	ST	DT
Trees												
Bigleaf maple	*Acer macrophyllum*					-/x	-/x	-/x	-/-	x		
Bitter cherry	*Prunus emarginata*					-/x	-/-	-/-	-/-			
Black hawthorn	*Craetagus douglasii*	x	x	x		-/x	x/x	-/x	x/-	x	x	x
Douglas fir	*Pseudotsuga menziesii*	x				x/x	-/x	-/x	-/-	x	x	x
Garry oak	*Quercus garryana*		x*			-/-	x/-	-/-	-/-	x		x
Pacific crab apple	*Malus fusca*	x		x	x	-/x	x/x	-/x	-/x	x	x	x
Shore pine	*Picea sitchensis*	x		x	x	x/-	x-	-/-	x/-	x	x	x
Sitka spruce	*Picea sitchensis*		x*			-/-	x/-	-/-	-/-	x	x	
Western red cedar	*Thuja plicata*		x*			-/-	x/-	-/-	-/-	x		
Shrubs												
Black twinberry	*Lonicera involucrata*			x		-/-	-/-	-/-	x /-	x	x	
Common snowberry	*Symphoricarpos albus*	x		x		-/ x	x / x	x /-	x /-	x	x	x
Nootka rose	*Rosa nutkana*	x		x	x	-/x	x/x	x/-	x/x	x	x	x
Oceanspray	*Holodiscus discolor*	x		x	x	-/-	x/-	-/-	x/-	x	x	x
Pacific ninebark	*Physocarpus capitatus*	x				-/-	x/-	-/-	-/-	x	x	x
Red elderberry	*Sambucus racemosa*					-/-	-/-	-/x	-/-			
Red flowering currant	*Ribes sanguineum*	x				-/-	x/-	-/-	-/-	x	x	x
Saskatoon berry	*Amelanchier alnifolia*			x	x	-/-	x/-	-/-	x/-	x	x	x
Scouler's willow	*Salix scouleriana*	x				-/-	x/-	-/-	-/-	x	x	x
Tall Oregon grape	*Mahonia aquifolium*					-/-	-/-	-/x	-/-	x		x
Thimbleberry	*Rubus parviflorus*					-/-	-/-	-/x	-/-	x	x	x
Forbs/ Perennials												
Coastal strawberry	*Fragaria chiloensis*			x		-/-	-/-	-/-	x/-	x	x	x
Large-leaved lupine	*Lupinus polyphyllus*			x	x	-/-	-/-	-/-	x/-	x	x	
Pacific silverweed	*Potentilla pacifica*					-/-	-/-	-/-	-/x	x	x	x
Sea milkweed	*Lysimachia maritima*					-/-	-/-	-/-	-/x	x	x	x
Silver beachweed	*Ambrosia chamissonia*					-/x	-/-	-/x	x/x	x	x	x
Yarrow	*Achillea millefolium*			x	x	x/x	-/-	-/-	-/x	x	x	x
Grasses												
Dune grass	*Elymus mollis*	x				-/-	-/-	-/-	-/-	x	x	x

Notes: Any 2016 plantings marked with an * means they were informal additions, installed in either 2015 or 2016. For sub-areas, "pl" is abbreviated from "plant" and "nat occur" is abbreviated from "naturally occurring". By sub-area, 1st x means species was planted and 2nd x means species is naturally occurring; any yellow-highlighted x denotes prevalence and/or noted vigour as determined by monitoring/plant inventory efforts (or relatively "successful" plants). Abundance/vigour of forbs/perennials was not assessed in detail, so highlighting is intentionally incomplete. Noted characteristics include MS (marine shoreline associated), ST (salt tolerance), and DT (drought tolerance).

3.0 Plant Inventory Results

As summarized in **Table 1**, the plant inventory completed by BCCF and QBSS volunteers on July 9, 2023 documented both previous revegetation efforts and naturally occurring native plants within the LQRERCA. In addition to the location of these naturally occurring plants by sub-area (as per the sub-area description in **Section 2.0**), the relative abundance/vigour of these additional plants is summarized in **Table 1**. The most successful naturally occurring native plants identified during this plant inventory are summarized below:

Trees

Deciduous

- Bigleaf maple (*Acer macrophylum*)
- Black hawthorn
- Pacific crabapple

Coniferous

- none

Shrubs

- Common snowberry
- Nootka rose
- Tall Oregon grape (*Mahonia aquifolium*)
- Thimbleberry

Of these naturally occurring species, only bigleaf maple was not included in previous plantings. Although known to occur on marine shorelines, bigleaf maple isn't particularly known for its salt- or drought-tolerance.

Previous revegetation efforts included planting some forbs/perennials. Although various forb/perennial species are referenced in **Table 1**, monitoring results did not fully evaluate success of these plantings. Based on observations made by QBSS, planted forb/perennial species had poor survival rates, likely due to impacts from browsing.

4.0 Soil Sample Results

The LQRERCA consists primarily of an estuarine spit, which is in turn characterized by well-drained substrates (e.g., sand and gravel) deposited by both coastal geomorphic and riverine processes. Interfacing with the marine environment and exposed to coastal weather, tides, and other physical factors, it is clearly a challenging environment for terrestrial vegetation. This is further evidenced by the patchiness of naturally occurring plants and the challenges experienced by BCCF and QBSS while undertaking previous revegetation efforts.

BCCF and QBSS identified the collection of soil samples as a critical step towards gaining a better understanding of key factors influencing revegetation efforts, potential causal agents for apparent changes in natural vegetation communities (e.g., decline of mature Douglas fir trees on seaward-facing side of the spit), and how to best approach future revegetation work in the LQRERCA.

On December 14, 2023, BCCF, in partnership with Qualicum First Nation collected soil samples within the LQRERCA. A total of 15 samples were collected and shipped to MB Laboratories in Sidney, BC for analysis. The goal of this sampling program was to provide a better understanding of site conditions (e.g., soil chemistry, including elements, pH, and other geochemical parameters) to help guide development of this planting plan.

The results of this sampling program indicate that soils are primarily sandy, with low soil moisture accompanied by low nutrient levels (BCCF 2024). As soil samples were screened for removal of particle sizes greater than 3 mm prior to lab analysis, these analysis results may actually over-represent soil nutrient levels to some extent (Daryl Erickson, QBSS, pers. com. September 19, 2024). The three main nutrients needed by plants for growth (i.e., nitrogen, phosphorus, and potassium) were all low to moderate at most sample sites (**Table 2**), while calcium and magnesium levels were consistent and within a normal range, sulfur was low at most sample sites. Although low nutrient levels applied throughout the LQRERCA, key nutrient deficiencies were most pronounced within sub-areas S/CI and MP/I. The most favourable sub-area with respect to soil conditions was SCC, followed by sub-area MS.

Additional discussion on key parameters of note (Na, pH, OM, and EC) and the apparent effects of saltwater intrusion are provided in Section 4.1 and a brief overview regarding these same parameters by sub-area is provided in Section 4.2.

Table 2 Soil Analysis – Key Parameters by Sub-area

	N (mn/mx/av)	P (mn/mx/av)	K (mn/mx/av)	Na (mn/mx/av)	pH (mn/mx/av)	OM (mn/mx/av)
S/CI	0.82/1.80/1.30	1.47/44.90/10.20	25.10/86.50/60.23	55.10/203.00/107.15	5.95/8.74/7.45	3.54/11.40/6.39
SCC	2.59/10.20/6.72	3.54/23.70/16.48	21.70/170.00/78.27	55.40/63.90/59.53	6.80/8.15/7.39	4.67/13.70/8.43
MS	3.48/5.92/4.55	9.11/30.10/21.14	17.40/49.90//32.20	47.90/178.00/91.80	5.82/6.82/6.38	11.40/26.40/19.40
MP/I	3.24/4.11/3.67	8.74/9.84/9.45	64.60/87.50/76.20	117.00/190.00/161.33	5.82/6.84/6.31	3.72/15.40/9.91
DL	--	20-100	150-800	<100	5-7.5	--

Notes: Summary from soil sample analysis (BCCF 2024), including Nitrogen (N), Phosphorus (P), Potassium (K), soil organic matter (OM), and pH. For each parameter, the minimum (mn), maximum (mx), and average (av) are presented. Relatively low (N, P, K, and OM) or high (Na and pH) analysis results are highlighted in yellow. DL means "desirable level" and includes the optimal range for each parameter (where available and as described previously in the soil analysis report (BCCF 2024)).

4.1. Overview of Key Parameters

Provided below is an overview of key parameters (Na, pH, OM, and EC) from the soil analysis results, plus some additional discussion on saltwater intrusion (including sea-level rise).

4.1.1. Sodium (Na)

Sodium (Na) levels were of note and presumably an indicator of saltwater intrusion, with sub-areas S/CI and MP/I characterized by the highest Na levels. This is not a surprise for sub-area S/CI, which should be the sub-area most influenced by the marine environment given its location in the outer estuary (i.e., seaward edge of the spit). It is, however, less clear with respect to sub-area MP/I.

The presence of saltgrass (*Distichilis spicata*) along the edges of the Mill Pond (sub-area MP/I) and its connecting channels suggests the presence of some saltwater intrusion, perhaps the result of some subsurface substrates with greater porosity and/or retention of more brackish water in the Mill Pond than applies within the nearby main river channel.

It is also noted that the lowest Na levels were in soil samples taken from sub-areas SCC and sub-area MS; sub-area SCC interfaces with riverine flows while the presence of higher elevations in sub-area MS may reduce sub-surface saltwater effects. An alternative explanation for low Na levels in sub-area MS may the distance of the soil samples from the marine environment. As sodium directly impacts both water uptake and retention in plants, it would presumably exacerbate already challenging site conditions with respect to well-drained soils, open exposure, and summer-time drought conditions. In addition, high sodium levels are known to compete with calcium, potassium, and magnesium for uptake by plant roots (Davies et al., 2014).

4.1.2. pH

pH generally ranged from moderately acidic to neutral with the greatest variability noted within sub-area S/CI where sample sites within more central portions of the spit were characterized by moderately alkaline soils. It is noted that saltwater intrusion typically results in alkalinization of soils; higher sodium levels in S/CI generally coincided with higher pH levels (i.e., more alkaline soils). In sub-area S/CI, at three of four soil sample sites where pH was also high (i.e., $\geq$ 8.0), sodium levels were also elevated. The same correlation between elevated sodium and pH levels did not apply in sub-area MP/I. For some unknown reason, although sodium levels were high in sub-area MP/I, pH was more neutral or acidic.

4.1.3. OM

OM was highest in sub-area MS; likely the result of the historic use of the site as a mill and resultant deposits of organic matter (i.e., saw dust).

4.1.4. EC

EC results showed a high degree of variability throughout the overall study area; although it can provide an indication of salt content, it is also highly influenced by soil drainage conditions and appears resultantly to be inconclusive with respect to how saltwater intrusion might be impacting the site. Instead of EC, it appears that sodium levels may be a more useful indicator of sub-surface salinity effects on native plants.

4.1.5. Saltwater Intrusion

With consideration of elevated sodium levels and alkalinity, as well as recent and ongoing decline of some vegetation (i.e., Douglas fir) in sub-area S/CI, the seaward edge of the LQRERCA is likely being impacted by increased saltwater intrusion. Saltwater intrusion can be viewed as the leading edge of sea-level rise, with salinization of groundwater preceding obvious changes in tidal inundation and impacting existing upland habitats like marine riparian forests (Tully et al., 2019).

Sea-level rise: Over the past 50 years, sea level is estimated to have risen by 3.1 cm in Victoria on Vancouver Island (Vadeboncoeur et al., 2016). Although sea level rise continues to be moderated to some extent by vertical (upward) land motion on portions of Vancouver Island (caused by a combination of tectonic activity, glacial isostatic adjustment, and other factors), 3.1 cm of sea level rise is substantial especially when exasperated by storm surge.

Within the more local setting, the Qualicum Beach area coastline is currently rising at a rate of approximately 0.2 to 0.3 cm/yr; this uplift was faster than the concurrent rate of global sea level rise until sometime after approximately 1950. With present day sea levels rising at approximately 0.33 cm/yr, the coastline is slowly being submerged (SNC, 2015). Global projections of relative sea level rise by 2100 indicate an increase of 80 to 90 cm for the Qualicum Beach areas, including the LQRERCA (Town of Qualicum Beach, 2020).

In the foreseeable future, climate change is expected to result in both sea level rise and potentially a change in the nature, intensity, and frequency of storms, which will in turn likely increase the number and frequency of events when storm surge events occur (SNC, 2015).

Given the likelihood that some degradation in LQRERCA site conditions has been occurring and is likely to continue in the foreseeable future, it is recommended that future planting efforts in the LQRERCA be planned accordingly. For instance, it seems prudent to limit planting efforts in the outer estuary (sub-area S/CI) and other areas where elevated sodium levels have been documented (sub-area MP/I) while also focusing on inclusion of the most salt- and drought-tolerant plants for LQRERCA revegetation. Furthermore, to maximize meaningful and measurable benefits to fish habitats and achieve some revegetation successes in the short-term, it appears appropriate to prioritize planting within sub-area SCRC and along the south-side of the constructed channel.

4.2. Summary of Key Parameters by Sub-area

Further to Section 4.1 which summarized key parameters from the soil analysis results, the information below highlights this same information on a sub-area by sub-area basis for the benefit of the reader.

4.2.1. Sub-area S/CI

Along with sub-area MP/I, Na levels were high and apparently an indicator of saltwater intrusion which is not surprising given the outer estuary location. As Na directly impacts both water uptake/retention and uptake of some minerals by plants, this could further challenge plant growth in this sub-area.

pH was highly variable in sub-area S/CI, with more central portions of the spit characterized by moderately alkaline soils. As saltwater intrusion usually causes soil alkalinization, higher sodium levels in S/CI generally coincided with higher pH levels (i.e., more alkaline soils).

4.2.2. Sub-area SCC

Along with sub-area MS, the lowest Na levels were in soil samples taken from sub-areas SCC, presumably the result of this sub-area's interface with freshwater from riverine flows. In general, sub-areas SCC and MS appear be most favourable for future planting efforts.

4.2.3. Sub-area MS

As noted above in Section 4.2.2., the lowest Na levels were in soil samples taken from sub-area SCC and sub-area MS. The reason for these lower levels in sub-area MS is less clear than it is for sub-area SCC, but may be due to higher elevations (note: this has not confirmed by detail survey work) or the simply the distance of the soil samples from the marine environment. OM was highest in this sub-area and is likely the result of the historic use of the site as a mill and resultant buried saw dust. Along with sub-area SCC, this sub-area should be considered a priority for further plantings.

4.2.4. Sub-area MP/I

As with sub-area S/CI, Na levels were high and appear to indicate saltwater intrusion which is not surprising given the outer estuary location. Although further from the marine environment than S/CI, sub-area MP/I may be characterized by underlying subsurface substrates with greater porosity or perhaps brackish water is being retained in the Mill Pond. Similar to sub-area S/CI, these high Na levels are expected to cause challenges for riparian vegetation growth within sub-area MP/I.

5.0 Evaluation of Priority Plants

This section provides a list of priority plants for future revegetation activities in the LQRERCA, based upon a review of characteristics and desirable site conditions for previously planted, naturally occurring, and any additional plant species that should be considered. The following online resources were reviewed to develop this priority plant list: Menashe, 1993; Network of Nature, 2002; Sound Native Plants, 2024; WDFW, 2016; WNPS, 2024; WSU Shore Stewards, 2015. **Table 3** provides a summary of these various native plant species, with additional information on plant characteristics derived from available online sources (eFloraBC, 2024; USDA, 2024).

Details on plant characteristics in **Table 3** includes: elevation range information (minimum and average); aspect (average); soil moisture regime (minimum, maximum, and average); nutrient regime from documented occurrences in BC (eFloraBC, 2024); soil pH (minimum to maximum); soil fertility requirements; mean root depth; and both salt- and drought-tolerance (low to high) (USDA, 2024). In some cases, available ecological information can be limited on eFloraBC or the USDA Native Plant Database site. For instance, there aren't any tracked occurrences/ ecological info on eFloraBC for sea milkweed and ecological info is unavailable for most forbs/perennials on the USDA site.

Table 3 Characteristics of Priority Native Plants

Common Name	Botanical Name	Elev	Asp	SMR	MNR	pH	SF	MRD	ST	DT
Trees										
Black hawthorn	*Craetagus douglasii*	1/601	248	1-7(4)	D	4.8-7.5	L	20	L	L
Douglas fir	*Pseudotsuga menziesii*	0/917	197	0-8(3)	C	5.0-7.5	M	65	L	L
Pacific crab apple	*Malus fusca*	0/121	208	0-8(5)	D	6.0-8.0	M	60	L	L
Shore pine	*Picea sitchensis*	0/1131	199	0-8(3)	C	5.5-8.5	L	50	L	M
Shrubs										
Common snowberry	*Symphoricarpos albus*	1/878	197	0-8(3)	C	6.0-7.8	M	45	H	H
Mock orange	*Philadelphus lewisii*	1/640	196	0-7(2)	C	7.0-8.0	L	15	M	H
Nootka rose	*Rosa nutkana*	1/761	210	0-8(3)	C	6.5-8.0	L	15	L	H
Oceanspray	*Holodiscus discolor*	1/607	203	0-7(2)	C	6.5-7.5	L	30	L	H
Pacific ninebark	*Physocarpus capitatus*	0/223	274	0-7(5)	D	6.5-7.0	L	50	L	L
Red flowering currant	*Ribes sanguineum*	15/343	228	0-6(3)	B	6.0-7.5	M	40	L	M
Saskatoon berry	*Amelanchier alnifolia*	0/928	193	0-8(3)	C	5.5-7.5	M	50	H	H
Scouler's willow	*Salix scouleriana*	5/955	188	0-8(3)	D	6.5-8.0	L	30	L	M
Thimbleberry	*Rubus parviflorus*	0/951	189	0-8(4)	C	4.8-7.2	M	30	H	M
Forbs/ Perennials										
Coastal mugwort		5/5	-	5-5(5)	E	-	-	-	H	H
Coastal strawberry	*Fragaria chiloensis*	0/424	231	0-4(2)	A	-	-	-	H	H

Gumweed	*Grindelia integrifolia*	0/1	245	4-8(5)	D	-	-	-	H	H
Large-leaved lupine	*Lupinus polyphyllus*	0/975	236	2-6(4)	D	-	-	-	H	L
Pacific silverweed	*Potentilla pacifica*	0/890	179	1-8(5)	D	-	-	-	H	H
Sea milkweed	*Lysimachia maritima*	-	-	-	-	-	-	-	H	H
Silver beachweed	*Ambrosia chamissonia*	0/193	92	1-6(2)	A	-	-	-	H	H
Yarrow	*Achillea millefolium*	0/1143	189	0-8(3)	C	-	-	-	H	H
Grasses										
Dune grass	*Elymus mollis*	0/3	299	1-7(3)	A	6.0-8.0	L	40	H	H

Notes: From eFloraBC (https://linnet.geog.ubc.ca/Atlas): Elev (min/ave in metres); Aspect (ave in degrees with 90 = East, 180 = South, and 270 = W) ; SMR = soil moisture regime (min-max and average with 0 very xeric, 4 mesic and 8 hydric as per Field Manual for Describing Terrestrial Ecosystems) ; MNR = mineral nutrient regime (A - very poor, B - poor, C - medium, D - rich, E - very rich, and S - saline). From the USDA's Native Plant Database (plants.usda.gov): DTR = drought resistance; STR = salt tolerance; pHmx = pH maximum; pHmn = pH minimum; SF = soil fertility; and MRD = minimum root depth in cm (when underlined it means that data was unavailable and/or revised to create a relative rating, as informed by professional judgement).

Based on this review, one additional shrub species (i.e., not previously planted nor naturally occurring) should be considered for inclusion in revegetation efforts within the short-term: mock orange (*Philadelpus lewisii*). Although not previously documented within the LQRERCA, mock orange is a native shrub species with known occurrences within the regional setting and with characteristics that should make it suitable for revegetation efforts.

6.0 Updated Plant List

Based upon the information provided in **Sections 2.0** thru **5.0** (including the plant summary provided in **Table 3**), the following native plants are considered appropriate for inclusion in future revegetation efforts within the LQRERCA:

Trees

Deciduous

- Black hawthorn
- Pacific crabapple

Coniferous

- Douglas fir
- Shore pine

Shrubs

- Common snowberry
- Mock orange
- Nootka rose
- Oceanspray
- Pacific ninebark
- Red flowering currant
- Saskatoon berry
- Scouler's willow
- Thimbleberry

Grasses

- Dune grass

Although Douglas fir are obviously experiencing some decline in the LQRERCA (e.g., sub-area S/CI, on outer edge of the spit), they are included as they occur naturally and are similar to shore pine with respect to their habitat needs and environmental tolerances. Although declining within some portions of the LQRERCA, likely due to degradation of conditions since their historic natural recruitment (e.g., saltwater intrusion, prolonged summer droughts, etc), Douglas fir may still be a suitable species elsewhere in the LQRERCA.

Table 3 lists 8 forb/perennial species that were planted and/or naturally occur within the LQRERCA. As the primary objective of ongoing revegetation efforts has been to establish native shrubs and trees for the general benefit to fish habitat and associated ecological functions, including dune grass to help stabilize shoreline areas, forb/perennial species are not discussed further in this planting plan. If an expressed interest in diversifying the plantings for broader benefits (e.g., gumweed for pollinators) applies at a future date, then further consideration can be given to these forbs/perennials at that time.

7.0 Pilot Program

A pilot program is proposed, to test different planting approaches (including various native plant species) within the various LQRERCA sub-areas. Any pilot plantings that proceed should be evaluated for a minimum of 2 years, prior to any transition towards a broader long-term planting program.

Proposed pilot plantings are summarized by sub-area below in **Table 4** (see **Figure 2**), with more details provided in the subsections that follow (**subsections 7.1-7.4**).

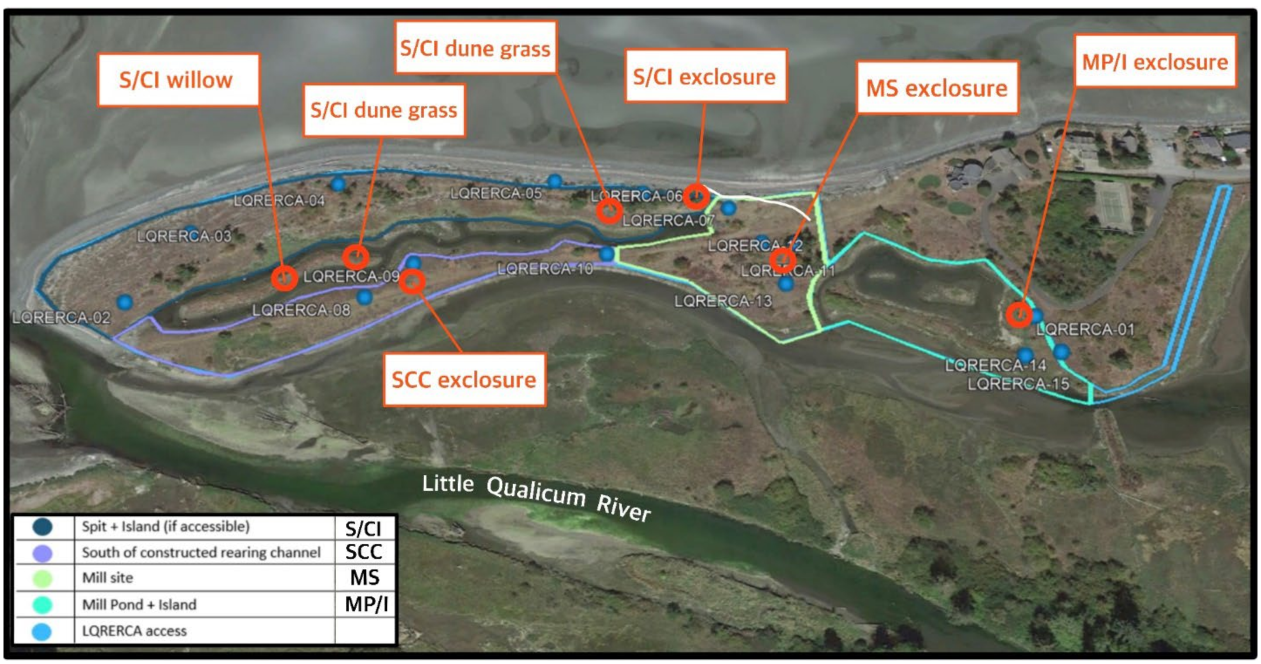

Figure 2 Proposed Pilot Plantings

For sub-area S/CI (Spit and Island within Constructed Rearing Channel), 4 separate pilot plantings are proposed. Given apparent site challenges with respect to existing tree vigour and health (e.g., general decline of Douglas firs) in this outer estuary location, a proposed exclosure planting with shrubs/trees is considered a low priority. If an exclosure is pursued, only the most hardy, salt- and drought-tolerant tree/shrub species should be planted. The planting of dune grass on the seashore to stabilize erodible sediments is rated as a high priority, while dune grass plantings and installation of willow (in particular, Scouler's willow) cuttings on the island in the constructed rearing channel are both rated moderate.

For the remaining 3 sub-areas (SCC – South of the Constructed Rearing Channel; MS – Mill Site; and Mill Pond and Island – MP/1), exclosures with trees/shrubs are proposed.

Sub-area SCC is considered most suitable of all LQRERCA sub-areas for installation of multiple exclosures and is rated as a high priority, given site conditions (including soils), past successes, and opportunity to establish plantings in prime locations on the south side of the rearing channel. Multiple exclosures in this sub-area could also be used to test revegetation success with different combinations of the various trees and shrubs listed in **Section 6.0**.
Single exclosures are proposed for sub-areas MS (priority rating: moderate) and MP (priority rating: low), the latter of which should be planted with the most hardy, salt- and drought-tolerant trees/shrubs if pursued.

Table 4 Proposed Pilot Program

	Pilot planting	Location	Timing	Recommended Maintenance	Priority
S/CI	1 exclosure	Near soil sample site LQRERCA-06, east end of spit	Fall	Water, weed, follow-up fertilization and ensure exclosure is fully functioning	Low
	Dune grass on seashore	North of soil sample site LQRERCA-06, on seaward-facing shoreline of spit	Late winter	Weed	High
	Dune grass on island	2 plots on north-facing and south-facing sides on the eastern end of island in rearing channel	Fall	Weed	Moderate
	Willow cuttings	2 plots on either side of island in rearing channel, one on south-facing slope and other on north-facing slope (latter of which is in sub-area SCC, but described alongside other complementary plot to avoid redundant descriptions)	Late winter	Weed	Moderate
SCC	1+ exclosure(s)	Primary exclosure near soil sample site LQRERCA-09; any additional exclosures can be sited between this location and westernmost pre-existing exclosure (i.e., west of soil sample site LQRERCA-08)	Fall	Water, weed, follow-up fertilization and ensure exclosure is fully functioning	High
MS	1 exclosure	Near soil sample site LQRERCA-13 (existing grassy area)	Fall	Water, weed, follow-up fertilization and ensure exclosure is fully functioning	Moderate
MP/I	1 exclosure	Near soil sample site LQRERCA-1	Fall	Water, weed, follow-up fertilization and ensure exclosure is fully functioning	Low

7.1. Sub-area S/CI

Three different pilot planting options are proposed for sub-area S/CI, as detailed below.

7.1.1. Exclosure with Trees/Shrubs

This pilot planting would involve installation of a **large, triangular- or trapezoidal-shaped exclosure** (widest side oriented to south, with opposite-side, directed north). Although the precise location would need to be finalized with field-truthing, it should be located near soil sample site LQRERCA-06 and within a suitable gap between any larger, naturally occurring vegetation. Soil analysis results suggest this general location may be more favourable for revegetation than areas further to the west along the spit (e.g., lower sodium levels and typically higher levels of other major nutrients towards the spit's eastern end). This location would also reduce the irrigation system piping distance, with the expectation that any water would be supplied from just east of the spit.

Planting would occur in the fall, consisting of shore pine (minimum #2 pot size, at least 1.0 m height) along the south side, followed by deciduous tree(s) (e.g., Pacific crabapple and/or black hawthorn) and then a combination of common snowberry, mock orange, Nootka rose, oceanspray, and thimbleberry towards the tapered limits of the exclosure.

A planting density of 2.0 to 2.5 m (centre-to-centre spacing; rectangular grid pattern) is recommended for trees, with shrubs spaced 1.0 m apart. As applies to any test plots described in this section, planting efforts and follow-up maintenance should be undertaken with guidance from **Section 8.0** of this report, with monitoring as generally described in **Section 9.0**.

7.1.2. Dune Grass on Seashore

This would involve establishing a **test plot of dune grass on the seaward side of the spit**, likely north (seaward) of soil sample site LQRERCA-06. The distance for this test plot from the adjacent intertidal zone should be informed by evidence of persistent wrack line and/or presence of existing vegetation (note: no exclosure is proposed, as herbivory is expected to be minimal).

Planting should occur in the late winter (i.e., early to mid March); fall planting should be avoided in case winter storms impact the edge of spit before dune grass plantings can properly root out.

A minimum of 25 plants should be planted, with a recommended planting density of 0.5 to 1.0 m (centre-to-centre spacing; rectangular grid pattern; at 0.5 m spacing, a test plot of 25 plants would be 4 m^2).

Maintenance should focus on weeding, with any watering pursued (1st year only) only if a nearby exclosure is installed and watering can be readily facilitated by an irrigation system.

7.1.3. Dune Grass on Island

This would involve establishing **2 rectangular-shaped test plots of dune grass on the eastern end of the island**, including one area on the north-facing slope and another on the south-facing slope of the island. Neither plot would need to be in an exclosure, test plot elevations should be informed by elevation of established dune grass on southside of the spit.

Planting should occur in the fall, as there is no anticipated risk from winter storms.

A minimum of 25 plants should be planted in each test plot, with a planting density of 0.5 to 1.0 m (centre-to-centre spacing; rectangular grid pattern; each test plot of 25 plants would be 4 m^2 in size if a spacing of 0.5 m is used).

Maintenance should include only weeding and no watering, given challenges with access.

7.1.4. Willow Cuttings on Island

Scouler's willow cuttings would be planted within two rectangular-shaped test plots in a central portion of the channel, including one plot on the south-facing slope of the island and another plot on the opposite, north-facing slope of the channel (note: north-facing plot is actually in SCRC sub-area, but discussed here to reduce redundancy). Similar to the proposed dune grass plantings, the elevation of these plots (location on slope, above high tide and/or wrack line) should be informed by elevation of other trees/shrubs on channel edge; neither plot needs to be in an exclosure.

Planting should occur in the late winter (i.e., early to mid-March).

It is recommended that a minimum of 30 cuttings be installed in each test plot, likely 3 parallel rows of cuttings over a 1.5 m slope distance for a distance of approximately 5 m. A planting density of 0.5 m (centre-to-centre spacing; rectangular grid pattern) is proposed (plot size: 5.5 m^2).

As with dune grass plantings on the island, the only proposed maintenance is limited weeding.

7.2. Sub-area SCC

Similar to sub-area SC/I, this would entail installation of **at least one large, triangular- or trapezoidal-shaped exclosure planted with native trees/shrubs** (widest side oriented to south, with opposite-side, directed north).

The location for a primary exclosure would need to be field-truthed, but it should be situated near soil sample site LQRERCA-09, which is close to where previous exclosure plantings have been relatively successful.

Fall-time plantings should be pursued with shore pine (minimum #2 pot size, ideally at least 1.0 m height) along the south side, followed by deciduous tree(s) (e.g., Pacific crabapple and/or black hawthorn) and then a broader combination of shrubs than proposed for sub-area S/CI within the tapered limits of the exclosure (i.e., common snowberry, mock orange, Nootka rose, oceanspray, Pacific ninebark, red flowering currant, saskatoon berry, and thimbleberry). As with sub-area S/CI, planting densities of 2.0 to 2.5 m for trees and 1.0 m for shrubs (centre-to-centre spacing; rectangular grid pattern) are recommended.

Pilot planting efforts in sub-area SCC should likely include additional and similar shaped exclosures, likely between soil sample site LQRERCA-09 and the westernmost existing exclosure (i.e., west of soil sample site LQRERCA-08). If at least two exclosures were installed, different combinations of coniferous/deciduous trees and/or shrub species could be planted; this would provide a good opportunity to further evaluate the suitability of plants like mock orange, oceanspray, and Pacific ninebark.

Maintenance and monitoring should follow guidance provided in **Section 8.0** and **9.0** of this report, as applies to all the proposed exclosures.

7.3. Sub-area MS

As with sub-area S/CI, a single large, triangular- or trapezoidal-shaped exclosure with native trees/shrubs (widest side oriented to south, with opposite-side, directed north) should be pursued. Any revegetation efforts should avoid several patches of naturally occurring plants and focus instead on enhancement of an existing grassy area which overlaps with soil sample site LQRERCA-13, where some of the most optimal sub-area soil conditions, including lowest sodium levels, were detected.

Unlike sub-area SCC, a single exclosure is proposed for sub-area MS as it has not been pursued for revegetation in the past, is relatively well vegetated compared to other sub-areas, and does not extensively interface with natural or constructed aquatic fish habitats (e.g., river, rearing channel, or mill pond).

The same approach taken for sub-area SCC should be applied here, including plant spacing, with fall-time plantings of shore pine (minimum #2 pot size, ideally at least 1.0 m height) along the south side of the exclosure, followed by deciduous tree(s) (e.g., Pacific crabapple and/or black hawthorn) and then a broad range of shrubs (i.e., common snowberry, mock orange, Nootka rose, oceanspray, Pacific ninebark, red flowering currant, saskatoon berry, and thimbleberry).

7.4. Sub-area MP/I

Consistent with the approach proposed for S/CI, a single triangular- or trapezoidal-shaped exclosure planted with native trees/shrubs (widest side oriented to south, with opposite-side, directed north) is proposed. A final location would need to be field-fitted, but it should likely be near soil sample site LQRERCA-01, within a suitable gap between previous planting and any naturally occurring vegetation (note: soil analysis results indicate lower sodium levels in this location).

As with the proposed tree/shrub plantings in sub-area S/CI, fall-time plantings of shore pine (minimum #2 pot size, ideally at least 1.0 m height) along the south-facing side, followed by deciduous tree(s) (e.g., Pacific crabapple and/or black hawthorn) and then a combination of shrubs most suitable for this sub-area towards the tapered limits of the exclosure (i.e., common snowberry, mock orange, Nootka rose, oceanspray, and thimbleberry). This plant list, which is abbreviated from that proposed for sub-areas SCC and MS, is intended to focus on the most hardy, salt- and drought-tolerant species.

8.0 Planting Best Management Practices

Based on general best management practices for native planting in British Columbia and as extensively informed by numerous years of revegetation experience within the LQRERCA by

BCCF and QBSS, this section provides an overview of preferred approaches for future planting efforts.

Included is a discussion of timing for planting (**Subsection 8.1**), exclosures (**Subsection 8.2**), plant installation (**Subsection 8.3**), and maintenance (**Subsection 8.4**).

8.1. Timing for Planting

Fall (October to early December) is generally considered the most optimal time for restoration/enhancement plantings in southwestern BC, given the frequent occurrence of long, hot summers with low levels of precipitation. Fall plantings provide an opportunity for some plant growth during the cooler, wet season (including subsurface root growth, which can be substantive even when above-ground growth is in senescence) and earlier plant establishment at the start of spring. There is some risk of impacts on fall plantings from inclement winter weather, but generally the pros outweigh the cons of spring plantings.

Furthermore, the potential for summer droughts and water conservation measures that might limit the ability to water plants, or irrigate as much as may be really warranted, also reinforces a default preference for fall plantings.

A notable exception applies to the planting of cuttings (e.g., Scouler's willow) versus potted plants, as discussed further below. Early spring (or even late winter, potentially late February to mid-March) are usually optimal times for the installation of cuttings. Likewise, this is an appropriate timing for the planting of dune grass and other marine foreshore plants to minimize risk of physical disturbance from winter storms.

8.2. Exclosures

Establishment of exclosures with group plantings has been and should continue to be a primary approach taken for LQRERCA revegetation. As shown in the past, exclosures are essential for protection against potential herbivory by deer and rabbits. In addition, exclosures work well with the concept of companion (or group) plantings, which may improve survivorship, with the grouping of plants also better facilitating maintenance (including weeding and watering) and streamlining monitoring efforts.

Given recent transition by the QBSS towards the establishment of less permanent exclosures supported by metal angle-iron posts instead of the more substantial exclosures installed in the past (i.e., wooden posts and page wire), should continue providing that intended objectives are achieved. As these exclosures are less expensive, easier to install, and more durable, they can provide long-term benefits to ongoing revegetation efforts.

8.2.1. Group Plantings

Many native plant species occur in nature within natural companion groupings, which is often influenced by microsite conditions, availability of propagules (including seed), successional processes, competitive interactions, and similar factors. In addition to physical site conditions, certain native plants may provide microsite conditions that can lead to the successful establishment and persistence of other plants; for instance, shade and shelter provided by larger plants (e.g., trees) may promote growth and survivorship of smaller shrubs (e.g., shrubs).

There are several natural examples where different species of native plants are growing together and apparent benefits are being conferred from one species to another at the LQRERCA. For instance, within the SCC there are long-established, mature Pacific crabapple trees growing on the south side of relatively dense patches of common snowberry; immediately adjacent areas without tree cover do not support similar shrub patches. One of the native shrub species most suited for ongoing use in revegetation efforts in the LQRERCA is common snowberry, as they became established without any human intervention.

Exclosures are, by design, well suited for group plantings. Larger conifers (e.g., shore pine) should be planted on the south side of future exclosures with smaller stock shrubs (e.g., common snowberry, thimbleberry, and Nootka rose) on the north side of these trees is continued in new exclosures.

Incorporation of ground cover plants: Seeding with drought-tolerant, deer-resistant ground cover plants may help support shrub/tree establishment within exclosures, by helping retain soil moisture, build soil, and suppress weeds. Seed mixes that include a variety of native perennials and grasses should be considered, with sowing times selected based on the species mix (including potential need for cold stratification to break seed dormancy), water availability, and other factors.

8.3. Plant Installation

Provided in the two subsections below are descriptive approaches for the planting of both potted plants and cuttings, which can be used as a guide for future revegetation efforts within the LQRERCA.

8.3.1. Potted Plants

Dig holes approximately twice as large in diameter as the pot width and at least 8 to 10 cm deeper than the pot height, then backfill the excavated hole with enough loose soil so that the top of the root mass will end up two to four centimetres below ground level. Add a handful (approximately half a cup) each of bone meal and canola meal into the hole and mix into the loose soil prior to planting.

To safely remove plants from their pots, the planter’s hand should be placed on the soil surface with the stem between the index and middle fingers prior to inverting the plant. Once inverted, the pot can be removed and then the planter’s other hand placed on the bottom of the root-mass to support it prior to turning the plant right side up. The plant roots should be disturbed as little as possible, unless the plant is highly rootbound (i.e., tight roots, encircling the root-mass) in which case the outside of the root-mass should be loosened.

Place in the hole and backfill with suitable imported topsoil and lightly tamp in the soil on sides and lightly top-dress the root mass with a thin layer of soil, making sure that no surface roots are exposed.

During planting, a ‘watering basin’ should be built around each plant, consisting of a depression two to four centimetres deep, which will assist with precipitation capture and irrigation water retention. If the ground is slightly sloped, a ridge of soil can be established on the lower side to form a watering basin.

Water thoroughly, prune off any damaged branches, and tag the plant with a unique identifier (e.g., plastic tag with indelible marker, indicating species using BC plant codes, unique plant number, and date planted).

For any locations within the LQRERCA that are known to be characterized by more alkaline soils (e.g., most locations in sub-area SC/I), add one handful (approximately half a cup) of elemental sulphur within the watering basis. This can be spread around the plant base and out to the drip line, within the area that will subsequently be covered with mulch. Alternatively, it can be mixed in with the mulch and spread at the same time. Mulch around each plant (a few centimetres in depth) with an appropriate mulching medium (e.g., bark mulch) to help preserve soil moisture and limit weed competition. Avoid burying the plant stem with mulch (i.e., pull mulch about 4 to 6 cm back from the stem).

8.3.2. Cuttings

Any cuttings taken for installation should be from “new growth” (i.e., previous growing season), with a minimum diameter of 0.5 cm (i.e., thick as a pencil) and at least 0.3 m in length. Both harvested stems/branches and resultant cuttings should be handled with care prior to installation; keep them cool, moist, and do not expose them to sunlight or wind. Harvest no more than 24 to 48 hours before installation, taking bundled cuttings and burying them in moist wood chips in a cool, shady place. Cuttings should also be soaked before planting.

Longer cuttings can be inserted deeper for better access to soil moisture. Cuttings should be buried to about 75% of their length; at least one or two buds need to be established above ground.

As it is critical that any cuttings are planted the right way up and to facilitate insertion into the ground, a common “best practice” approach is to do the following when harvesting cuttings:

- Angle the bottom cut across the cutting (or whip) just below a bud (node)
- Make the top cut horizontal and approximately two centimetres above the uppermost bud (allows for a zone of desiccation
- Orient all cuttings the same way and tie them in bundles for storage/transport

Installation of cuttings can be done with dibblers or lengths of rebar and a mallet, which is used to generate a hole. The hole diameter should approximate the cutting’s diameter to maximize soil contact and avoid excess water accumulation in the hole; the hole depth should ensure the proper insertion depth. To finish installation, the soil should be stamped in around each cutting to tighten up the earth around it and then “watered in”.

Mulching can also be done around cuttings using the same methodology as described in "Potted Plants" above.

8.4. Maintenance

Previous experience with LQRERCA revegetation clearly demonstrates that maintenance (or "after-care") will be essential for the successful establishment of native plants. This should include not only irrigation (watering) and weeding, but potentially also follow-up fertilization, exclosure repairs, and plant-specific interventions (e.g., staking of any trees bent from snow-crush).

Maintenance needs should be further informed by annual monitoring efforts, primarily conducted at the end of each growing season (e.g., late September) with some reconnaissance-level evaluations also done each spring.

8.4.1. Irrigation

Based on past experience within the LQRERCA and standard best practices for challenging sites like the LQRERCA, irrigation should be supplied for the first two summers following installation for most plantings.

With the understanding that the irrigation approach and schedule implemented starting in 2020 was generally effective, it is recommended that early morning watering occur for 30 minutes every two to three days (e.g., 0500 hours every Tuesday, Thursday, and Sunday) throughout the summer months.

Given the recent occurrence of pre-summer droughts that can begin as early as May and extend through early October (e.g., 2023), plans should be in place to initiate irrigation as early as mid-May and continue into September. When precipitation in the past two weeks has been less than five millimetres and there is no substantive rain in the 14-day forecast, it is likely time to begin watering.

To ensure that this suggested approach is sufficient for plantings within the LQRERCA, it would be useful to monitor the plants quite closely during the first lengthy dry period (e.g., two to three weeks).

Watering should be slowly reduced starting in early September (e.g., stepping down from three to two and then one day per week, over a three week period), as this encourages dormancy in plantings.

<u>Watering Contingency Plan</u>

Irrigation within the LQRERCA is currently dependent upon municipal water which is piped overland from an adjacent private property; in the summer of 2024, the area was on Stage 4 watering restrictions with a high risk of salt update. Even with drip water in place, water usage has been approximately one cubic metre of water per day in the hot summer months.

As there is some potential for future watering restrictions to require the curtailment of irrigation when some watering is still considered vital for establishment of newer plantings, a watering contingency plan should be developed.

This plan should include measures to reduce watering needs and alternate sources of water for more critical plantings. The following are some measures and approaches which may be considered:

Reduce watering needs

- Modify planting plans/approaches to limit need for watering (e.g., minimize new planting areas each year and/or focus on more drought-tolerant plants)
- Add natural soil amendments which help retain water (e.g., peat moss) to the top soil layer
- Consider adding biodegradable hydrocolloids (e.g., Hydrogel) in amended soils
- Increase the thickness of organic mulch
- Plant patches of native ground-covers (e.g., kinnikinnick, *Arctostaphylos uva-ursi* or beach strawberry)

Alternate sources of water

- Deploy water storage tank nearby (e.g., boundary of RDN/Sawers property) as a contingency water supply to support supplemental watering by ATV or alternate
- Install slow-release tree watering bags for key trees and larger shrubs (e.g., south-facing side of exclosures)

8.4.2. Weeding

Weeding should occur in conjunction with a mid-growing season inspection, with a specific focus on removal of larger weeds and/or any noxious or invasive species that may be detected. Weeding should ideally occur before any target species have gone to seed; if seed heads are present, they can be clipped and bagged for offsite disposal.

8.4.3. Follow-up fertilization

Follow-up fertilization will likely be of benefit in all sub-areas, especially where any exclosures have been installed. The addition of fertilizers (e.g., bone meal and/or canola meal) should ideally be pursued a minimum of every second year. Fertilizer addition should occur in the spring, in conjunction with proposed reconnaissance-level monitoring efforts.

For more alkaline soils in sub-areas S/I or M/PI, where elemental sulphur may have been added, additional treatments may be required on an annual basis. This can be undertaken by top-spreading sulphur within the mulched zone around each plant (i.e., one handful or half a cup).

8.4.4. Plant-specific interventions

In the event that any snow-crush impacts are detected during spring monitoring efforts, bent trees or shrubs can be temporarily staked. Conifers with double-leaders can be pruned to re-establish a primary leader and any dead branches can be clipped, if considered desirable. Although clipping dead branches is an activity often focused more on aesthetics than plant health, removal of dead branches may support future monitoring by helping the monitor distinguish between older versus newer changes in plant health (e.g., branch die-back, from extended droughts).

8.4.5. Infrastructure repairs

As informed by reconnaissance-level monitoring in the spring, any necessary infrastructure repairs should be undertaken as soon as feasible to ensure proper function of exclosures to minimize the risk of herbivory impacts.

9.0 Monitoring

Monitoring will be essential for the evaluation of the success of revegetation efforts, which can be used to determine which pilot plantings are successful and how to guide more extensive revegetation efforts throughout the LQRERCA.

Monitoring should be pursued in both the spring (e.g., early to mid-March) and early fall (e.g., late September). In addition, at least one mid-growing season inspection would be beneficial and can coincide with a weeding event. Additional summertime inspections may also be required to ensure that adequate irrigation is being provided.

Spring monitoring should be undertaken in early to mid-March, involving reconnaissance-level evaluations after the winter period to determine if there have been any specific winter-time impacts on plants (e.g., snow crush, small mammal herbivory, etc) or exclosures. The results of spring monitoring will inform any maintenance needs (e.g., staking of trees, exclosure repairs, etc), which should be implemented in a timely fashion.

Fall monitoring of plants within exclosures should involve inspection of individual plantings as denoted by unique identifying tags that were attached to each plant during installation. Monitoring should include health status (vigour value, based on a zero to three scale as used in the past by BCCF/QBSS) and any sign of browse, sun/heat stress, insect damage, or similar observations. It is also recommended that the height and diameter at breast height (DBH) be measured for each planted tree (deciduous or coniferous). Any natural recruitment of native plants, vegetative spread of plantings (e.g., suckering roots of common snowberry or Nootka rose), or growth of grasses or weeds should be noted.

Dune grass and willow cuttings, for which unique identifying tags can be considered unnecessary, can be evaluated as a grouping with the number of plants per vigour value tallied for each specific plot.

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