

Coats Marsh – Weir Pond Restoration Plan



Prepared For

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Down to Earth Biology

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

Coats Marsh Regional Park is the first protected wetland on Gabriola Island and is managed by the Regional District of Nanaimo (RDN) (RDN n.d.). This regional park is in the traditional territory of the Snuneymuxw First Nation. As identified in the Coats Marsh Regional Park Management Plan: 2011-2021, the primary management objective for the park is environmental conservation (RDN 2011). The wetland complex within the park is controlled by a concrete outlet weir and an upstream beaver dam. For the purpose of this restoration plan, the “marsh area” is defined as the full extent of the Coats Marsh wetland complex impounded by the existing weir and beaver dam (see Appendix A). This report focuses specifically on the smaller “weir pool area,” defined as the wetted area immediately upstream of the outlet weir but below the beaver dam.

In 2020, it was determined that the weir had deteriorated, and there was a risk of downstream flooding to private property if the structure failed. A subsequent study (NHC 2023a, 2023b) evaluated both weir replacement and decommissioning options, after which the RDN elected to pursue a weir decommissioning plan that retains the upstream beaver dam as the preferred management approach.

As outlined in the Preliminary Dam Decommissioning Plan Report (NHC 2023b), the primary objective of decommissioning is to remove the concrete weir and restore natural marsh hydrology. The preliminary plan assumes that the upstream beaver dam will be left intact during and after decommissioning. Additionally, a 1.2 m high concrete grade control structure is proposed at the current weir location to reduce erosion and sediment mobilization from upstream and to partially restore the controlling bed level that existed prior to historical blasting of the marsh outlet channel. The Dam Safety Regulation (DSR) requires that decommissioning be conducted in a manner that mitigates adverse impacts on public safety, the environment, infrastructure, and private property.

To address flooding concerns on adjacent properties west of the marsh, the existing berm (saddle dam) will be retained and backfilled to function as a landscape feature rather than an active water-retention structure. Additionally, the project includes the provisional creation of back-channels to improve aquatic and emergent habitat for northern red-legged frogs (*Rana aurora*) and other amphibian species. These side channels, if deemed feasible following site dewatering, will be designed to a minimum depth of 0.5 m, with a 1.2 m base width and side slopes of 3H:1V or shallower, ensuring positive drainage toward the main channel. Preliminary designs have been included in the project scope as provisional items.

Several environmental and hydrological assessments have been conducted within Coats Marsh and downstream watersheds, including:

- Coats Marsh Weir Removal: Environmental Impacts and Mitigation Measures for Weir Pool Area (EDI 2024)
- Coats Marsh Weir Decommissioning – Beaver Dam Risk Assessment Final Report (NHC 2024)



- Coats Marsh Weir Replacement Elevation Study – Final Report (NHC 2023a)
- Coats Marsh Dam Preliminary Decommissioning Plan Report (NHC 2023b)
- A Proposed Strategy for Water Level Management – Coats Marsh, Gabriola Island, BC (Madrone Environmental Services 2021)
- Coats Marsh Weir Assessment (SRM Projects 2020)
- Coats Marsh Regional Park – 2011-2021 Management Plan (RDN 2011)
- Citizen-science studies from local Gabriola Island resident N. Doe and Gabriola Streamkeepers (Doe 2019, Doe 2020, Doe 2021, Doe 2023)

EDI has prepared a habitat assessment of the wetland (EDI 2023) and a weir decommissioning plan (EDI 2023a). A public engagement open house was held in January 2024 to present the preliminary decommissioning plan and gather community feedback. Following this process, RDN requested that EDI prepare an additional environmental assessment focusing on project effects and mitigation measures for the weir pool area. This restoration plan incorporates those findings and provides a framework for site restoration and habitat enhancement following decommissioning.

1.2 PROJECT OVERVIEW, GOALS AND OBJECTIVES

The decommissioning process involves the removal of the existing concrete weir, which will result in a significant reduction in the current wetted area of the weir pool. The current estimated wetted area of 2,393 m² will decrease to approximately 739 m² following decommissioning, leading to the dewatering of approximately 1,654 m² of aquatic habitat. The transition from open water habitat to swamp and riparian conditions will also affect the existing aquatic vegetation communities and amphibian habitat, necessitating efforts to restore the ecological functions of the area.

The project includes:

- Full weir removal to eliminate artificial water retention.
- Construction of a grade control structure to stabilize the stream channel.
- Potential creation of finger channels to increase aquatic and emergent habitat for amphibians (dependent on site conditions post-dewatering).
- Targeted restoration efforts focused on revegetation and invasive species control, particularly reed canarygrass (*Phalaris arundinacea*).

This restoration plan provides a structured approach to mitigating habitat loss and hydrological changes associated with the weir removal. The primary objectives include:

- Restoring wetland function in areas affected by dewatering.



- Supporting amphibian and riparian wildlife by maintaining breeding and foraging habitat.
- Controlling invasive reed canarygrass through mechanical suppression and competitive planting.
- Ensuring long-term ecological stability through revegetation and adaptive management.

This restoration plan is based on predicted conditions following dewatering; however, actual hydrologic and vegetative conditions in the newly exposed wetland areas, particularly in Treatment Units 1 and 2, will only be confirmed post-dewatering. The extent to which native vegetation establishes naturally remains uncertain as does the extent cover of non-native reed canarygrass. To account for this, the plan includes an adaptive approach with staggered planting over two years and provisions for reassessing planting needs based on field observations. Further discussion of this uncertainty and how it will be managed is provided in Section 2.3 (Challenges & Considerations).

The key restoration goals are to:

- Re-establish native wetland vegetation within the newly exposed areas of the weir pool.
- Enhance amphibian habitat by maintaining breeding and rearing conditions for northern red-legged frogs.
- Promote a stable hydrological regime that supports wetland ecosystem function.
- Suppress invasive reed canarygrass to prevent monoculture dominance.
- Increase biodiversity by creating diverse wetland and riparian habitat structures.

The restoration strategy is designed to enhance:

- Hydrological Stability – Maintaining natural water level regulation and preventing erosion.
- Wildlife Habitat – Providing conditions for amphibians, birds, and riparian species.
- Vegetation Recovery – Encouraging native species establishment and outcompeting invasives.
- Water Quality – Implementing erosion and sediment control measures.

This restoration plan provides a framework for ensuring that Coats Marsh continues to function as a productive and ecologically valuable wetland following weir removal.

1.3 REGULATORY AND LIABILITY CONSIDERATIONS

The weir removal and associated restoration activities must comply with multiple provincial and federal regulatory requirements to ensure environmental protection, public safety, and legal compliance. Key considerations include:

- *BC Water Sustainability Act* (WSA) – Permitting requirements for dewatering and hydrological modifications.



- *Fisheries Act* – Ensuring sediment control measures prevent impacts on downstream fish-bearing waters.
- *Species at Risk Act* (SARA) – Protection of northern red-legged frogs, a species of special concern, through habitat mitigation measures.
- *Dam Safety Regulation* (DSR) – Requirements for decommissioning to prevent infrastructure failures and mitigate flood risks.
- Local and Regional Permitting – Compliance with municipal environmental policies.

The RDN is responsible for ensuring that the project meets all regulatory obligations and that restoration measures are effectively implemented to offset habitat changes resulting from the decommissioning process.

2 SITE DESCRIPTION

2.1 EXISTING CONDITIONS

2.1.1 LOCATION AND GENERAL CHARACTERISTICS

Coats Marsh is a protected wetland within Coats Marsh Regional Park on Gabriola Island, British Columbia, managed by the Regional District of Nanaimo (RDN). It forms part of a larger wetland complex that is regionally significant for its hydrological functions, biodiversity, and habitat connectivity (RDN 2011). The lower weir pool, which is the focus of this restoration plan, has been influenced by artificial water retention but continues to support wetland-dependent species.

Hydrological studies (NHC 2023a) indicate that the wetland is seasonally dynamic, with water levels fluctuating based on precipitation, groundwater contributions, and outflow regulation. The primary outflow is through the weir, which maintains elevated water levels in the weir pool (Photo 2-1). The total water storage capacity of Coats Marsh is estimated at 38,950 m³, with the weir pool retaining 5-7% of this volume.



Photo 2-1 Wood bridge over Coats Creek and adjacent to cement weir



2.1.2 OVERVIEW OF THE EXISTING CONDITIONS AT THE WEIR POOL

The weir pool is a shallow, open-water feature characterized by gradual water level reductions in late summer and seasonal flooding in winter (NHC 2023b). The existing weir influences hydrological stability, but the upstream beaver dam also plays a role in water retention and flow variability.

Prior to drawdown, the weir pool substrate consists of fine organic sediments overlaying mineral soils, with some areas exhibiting localized erosion near the outflow channel (SRM Projects 2020).

Hydrological assessments (NHC 2023b) have described key attributes of the weir pond as follows:

- Depth Variability: Seasonally influenced, with higher retention in winter and gradual exposure of marginal zones in summer.
- Soil Conditions: Organic-rich sediments, likely to compact upon dewatering, leading to shifts in vegetation succession.
- Water Chemistry: Neutral to slightly acidic pH, with high organic matter content supporting aquatic vegetation (EDI 2024).

2.1.3 VEGETATION COMMUNITIES, HYDROLOGY, WILDLIFE, AND FISH HABITAT

2.1.3.1 Vegetation Communities

The weir pool area supports a mix of aquatic, emergent, and riparian vegetation, shaped by seasonal inundation, substrate characteristics, and hydrological conditions. Past botanical assessments (EDI 2024) identified three primary vegetation zones:

- Aquatic vegetation – Found in permanently flooded areas.
- Emergent vegetation – Present in seasonally inundated zones.
- Riparian and transitional vegetation – Occurs in areas subject to periodic drying.

The open-water zone is characterized by yellow pond lily (*Nuphar variegata*), bladderwort (*Utricularia* spp.), and water smartweed (*Persicaria amphibia*). These floating-leaved plants provide habitat for aquatic invertebrates, amphibians, and potentially fish, contributing to primary productivity within the wetland ecosystem.

A 2-meter-wide and 50-meter-long open-water drainage channel runs through the center of the weir pool, directing flow from the beaver dam to the concrete weir. This submerged channel, which was likely excavated or blasted at the time of the weir's construction (NHC 2023a), serves as the primary conveyance pathway for water movement through the lower marsh.

In shallow, emergent areas, vegetation includes marsh horsetail (*Equisetum palustre*), pondweed (*Potamogeton* spp.), and sedges (*Carex* spp.). These species play an important role in sediment stabilization, nutrient cycling, and organic matter accumulation.



The riparian margins, which experience fluctuating soil moisture, are increasingly dominated by reed canarygrass, an aggressive invasive species. Without intervention, reed canarygrass will likely expand into newly dewatered areas, outcompeting native species and reducing habitat complexity.

2.1.3.2 Hydrology

Hydrological monitoring (NHC 2023a, 2023b) confirmed that seasonal water fluctuations in the weir pool are influenced by:

- Direct precipitation and watershed runoff, which supply water during the wet season.
- Groundwater seepage, which sustains base flow during drier months.
- Weir-regulated outflow, historically dampening seasonal fluctuations.
- Beaver activity, modifying water storage and drainage patterns.

The highest water levels occur between November and April, driven by precipitation and groundwater recharge. Gradual drawdowns occur from May to September, exposing seasonally inundated wetland margins. The presence of the weir has historically dampened variability, but post-removal, increased seasonal fluctuations are expected.

Hydrological modeling suggests that after the weir decommissioning, seepage through the beaver dam will play a larger role in determining residual wetland conditions during the drier summer months. This shift is expected to influence sediment transport, vegetation community succession, and aquatic habitat structure.

2.1.3.3 Wildlife Usage

The weir pond and adjacent wetland areas provide critical habitat for amphibians, waterfowl, songbirds, and mammals, many of which depend on shallow-water wetlands for foraging, breeding, and shelter. Recent ecological surveys (EDI 2024) confirmed the presence of key species within the wetland.

Amphibians and Reptiles

The northern red-legged frog, a Species of Special Concern under the Species at Risk Act (SARA), is a confirmed breeding species within the weir pond (COSEWIC 2004). This species depends on shallow-water wetlands for egg-laying and larval development (Maxcy 2004). Other species include Pacific chorus frogs (*Pseudacris regilla*) and rough-skinned newts (*Taricha granulosa*), which rely on shallow aquatic zones for egg-laying and larval development.

Birds

The lower weir pond supports both resident and migratory waterfowl, including but not limited to:

- Trumpeter swans (*Cygnus buccinator*) – Wintering populations observed from November to February.



- Mallards (*Anas platyrhynchos*) – Commonly found foraging along emergent margins.
- Canada geese (*Branta canadensis*) – Utilizing both open water and riparian buffers.
- Green-winged teal (*Anas crecca*) – Prefer shallow flooded areas for feeding.

Riparian shrubs and emergent vegetation also provide nesting habitat for songbirds, including the Pacific wren (*Troglodytes pacificus*) and spotted towhee (*Pipilo maculatus*). Raptors such as bald eagles (*Haliaeetus leucocephalus*) have been observed hunting at the wetland margins, indicating the presence of small prey species.

Mammals

Mammal species documented in previous surveys include:

- Beavers (*Castor canadensis*), which actively shape wetland hydrology by maintaining the upstream beaver dam, regulating water retention and vegetation structure.
- Black-tailed deer (*Odocoileus hemionus columbianus*), commonly foraging in riparian transition zones.
- River otters (*Lontra canadensis*), which travel through the weir pond, though their presence is likely limited due to the absence of a permanent fish population.
- Raccoons (*Procyon lotor*), which utilize the wetland for foraging opportunities along the pond margins.
- Red squirrels (*Tamiasciurus hudsonicus*), present in adjacent forested areas, often venturing into the wetland for food.
- Small mammals, including deer mice (*Peromyscus maniculatus*) and Townsend's voles (*Microtus townsendii*), which likely inhabit riparian grasslands surrounding the wetland.
- Bats (*Myotis* spp.), with seasonal foraging activity observed over the wetland, indicating an abundant insect prey base.

The weir pool area is ecologically significant within the broader Coats Marsh wetland complex. As seasonal hydrological variability increases post-weir removal, monitoring will be necessary to track species responses to habitat changes and inform adaptive management strategies.

2.1.3.4 Fish and Fish Habitat

Historical fish surveys and habitat assessments confirm that Coats Marsh does not support a resident fish population. Multiple sampling efforts, including fish roe-baited minnow trapping by EDI (2023, 2024), found no fish. Instead, amphibians such as northern red-legged frogs, Pacific chorus frogs, and rough-skinned newts were present.

Barriers to fish passage have likely prevented fish from establishing in Coats Marsh. Key barriers include:

- A 3.3-meter-high concrete weir, preventing upstream movement.



- Two 1.5-meter-tall rock dams downstream, blocking connectivity.
- A bedrock step near Hoggan Lake, further restricting passage.

Despite historical records of cutthroat trout (*Oncorhynchus clarkii*), rainbow trout (*Oncorhynchus mykiss*), and three-spined stickleback (*Gasterosteus aculeatus*) in downstream waters, no evidence supports their occurrence in Coats Marsh.

Given the absence of suitable habitat and connectivity, fish passage restoration is not a primary goal. Instead, restoration efforts focus on enhancing wetland function and amphibian habitat.

2.2 POST-DEWATERING CONDITIONS (PREDICTED)

The decommissioning of the weir will significantly alter the hydrology, soil conditions, and vegetation composition of the weir pool area, resulting in a reduction of aquatic habitat and a transition to swamp and riparian environments. The current wetted area of 2,393 m² will decrease to approximately 739 m², leading to the dewatering of 1,654 m² of former marsh habitat. This newly exposed area will no longer function as open water or marsh habitat but is expected to transition into a swamp ecosystem characterized by frequent soil saturation and a shallow water table. The shift in hydrological conditions will promote the establishment of shrubs and transitional riparian habitat, with targeted revegetation efforts supporting the growth of appropriate native species to enhance long-term ecological function.

The remaining wetted area within the new annual high-water mark will still provide a mix of open water and marsh habitat, but the reduction in edge habitat and overall wetted area will result in a decline in aquatic vegetation. Species such as yellow pond lily, water smartweed, and bladderwort are expected to decrease in abundance, along with emergent vegetation such as pondweed, sedges, and marsh horsetail.

In addition to hydrological changes, the project includes the establishment of two soil spoil sites outside of the weir pool's existing wetted perimeter, covering a combined 420 m². These areas, currently dominated by shrubs and grasses with minimal tree cover, will experience temporary vegetation loss but will be revegetated as riparian forest habitat post-construction to support long-term ecological function. The deposition of excavated soils at these sites is also intended to help suppress reed canarygrass encroachment, reducing the risk of invasive expansion into newly exposed wetland areas.

As part of the restoration effort, provisional back-channels or “finger” channels have been proposed to increase the amount of aquatic and emergent habitat. These finger channels will be assessed for feasibility after weir removal, with final designs contingent on on-the-ground hydrological and substrate conditions. If implemented, these channels would add an additional 81 m² of aquatic habitat, increasing the total open-water area to 820 m². Additionally, up to 221 m² of new marsh habitat could be established, expanding the zone for emergent vegetation recruitment. These enhancements would provide additional egg-laying habitat for amphibians such as northern red-legged frogs and Pacific chorus frogs helping to mitigate the loss of some amphibian breeding habitat.



2.3 CHALLENGES & CONSIDERATIONS

2.3.1 VEGETATION AND HYDROLOGY UNCERTAINTY

The transition from open water habitat (currently 2,393 m²) to a reduced open water area of approximately 739 m² following the weir removal will significantly alter aquatic vegetation communities and amphibian habitat. The remaining 1,654 m² of dewatered land is expected to transition into swamp and riparian conditions. However, because post-dewatering conditions remain uncertain, an adaptive planting strategy will be implemented (see Uncertainty in Post-Dewatering Conditions and Adaptive Management in this section). This approach allows for planting densities and species selection to be adjusted based on actual hydrological and vegetative conditions.

The newly exposed 1,654 m² of land will experience fluctuating moisture levels, and the degree of natural revegetation remains unknown. While this plan assumes planting of the entire treatment units TU1 (627 m²) and TU2 (1,125 m²), the presence of residual native vegetation post-dewatering may reduce planting requirements in some areas. If significant natural recovery occurs, fewer plantings may be required, and efforts can be focused on infill planting and invasive species suppression instead.

2.3.2 INVASIVE SPECIES CONSIDERATIONS

Without active management, reed canarygrass may colonize dewatered areas, particularly within TU1 and TU2. The primary strategy for managing this risk will be to complete planting as early as possible to encourage the establishment of native vegetation, reducing opportunities for reed canarygrass to take hold. If natural revegetation occurs more extensively than expected, planting densities may be adjusted, and suppression efforts may be minimized (see Uncertainty in Post-Dewatering Conditions and Adaptive Management in this section). While targeted mechanical removal may be used in high-density reed canarygrass areas, the focus will remain on establishing competitive native vegetation. These strategies will be reassessed after Year 1 to ensure that restoration efforts remain effective and resource efficient.

2.3.3 HYDROLOGICAL CHANGES AND BEAVER ACTIVITY

The final hydrological outcome of the weir removal remains an area of uncertainty. While modeling suggests that flows over, and seepage through, through the beaver dam will help maintain seasonal wetland conditions, the actual extent of soil saturation, hydrological persistence, and seasonal flooding will depend on several factors, including beaver activity, seasonal precipitation, and drainage effectiveness.

Following dewatering, the remaining 739 m² of open water habitat will persist, but 1,654 m² of the former weir pool will no longer function as open water and is expected to transition into swamp and riparian habitat. However, if water retention is lower than anticipated, some areas may dry more rapidly, resulting in a shift to meadow or shrubland habitat rather than a saturated swamp. Similarly, if beaver activity increases post-weir removal, portions of the site may remain flooded longer than predicted.



To address these uncertainties, restoration strategies—including planting densities, species selection, and invasive species control—will be reassessed post-dewatering as outlined in Uncertainty in Post-Dewatering Conditions and Adaptive Management. This adaptive approach ensures that restoration measures align with actual site conditions rather than fixed assumptions.

2.3.4 UNCERTAINTY IN POST-DEWATERING CONDITIONS AND ADAPTIVE MANAGEMENT

The restoration plan for Coats Marsh has been developed based on predicted/modeled post-dewatering conditions. However, the actual hydrologic and vegetative conditions that will be encountered will remain somewhat uncertain until dewatering occurs. The degree of flooding and presence of existing native vegetation within the dewatered areas (particularly TU1 and TU2) will only be confirmed through post-dewatering assessments.

A key assumption in this plan is that all treatment units except TU3 will require full planting. However, native wetland vegetation may naturally establish in some areas, reducing planting requirements. The presence of residual seed banks or buried rootstocks could facilitate natural recovery, allowing for a more targeted approach to revegetation efforts.

To accommodate these uncertainties, the restoration plan incorporates an adaptive planting strategy, implemented as follows:

- Year 1
 - In TU1 and TU2 (Lower Elevation Areas): Initial planting will focus on reduced-density flood-tolerant species, as these treatment units have a higher risk of future flooding due to potential beaver activity.
 - In TU3 and TU4 (Higher Elevation Areas): Full planting will be completed in Year 1 to maximize native vegetation cover and improve competition with reed canarygrass.
- Year 2
 - Remaining planting in TU1 and TU2 will be completed based on post-dewatering assessments and observed hydrological conditions.
 - Reassessment of site conditions and adjustment of planting efforts across all treatment units based on vegetation establishment and water levels.



2.3.4.1 Adaptive Management Measures

A range of adaptive management measures have been incorporated to address potential variability in site conditions following weir removal. These include:

- Water Level Threshold for Planting Plan Review:
 - If water levels at the outlet meet or exceed 95.5 m (i.e., an additional 0.5 m above the anticipated post-weir removal level of 95.0 m), a formal review of the planting plan will be triggered to determine whether adjustments are needed.
 - If sustained higher water levels are observed—whether due to beaver activity or other factors—species composition and planting locations may be adjusted to prioritize flood-tolerant species and reduce the risk of planting failure in inundated areas.
- Targeted Planting Approach
 - In TU1 and TU2, initial lower-density planting will occur in Year 1, with the remaining planting completed in Year 2 based on water levels and vegetation establishment.
 - In TU3 and TU4, full planting will be completed in Year 1 to promote early native cover and suppress invasive species.
- Monitoring and Adaptive Responses
 - Monitoring will track site conditions and plant success, with adjustments made as needed.
 - See Section 5 for detailed monitoring requirements, success thresholds, and reporting procedures.
- Ongoing Hydrological and Vegetation Monitoring: Monitoring will be conducted twice per year to track water levels, vegetation establishment, and species performance:
 - **Spring Monitoring** (May–June): Assess plant survival, early growth, and competition from invasive species before the peak growing season, and document water elevation at outlet.
 - **High Water Monitoring** (November–January): Evaluate seasonal high-water levels in comparison to targeted elevation of 95.0 m at the grade control structure outlet and threshold elevation of 95.5 m.

By incorporating these adaptive strategies, restoration efforts can be tailored to real conditions, ensuring that resources are used effectively and ecological recovery is optimized.



2.4 GUIDING PRINCIPLES AND RESTORATION OBJECTIVES

The restoration of the weir pool area at Coats Marsh aims to mitigate ecological impacts resulting from weir decommissioning by restoring wetland and riparian habitat, controlling invasive species, and ensuring long-term ecosystem function. This restoration strategy aligns with provincial dam decommissioning objectives, specifically:

- Restoring the site to a safe, stable, and low-maintenance condition following weir removal.
- Re-establishing natural hydrological processes to support wetland and riparian ecosystem function.
- Enhancing disturbed areas with native vegetation to support wildlife habitat, particularly for northern red-legged frogs.

To achieve these goals, the restoration plan is structured around the following key ecological objectives:

- Restore disturbed areas to regionally appropriate, functional ecosystems.
 - Convert dewatered portions of the weir pool to marsh, shrubby swamp, and riparian habitat.
 - Enhance native plant establishment while minimizing the spread of invasive species.
- Maintain hydrological stability and prevent excessive erosion and sediment transport.
 - Remove the artificial weir control structure while ensuring gradual sediment stabilization.
 - Assess the feasibility of excavated back-channels to increase aquatic habitat connectivity.
- Provide a diversity of wetland and riparian habitats to support local wildlife.
 - Ensure at least 80% survival of planted vegetation over the first five years.
- Minimize the spread of invasive plant species, particularly reed canarygrass.
 - Implement seasonal trampling, hand-cutting, and shading techniques to control reed canarygrass.
- Maintain water quality and ecological function.
 - Ensure turbidity levels in Coats Marsh Creek remain within BC Water Quality Guidelines during and post-construction (BC MOECCS 2023).
 - Monitor hydrology and vegetation recovery to guide adaptive management strategies.



2.5 WETLAND RESTORATION AND HABITAT ENHANCEMENT

Restoration efforts will focus on enhancing wetland function and promoting native plant establishment. Restoration efforts prioritize maintaining emergent vegetation cover, essential for amphibian breeding, particularly for species such as the northern red-legged frog, which depends on these habitats for successful reproduction (Maxcy 2004). The dewatered portions of the weir pool will be converted to a mix of marsh, shrubby swamp, and riparian habitat, ensuring that:

- Native wetland plants such as sedges, rushes (*Juncus* spp.), and willows (*Salix* spp.) dominate the landscape.
- Reed canarygrass suppression measures are implemented through mechanical control and native species competition.
- Amphibian habitat is retained and enhanced through the potential excavation of back-channels.

3 TREATMENT UNITS AND RESTORATION STRATEGIES

3.1 OVERVIEW OF TREATMENT UNITS

Restoration efforts at Coats Marsh are structured around four treatment units (TUs), defined based on anticipated hydrological conditions, soil moisture, and site disturbance following weir decommissioning. These treatment units provide a targeted framework for implementing restoration prescriptions that support native vegetation establishment and ecological function recovery (see Figure 3-1 for layout and Appendix A for design drawings).

Table 3-1. List of restoration treatment units, elevation ranges and site conditions

Treatment Unit	Elevation Range (m)	Description
TU1	< 93.5 m	Low-elevation marsh within the new annual high-water mark, where planting will focus on emergent species such as cattails (<i>Typha latifolia</i>) and sedges (<i>Carex</i> spp.).
TU2	93.5 m - 96.2 m	Mid-elevation swamp with seasonally saturated soils, transitioning from marsh to shrubby wetland habitat with species like hardhack (<i>Spiraea douglasii</i>) and Pacific willow (<i>Salix lucida</i>).
TU3	96.2 m - 96.5 m	Transitional zones on the periphery of the dewatered wetland, where infill planting will be applied selectively to revegetate exposed soils with species such as osoberry (<i>Oemleria cerasiformis</i>) and bluejoint (<i>Calamagrostis canadensis</i>).
TU4	> 96.5 m	Riparian areas above the 200-year high-water mark, including construction-disturbed areas near the berm and weir work sites, which will be replanted with species such as red alder (<i>Alnus rubra</i>), western redcedar (<i>Thuja plicata</i>), and native shrubs.

Note: The placement of treatment units is based on current elevation modeling and anticipated hydrological conditions. Final treatment unit boundaries will be adjusted as needed once site dewatering occurs and actual substrate conditions are confirmed.

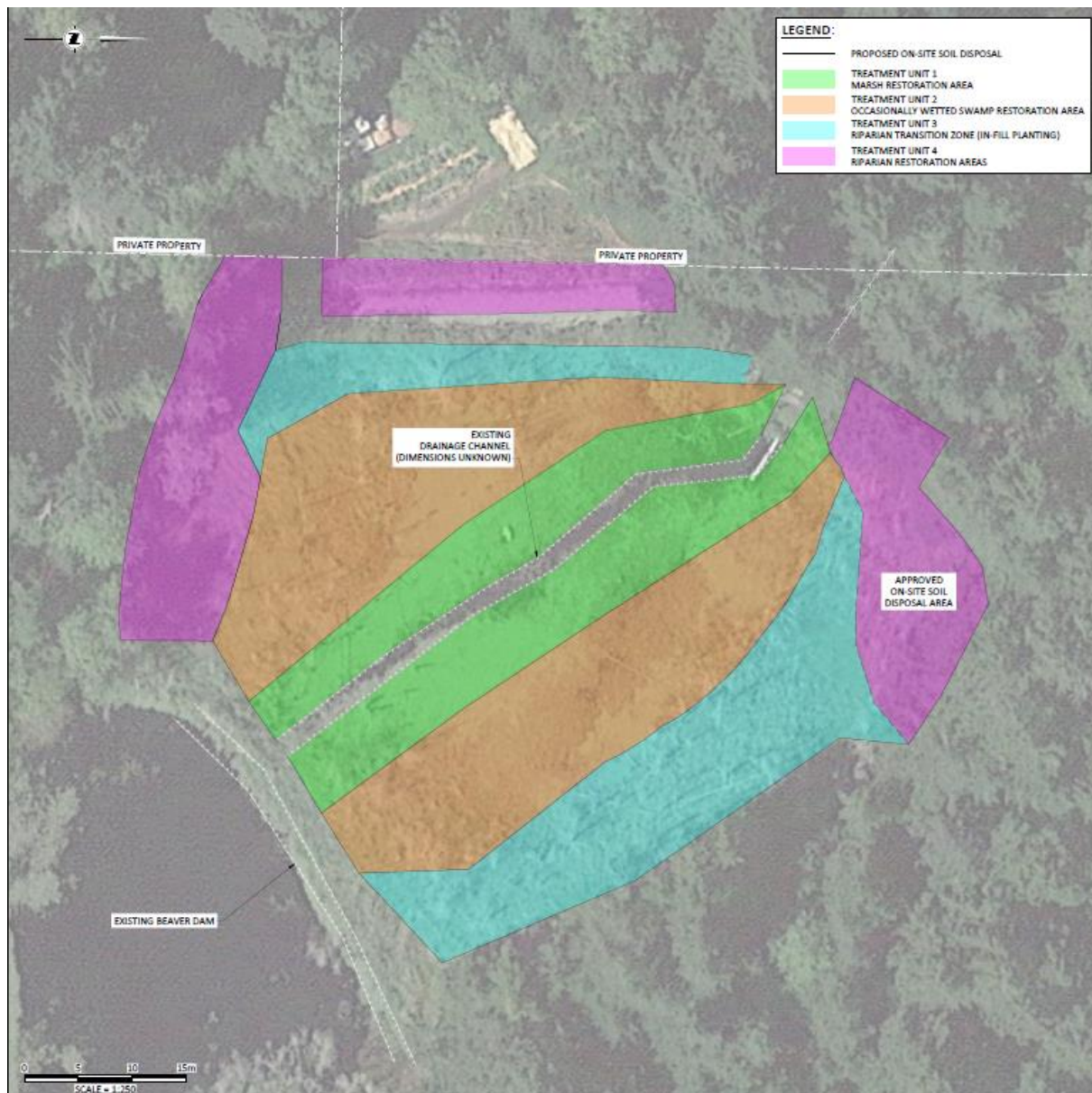


Figure 3-1. General layout of treatment units for weir pool area of Coats Marsh following weir removal

3.2 PLANTING PRESCRIPTIONS FOR ALL TREATMENT UNITS

3.2.1 GENERAL PRESCRIPTIONS

General restoration prescriptions provide overarching guidance for the selection, placement, and establishment of plant species, ensuring successful restoration across all treatment units.

- Native vegetation will be prioritized for all revegetation efforts, with species selection based on site-specific conditions, anticipated hydrology, flooding frequency, and documented occurrence



in local wetland and riparian ecosystems on the South Coast of BC (MOE 2008; Cox and Cullington 2009).

- The planting of 1,686 Pacific willow and red alder trees will more than compensate for the loss of five trees during construction. These plantings will enhance habitat complexity, provide shading to suppress reed canarygrass, and improve long-term ecosystem resilience. No additional tree removals are anticipated, but if unforeseen removals occur due to construction constraints, they will be documented, and additional compensatory plantings will be considered if necessary.
- Tree and shrub species will be guaranteed nursery stock, tagged clearly with botanical names, and sourced from local suppliers whenever possible.
- Plant stock will be installed at the following densities without overlap:
 - Potted Trees: 0.25 plant/m² (2-meter spacing)
 - Shrubs: 1 plant/m² (1-meter spacing)
 - Groundcover species: 2 plants/m² (0.5-meter spacing within TU1)
 - Livestakes: 3 stakes/m² (primarily in TU2)
- Recommended container sizes:
 - Potted Trees: minimum 2-gallon pots (for red alder and western redcedar)
 - Shrubs: 2-gallon pots for most shrub species to encourage survival with competition. 1-gallon pots can be used for salal, as this species can spread clonally and does well in shade.
 - Groundcover: plugs or small containers.
- Planting should be conducted during optimal growth periods, preferably fall (September–October) to maximize establishment success.
- In all treatment units where soil disturbance has occurred (primarily TU4), a native coastal BC riparian restoration seed mix, tested free of invasive species, will be applied to provide rapid vegetative cover, prevent erosion, and reduce the establishment of invasive species (see Section 3.3.2 for details). Seeding will be conducted immediately following final grading or soil placement to optimize establishment success.

3.2.2 SUGGESTED PLANTING LIST

A recommended planting list, based on locally appropriate native wetland and riparian species, has been developed for the proposed restoration work.



Table 3-2 provides an estimate of the total quantities of each plant species specific to each treatment unit.



Table 3-2. Estimated total quantities of plants for each treatment unit

Plant Species		Container Size	TU1	TU2	TU3*	TU4	TOTAL
			627 m ²	1125 m ²	257 m ²	750 m ²	
Trees							
Red alder	<i>Alnus rubra</i>	2-gal	0	0	64	139	203
Western redcedar	<i>Thuja plicata</i>	2-gal	0	0	0	48	48
Pacific willow	<i>Salix lucida</i>	Livestake	0	1686	0	0	1686
Total			0	1686	64	187	1937
Shrubs							
Hardhack	<i>Spiraea douglasii</i>	2-gal	0	563	129	0	692
Osoberry	<i>Oemleria cerasiformis</i>	2-gal	0	0	64	240	304
Salal	<i>Gaultheria shallon</i>	1-gal	0	0	64	434	498
Red elderberry	<i>Sambucus racemosa</i>	2-gal	0	0	0	76	76
Total			0	563	257	750	1570
Groundcover							
Bluejoint	<i>Calamagrostis canadensis</i>	Plug/ container	0	282	193	0	475
Cattail	<i>Typha latifolia</i>	Plug/ container	627	0	0	0	627
Beaked sedge	<i>Carex rostrata</i>	Plug/ container	314	282	0	0	596
Common rush	<i>Juncus effusus</i>	Plug/ container	314	0	193	0	507
Total			1255	564	386	0	2204
Total Plants			1255	2813	707	937	5712

*Assumes in-fill planting only – estimate that 35% of total area requiring planting ($35\% \times 735 \text{ m}^2 = 257 \text{ m}^2$)

3.2.3 SITE PREPARATION AND SOIL AMENDMENTS

Effective site preparation measures are critical to ensuring successful native plant establishment and long-term habitat restoration at the weir pool. These activities will involve careful management of topsoil and excavated materials, targeted placement of soil resources, and strategic distribution of woody debris to enhance site conditions for revegetation.

3.2.3.1 Soil Management

Soil management during restoration will focus on strategic handling of soil spoils from excavation to minimize the risk of reed canarygrass spread while supporting revegetation success.

- Soil spoils from areas with high-density reed canarygrass (e.g. TU3, TU4) will not be salvaged or reused on-site to prevent the spread of invasive species.
- Most excavated material will come from the aquatic area immediately upstream of the weir, where there is no cover of reed canarygrass. While the risk is low, some seed presence in the soil seed bank is possible.



- In TU4 (Upland Riparian Areas), excavated soil from the dewatered area may be disposed of on-site and used to suppress invasive species and improve revegetation success.
- Where soil placement occurs in areas at risk of RCG regrowth, mitigation measures will be applied as described in Section 3.3.3. These include burial to a minimum depth of 50 cm, use of biodegradable barriers (e.g., cardboard or Terrafibre hemp mats), and targeted monitoring.
- Water quality monitoring will be conducted during the construction phase to assess turbidity and sedimentation risks associated with in-stream works. Monitoring requirements and mitigation measures are detailed in the Construction Environmental Management Plan (CEMP).
- Post-restoration monitoring will assess soil placement areas for reed canarygrass regrowth, with adaptive management measures (e.g., shading strategies, selective removal) implemented as needed (see Section 3.3.3 for details).

3.2.3.2 Mulching and Moisture Retention Measures

Mulching will be used strategically to retain soil moisture, suppress invasive plants, and improve native plant survival in areas that do not experience regular flooding.

- TU3 (Transitional Riparian Zone) and TU4 (Upland Riparian Area):
 - If wood chip mulch is used to reduce cover of reed canarygrass, it should be applied at a depth of 5–10 cm around planted trees and shrubs.
 - Cardboard or biodegradable weed barriers (e.g., Terrafibre hemp mats) may be used beneath mulch in high-invasion risk areas to prevent reed canarygrass regrowth.
- TU1 (Low Elevation Marsh) and TU2 (Mid-Elevation Swamp):
 - Mulching is not recommended, as floating debris may disrupt water movement and displace plantings in areas subject to seasonal flooding.

3.2.3.3 Distribution of Coarse Woody Debris

Coarse woody debris salvaged during site preparation will be strategically distributed throughout restoration areas to:

- Enhance wildlife habitat complexity for small mammals, amphibians, and birds.
- Support soil moisture retention in upland and riparian planting zones.
- Provide natural erosion control in areas with unstable soils.



3.3 INVASIVE PLANT CONTROL

Controlling invasive plants, particularly reed canarygrass, is essential to achieving successful restoration. Invasive plant management will be an ongoing task implemented during all project phases, including initial site preparation, planting, and throughout the entire post-restoration monitoring period. Given the aggressive nature and established presence of reed canarygrass within Coats Marsh, management efforts will focus on suppression rather than complete eradication, emphasizing measures to reduce invasive competition, promote native plant establishment, and enhance habitat diversity.

3.3.1 GENERAL INVASIVE PLANT MANAGEMENT

The following general prescriptions will guide invasive plant management:

- Prioritize early and ongoing invasive species management beginning with site preparation and continuing through all phases, to post-restoration monitoring (i.e., 5 years).
- Implement mechanical management strategies (mechanical brushing, hand-cutting, seasonal trampling) regularly throughout each growing season to weaken invasive plant vigor and competitiveness. Recommend 3-5 visits per year to assess and suppress reed canarygrass in vicinity of plantings.
- Regularly inspect the restoration area and promptly address any occurrences of new invasive species to prevent establishment.
- Prevent the introduction of additional invasive species by using only certified invasive-free seed mixes, nursery stock, and other imported plant materials (see below)
- Target live staking and dense planting of fast-growing native shrubs to increase shading of invasive vegetation and reduce its competitive ability.

3.3.2 SEED CERTIFICATION AND INVASIVE SPECIES PREVENTION

To minimize the risk of introducing invasive plant species through revegetation efforts, all seed supplies will be verified for purity before use. The following steps will be taken:

1. Request a Certificate of Seed Analysis – Prior to purchasing, all seed lots will require a Certificate of Seed Analysis from an accredited testing laboratory. This certificate provides details on seed composition and the presence of any weed seeds.
2. Review for Contaminants – Each certificate will be examined for weed contaminants, with a focus on “Other Crop Seeds,” “Other Weed Seeds,” or “Noxious Weeds.” Any seed lot containing prohibited or noxious species will be rejected.
3. Compliance with BC and Federal Regulations – The seed selection process will adhere to:



- The BC Weed Control Act, which identifies invasive species of concern in the region.
 - The Weed Seeds Order under the Canada Seeds Act, which classifies weed species into regulatory categories.
4. Certified Seed Suppliers – Preference will be given to suppliers participating in seed certification programs, such as those overseen by the Canadian Seed Growers' Association (CSGA).
 5. Reporting Contaminated Seed Lots – If any invasive species are detected in purchased seed lots, they will be reported to the appropriate authorities to prevent accidental introduction into restoration sites.

By implementing these seed certification measures, this restoration plan ensures compliance with provincial and federal regulations while reducing the risk of unintentional invasive species introduction.

3.3.3 REED CANARYGRASS CONTROLS

Prescriptions for control of reed canarygrass in the dewatered wetland section and adjacent riparian areas have been developed based on methods outlined in *Coats Marsh Dam Decommissioning: Environmental Assessment for Preliminary Decommissioning Plan* (EDI 2023a). Reed canarygrass is extremely persistent and aggressive, and full removal or eradication from the marsh area is considered unlikely. Management objectives focus instead on persistent manual suppression to facilitate native plant establishment and growth.

Specific control measures for reed canarygrass include:

- Mechanical brushing and trampling:
 - Each spring, and as needed throughout the growing season, reed canarygrass will be mechanically brushed or cut by the site manager or property owner using manual methods.
 - Approximately 3 to 5 control visits per growing season are recommended, particularly during early spring and mid-summer periods.
 - Treatments will be timed to prevent seed formation and reduce competitive dominance over native plantings. Cutting should occur prior to seed maturity (typically May to June) to prevent seed production and further spread (Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021).
 - Brushing and physical stomping will be utilized regularly to reduce reed canarygrass height, limit competition, and encourage native vegetation establishment.
 - Control activities will be adjusted based on vegetation response, with increased frequency in high-growth areas as needed.
- Burial and smothering at excavation and soil disposal locations:
 - Soil spoils from areas with high-density reed canarygrass (e.g. vegetated areas of TU4) will not be salvaged or reused on-site to minimize the risk of spreading invasive species.



- Most excavated materials will come from the aquatic area immediately upstream of the weir, where there is no visible cover of reed canarygrass. While this soil is not expected to contain reed canarygrass, there is a possibility of some seed presence in the soil seed bank.
 - Where soil placement occurs in areas with high density of reed canarygrass (e.g., TU4), a minimum burial depth of 50 cm will be applied to reduce the likelihood of regrowth.
 - In high density areas of reed canarygrass, biodegradable barriers (e.g., cardboard, Terrafibre hemp mats or similar product) may be placed beneath soil before planting to help suppress potential regrowth.
 - To minimize the risk of reed canarygrass resurgence, any soil placement will be followed by regular monitoring, with additional suppression actions (e.g., live staking, regrading, increased shading strategies) if needed (see Section 5)
- Shading approach:
 - Native shrub and tree species (e.g., Pacific willow, red alder, hardhack) will be planted in strategic locations to establish shade and reduce reed canarygrass vigor over time.
 - Live staking will be prioritized in appropriate treatment units (e.g., TU2), where prolonged soil moisture will support willow and other fast-growing species. Guidance for installation is provided in Appendix B.
- Mulching and physical suppression:
 - Organic mulch or geotextile fabric may be selectively applied to exposed soils or areas of high invasive plant density to help reduce reed canarygrass regrowth.
 - Mulching will help conserve moisture, promote native plant establishment, and suppress invasive seedling germination.
- Ongoing monitoring and adaptive management:
 - The effectiveness of reed canarygrass control efforts will be assessed annually as part of the monitoring program.
 - Monitoring methods will include:
 - Visual surveys to assess changes in reed canarygrass extent and spread within restoration areas.
 - Photopoint monitoring at fixed locations to track vegetation changes over time.
 - Survival assessments of native plantings in areas where shading strategies have been implemented.
 - Triggers for Adaptive Management Actions:
 - If reed canarygrass cover increases by more than 10% within a treatment unit (including new establishment in previously uninvaded areas), additional suppression actions (e.g., more frequent cutting, trampling, or shading interventions) will be implemented.



- If planted native species survival is below 60% in year two, additional live staking or supplemental plantings will be introduced.
- Risks of Inadequate Reed Canarygrass Management
 - Reed canarygrass can expand into areas with low vegetative cover, outcompeting native regrowth and potentially creating a monoculture that reduces wetland habitat complexity and native species diversity.
 - Planted native species may fail to establish, particularly in areas where shading and suppression treatments are not maintained.
 - Control costs will increase over time, as unmanaged reed canarygrass spread will require more intensive removal efforts in later years.
 - Ecosystem benefits such as erosion control, habitat quality, and hydrological function will decline, reducing the long-term success of restoration efforts.

To prevent these outcomes, consistent investment in reed canarygrass management—including annual monitoring and targeted suppression treatments—will be required to maintain the ecological integrity of the site.

3.4 PLANTING PROTECTION FROM BROWSING WILDLIFE

To mitigate the risk of beaver browse on newly planted vegetation, the contractor will determine the most appropriate protection measures for planted stock. Priority for protection should be given to Pacific willow (*Salix lucida*) live stakes and red alder (*Alnus rubra*), which are at higher risk of beaver browse. Western redcedar (*Thuja plicata*) has a lower risk of browse and may not require individual protection, but the contractor should assess site conditions and implement protective measures as needed.

The contractor may consider the following protection options:

- Fencing Off Planting Areas: Temporary fencing (e.g., 1 m tall, 1 cm mesh) can be installed around planted areas to prevent direct access by beavers. This approach is most effective in areas where dense planting makes individual protection impractical.
- Individual Plant Protection: Where areas can't be protected adequately with fencing, vole guards or wire mesh cages (1 cm mesh size) should be applied to live stakes:
 - A 0.3 m vole guard should be slipped over each stake, with the lower end pressed into the soil, leaving only the top few centimeters exposed.
 - For young potted alder trees, small wire cages (45-60 cm tall, 1 cm mesh) may also be used.



- Other individual tree protection measures (e.g., tree guards, tree protection tubes) may be considered, subject to approval by the Qualified Environmental Professional (QEP).

3.5 RESTORATION PRESCRIPTIONS FOR EACH TREATMENT UNIT

The following restoration prescriptions detail the specific planting approach for each treatment unit (TU), ensuring appropriate species selection, spacing, and adaptive management strategies based on anticipated hydrology, soil conditions, and invasive species risk (see .

3.5.1 PLANTING PRESCRIPTIONS – TU1 (LOW ELEVATION MARSH)

Objective:

Establish emergent wetland vegetation to provide habitat for amphibians and improve water quality while ensuring resilience to seasonal flooding and potential beaver activity.

Site Conditions:

- **Elevation:** <95.5 m
- **Area:** 627 m²
- **Hydrology:** Anticipate seasonal flooding (flooded in winter/spring, drier in summer/early fall)
- **Substrate:** Anticipate organic-rich wetland soils, suitable for emergent vegetation
- **Invasive species concerns:** Low initial cover of reed canarygrass but potential for future encroachment

Planting Approach:

Year 1 (Initial Planting – Cattails only):

- Half of the planned groundcover species (cattail only) will be planted at a density of 2 plants/m², covering approximately half of the treatment area.
- Cattails will be the first species planted due to their tolerance for seasonally flooded conditions and ability to establish quickly.

Year 2-5 (Planting Completion and Adaptive Management):

- Remaining half of the groundcover plants (rushes and sedges) will be planted at 2 plants/m² in Year 2.
- Final planting densities may be adjusted depending on the extent of natural revegetation observed post-dewatering. If sufficient native vegetation is present, fewer plants may be required.



- Monitoring and adjustments will follow the Adaptive Management Measures outlined in Section 2.3.4.1, including a late spring site assessment (for plant survival, water levels, and invasive species encroachment) and a winter site assessment (for water levels).
- In-fill planting of all species (cattail, rush, sedge) to occur in Years 3-5 based on site conditions and plant survival.

Table 3-3. Number of plants and timing of planting for Treatment Unit 1, with planting split between Year 1 and Year 2

Species	Type	Year 1 (# of plants)	Year 2 (# of plants)	Year 3-5 (# of plants)	Container Type	Density (per species)
Common cattail	Groundcover	627	Infill	Infill	Plug/container	1 plant/m ²
Common rush	Groundcover	0	314	Infill	Plug/container	0.5 plant/m ²
Beaked sedge / Sitka sedge	Groundcover	0	314	Infill	Plug/container	0.5 plant/m ²

Planting Method:

- Use container stock or plugs to ensure high survival rates in wet conditions.
- Cattails should be planted in clusters (5-10 plants per clump) to encourage rapid establishment and prevent reed canarygrass encroachment.
- Rushes and sedges should be evenly distributed across lower-elevation zones to create a natural spread.
- No mulch application, as floating debris may cause displacement in high-water areas.

Timing:

- Preferred: Fall (September–October) when soil moisture levels are optimal.
- Avoid planting during peak inundation periods (November–March) to prevent washout.

Adaptive Management Considerations:

- See Section 2.3.4.1 for details on adaptive management measures.
- If areas remain wetter than the water elevation threshold of 95.5 m at the grade control structure, the planting plan will be revised, with a strategy of shifting vegetation species composition toward more flood-tolerant plants, and higher-density planting in slightly elevated areas to increase resilience.
- See Section 5 for full details on monitoring requirements and success criteria.



3.5.2 PLANTING PRESCRIPTIONS – TU2 (MID ELEVATION SWAMP)

Objective:

Restore mid-elevation swamp habitat by establishing Pacific willow through live staking in Year 1, with the remaining planting in Year 2, followed by adaptive in-fill planting in Years 3-5. This approach enhances resilience to seasonal saturation and potential beaver-induced flooding.

Site Conditions:

- **Elevation:** 95.5 – 96.2 m
- **Area:** 1,125 m²
- **Hydrology:** Anticipate frequently saturated soils, with a shallow water table, particularly during wet periods.
- **Substrate:** Anticipate organic-rich surface horizon with fine mineral soils.
- **Invasive species concerns:** Moderate risk of reed canarygrass encroachment, particularly in drier zones.

Planting Approach:

Year 1 (Initial Planting):

- Pacific willow live stakes planted at 3 stakes/m² across 50% of TU2 (562 m²) for a total of 1,686 live stakes.
- Pacific willow was selected for Year 1 because of uncertainty around potential new beaver activity and flooding. Unlike other species, Pacific willow is highly resilient to partial flooding, making it a lower-risk option in areas where hydrology may shift.

Year 2-5 (Planting Completion and Adaptive Management):

- Shrubs (hardhack) planted in 50% of TU2 (563 m²) at 1 plant/m² (total 563 shrubs) in Year 2.
- Groundcover species will be planted as a sparse in-fill layer across the entire treatment area (with a maximum density of 4 plants/m², totaling 564 plants) in Year 2.
- Monitoring and adjustments will follow the Adaptive Management Measures outlined in Section 2.3.4.1, including a late spring site assessment (for plant survival, water levels, and invasive species encroachment) and a winter site assessment (for water levels).
- In-fill planting will occur for Pacific willow livestakes in Years 2-5, and for shrubs and groundcover in Years 3-5.



Table 3-4. Number of plants and timing of planting for Treatment Unit 2, with planting split between Year 1 and Year 2

Species	Type	Year 1 (# of plants)	Year 2 (# of plants)	Year 3-5 (# of plants)	Container Type	Density (per species)
Pacific willow	Tree (Live stakes)	1686	Infill	Infill	Live stakes	3 stakes/m ² (for 50% of treatment area)
Hardhack	Shrub	0	563	Infill	2-gal pot	1 plant/m ² (for 50% of treatment area)
Beaked sedge	Groundcover	0	282	Infill	Plug/container	0.25 plant/m ² (for 100% of treatment area)
Bluejoint grass	Groundcover	0	282	Infill	Plug/container	0.25 plant/m ² (for 100% of treatment area)

Planting Method:

- To protect against beaver browsing, fencing will be applied the planted area if possible. Alternatively, vole guards or a suitable alternative will be applied to each live stake at the time of planting.
- Shrubs and groundcover species will be planted in Year 2, using a clustered approach to enhance shading and competition against invasive species.
- Mulching is not recommended in this treatment unit due to the likelihood of seasonal flooding and potential displacement.
- For detailed guidance on live stake planting methods, refer to Appendix B.

Timing:

- Live staking: Fall (September–October) in Year 1 to allow for root establishment before high winter and spring water levels.
- Shrubs and groundcover species: Fall (September–October) of Year 2 after site conditions are better understood.

Adaptive Management Considerations:

- See Section 2.3.4.1 for details on adaptive management measures.
- See Section 5 for full details on monitoring requirements and success criteria.



3.5.3 PLANTING PRESCRIPTIONS – TU3 (TRANSITIONAL ZONE, INFILL PLANTING)

Objective:

Encourage the recovery of native vegetation by implementing selective infill planting where native cover remains sparse after site dewatering.

Site Conditions:

- **Elevation:** 96.2 – 96.5 m
- **Area:** 257 m² - anticipate about 35% of Treatment Unit 3 will need in-fill planting for total planting area of 735 m² x 35% = 257 m².
- **Hydrology:** Anticipate area to be poor to moderately drained, depending on microtopography. Transitional zone from swamp to riparian conditions.
- **Substrate:** Anticipate organic-rich mineral soils.
- **Invasive species concerns:** High risk of reed canarygrass colonization in newly open or disturbed areas.

Planting Approach:

Year 1 (Full Planting – infilling gaps):

- Trees planted at 1 tree per 4 m² (2-meter spacing) for a total of 64 plants.
- Shrubs planted at 1 plant/m² (1-meter spacing) for a total of 257 plants.
- Groundcover species will be planted as a sparse in-fill layer across the entire treatment area (with a maximum density of 4 plants/m², totaling 193 plants).
- Mulching (potentially combined with cardboard) may be used in areas where invasive species control proves challenging and where there is no risk of annual flooding.

Year 2-5 (Adaptive Management & Additional Planting):

- Supplemental in-fill planting as needed in areas with poor initial survival or persistent invasive species encroachment.

Table 3-5. Number of plants and timing of planting for Treatment Unit 3, with planting focused on Year 1 and infill planting in following years.

Species	Type	Year 1 (# of plants)	Year 2-5 (# of plants)	Container Type	Density (per species)
Red alder	Tree	64	Infill	2-gal	0.25 plant/m ²
Hardhack	Shrub	129	Infill	2-gal	0.5 plant/m ²
Osoberry	Shrub	64	Infill	2-gal	0.25 plant/m ²



Salal	Shrub	64	Infill	1-gal	0.25 plant/m ²
Bluejoint	Groundcover	193	Infill	Plug/container	0.75 plant/m ²
Common Rush	Groundcover	193	Infill	Plug/container	0.75 plant/m ²

Planting Method:

- Shrubs and groundcover will be planted in clusters to maximize shading and competition against invasive species.
- Mulching (potentially combined with biodegradable cardboard) may be applied in areas with persistent invasive species issues to suppress reed canarygrass.
- To protect young trees from wildlife browsing, alternative deterrent methods such as mesh tree cages (1 cm mesh) or temporary fencing should be used where necessary.
- If necessary, a native coastal BC riparian restoration seed mix, tested free of invasive species, can be used in select disturbed areas within TU3 to stabilize soil and prevent the establishment of invasive species. Seeding will be conducted after final planting to ensure sufficient groundcover in sparsely vegetated areas.

Timing:

- Tree, shrub, and grass planting: Fall (September–October) for optimal establishment before the dry season.
- Mulch application: Conducted after planting if invasive species pressure is high.

Adaptive Management Considerations:

- See Section 2.3.4.1 for details on adaptive management measures.
- See Section 5 for full details on monitoring requirements and success criteria.

3.5.4 PLANTING PRESCRIPTIONS – TU4 (RIPARIAN AREAS, ABOVE 200-YEAR HIGH WATER MARK)

Objective:

Restore upland riparian forest habitat in areas disturbed by construction or soil placement, stabilizing site conditions, improving biodiversity, and establishing long-term canopy cover. This treatment unit includes all soil disposal areas and the top of the western berm on RDN lands.

Site Conditions:

- **Elevation:** >96.5 m (above 200-year high-water mark)



- **Area:** 750 m² (Includes riparian areas adjacent to wetland and on top of western berm area on RDN lands)
- **Hydrology:** Anticipate area moderately drained.
- **Substrate:** Variable soils, including areas with recent soil in-filling, disposal or grading.
- **Invasive species concerns:** Moderate risk of competition from invasive plants; potential for reed canarygrass or other aggressive species in disturbed areas.

Planting Approach:

Year 1 (Initial Planting):

- Trees (in total) will be planted at 1 tree per 4 m² (2-meter spacing) for a total of 187 trees.
- Shrubs will be planted at 1 plant/m² (1-meter spacing) for a total of 750 shrubs.
- Tree planting will be focused on soil disposal areas and the berm, where deeper rooting will help stabilize placed soils.
- Mulching (potentially combined with cardboard) may be used in areas where invasive species control proves challenging. A cardboard underlay can also be applied beneath soil disposal areas to inhibit regrowth of buried reed canarygrass.
- Native grass seeding will be applied across all disturbed or disposed soils to provide groundcover, reduce erosion, and limit encroachment by invasive species. A native coastal BC riparian restoration seed mix, tested free of invasive species, will be used to ensure compatibility with local riparian conditions and long-term ecological stability. Seeding will occur immediately following final grading or soil placement to promote rapid establishment. Re-seeding may be applied in subsequent years if gaps in vegetative cover persist.

Year 2-5 (Adaptive Infill Planting & Maintenance):

- Additional planting conducted if tree or shrub survival is below expected levels.
- Invasive species control applied as needed, including re-mulching if competition persists.

Species, Spacing, and Planting Layout:

Species	Type	Year 1 (# of plants)	Year 2-5 (# of plants)	Container Type	Density (per species)
Red alder	Tree	139	In-fill	2-gal	0.19 plant/m ²
Western redcedar	Tree	48	In-fill	2-gal	0.06 plant/m ²
Osoberry	Shrub	240	In-fill	2-gal	0.32 plant/m ²
Salal	Shrub	434	In-fill	1-gal	0.58 plant/m ²
Red elderberry	Shrub	76	In-fill	2-gal	0.10 plant/m ²

**Planting Method:**

- Shrubs and groundcover will be planted in clusters to maximize shading and competition against invasive species.
- To protect young trees from wildlife browsing, alternative deterrent methods such as mesh tree cages (1 cm mesh) or temporary fencing should be used where necessary.
- Mulch can be applied where invasive species competition is observed, helping retain soil moisture and suppress invasive plants species. Cardboard underlay can be used to reduce re-establishment of reed canarygrass.

Timing:

- Tree and shrub planting: Fall (September–October) for best establishment before the dry season.
- Topsoil amendments: Applied prior to planting to improve soil conditions.
- Mulch application: Applied as needed to minimize re-growth of invasive plant species.

Adaptive Management Considerations:

- See Section 2.3.4.1 for details on adaptive management measures.
- See Section 5 for full details on monitoring requirements and success criteria.

3.6 PROVISIONAL FINGER CHANNELS

In addition to standard site preparation measures, provisional back channels (or “finger channels”) have been proposed as a potential enhancement to increase available aquatic habitat and marshy edge habitat for amphibians. These channels would extend from the main channel of the weir pond area, improving hydrological connectivity and providing additional breeding habitat for amphibians such as northern red-legged frogs and Pacific chorus frogs (see Appendix A for provisional design).

3.6.1 DESIGN SPECIFICATIONS

Proposed finger channels have been designed with the following characteristics:

- Minimum depth: 0.5 meters to ensure persistent aquatic habitat.
- Base width: 1.2 meters to provide suitable open water conditions for amphibian breeding.
- Side slopes: 3H:1V or shallower, promoting gradual wetland transitions along channel edges.
- Slope direction: Channels will be positively sloped toward the main channel, ensuring year-round hydrological connectivity.



- Hydrology: The channel bottom will remain wetted year-round, while channel banks will be seasonally wetted, supporting a diverse mix of aquatic and emergent vegetation.

3.6.2 PLANTING PRESCRIPTION

Vegetation within the provisional finger channels will follow the planting densities and species selection established for TU1 (Low Elevation Marsh) to support wetland habitat function and amphibian breeding. Planting will focus on emergent wetland vegetation to stabilize channel banks, provide cover, and enhance water quality.

Collectively, emergent groundcover plants will be applied at 2 plants/m², distributed evenly as follows:

- Cattail – 1 plant/m²
- Beaked sedge – 0.5 plants/m²
- Common rush – 0.5 plants/m²

Planting Method

- All species will be planted as plugs to ensure high survival rates in wet conditions.
- Clusters of plants will be strategically placed to maximize shading and root stabilization along the channel edges.
- No mulch will be applied, as floating debris could disrupt plant establishment.

3.6.3 IMPLEMENTATION CONSIDERATIONS

Substrate Stability:

- Feasibility of excavation will be assessed post-weir removal, ensuring that substrate conditions allow for stable channel formation.
- If unstable or overly fine substrates are present, modifications to the channel depth or slope may be required.

Hydrologic Monitoring:

- Post-excavation monitoring will determine if the channels maintain adequate seasonal water levels.
- If water retention is lower than expected, minor adjustments (e.g., deepening channel sections or modifying flow paths) may be required.

Vegetation Establishment:



- Wetland plantings along the channel margins will include sedge, rush, and emergent aquatic species, enhancing habitat complexity and stabilizing the channel edges.

Invasive Species Risk:

- The potential for unintentional attraction of invasive wildlife species, such as American bullfrogs (*Lithobates catesbeianus*), must be considered. To reduce the likelihood of bullfrog establishment, the following measures will be incorporated:
 - Habitat Design Considerations: Where feasible, water levels will be managed to avoid stagnant, warm pools that are highly suitable for bullfrog breeding. Finger channels have been designed not to create pooling and to have seasonal fluctuations in water elevation.
 - Early Detection and Monitoring: The site will be monitored for bullfrog presence as part of regular spring effectiveness monitoring (Section 5), with a focus on auditory and visual detections during the breeding season (May–August).
 - Public Awareness and Prevention: Information will be shared with local stakeholders and land managers by the RDN to discourage accidental introductions of bullfrogs or their eggs/tadpoles into restored areas.
 - Response Planning: If bullfrogs are detected, a response strategy will be developed in collaboration with the RDN.

Decision on Finger Channel Installation

- The final decision on whether to proceed with finger channel installation will be made at the time of dewatering, based on post-weir removal site conditions including substrate stability and hydrology.
- This decision will be made in consultation with the Regional District of Nanaimo (RDN), project engineers (NHC), and the QEP leading restoration activities, ensuring that the channels function as intended and do not create unintended hydrological or ecological impacts.

Adaptive Management:

- If provisional channels fail to maintain sufficient water levels, alternative designs (e.g., smaller pools or modified depths) may be considered.

4 PLANT MAINTENANCE

Ongoing maintenance will focus on invasive species control, replacement planting, and site management activities to ensure the long-term establishment of native vegetation. Maintenance efforts will be required throughout the five-year period, with adjustments based on annual monitoring results.

Invasive Species Control



Reed canarygrass shall be mechanically controlled each spring and as needed throughout the year. Manual methods include brushing, cutting, or stomping down grass cover to reduce competition. Mulching (potentially with cardboard) may be used where invasive species pressure is high and outside of seasonally flooded areas.

Replacement Planting

The target survival rate is 80%. If survival falls below this threshold, replacement planting shall be conducted to restore survival to at least 80%. This applies to all plant types, including trees, shrubs, and groundcover. If natural revegetation reduces the need for full planting, survival rate calculations will be adjusted accordingly, focusing on overall vegetation cover and species diversity.

Soil and Hydrology Management

Any erosion, sedimentation, or drainage issues affecting plant health shall be addressed promptly. This may include additional soil stabilization, regrading, or minor hydrological adjustments to improve site conditions.

Structural Maintenance

If protective measures such as vole guards, wire cages, or fencing are implemented, they shall be inspected annually to ensure effectiveness. Any damaged or ineffective structures shall be repaired, adjusted, or removed as necessary.

All maintenance activities will be documented and included in the annual restoration monitoring reports.

5 EFFECTIVENESS MONITORING

Restoration at the weir pool area will be assessed over a five-year period to ensure the success of vegetation establishment, invasive species control, and habitat function. Monitoring will track site conditions and restoration outcomes, identifying whether adjustments are needed to achieve project goals.

5.1 MONITORING FREQUENCY AND ASSESSMENT PARAMETERS

To ensure restoration success, a Qualified Environmental Professional (QEP) shall conduct twice-annual monitoring for five years:

- Spring Monitoring (May–June):
 - Evaluate plant survival, early growth, and invasive species competition before the peak growing season.
 - Document water elevation at the outlet to compare with the 95.0 m target elevation and 95.5 m adaptive threshold.



- Complete an auditory survey and opportunistic visual observations for invasive American bullfrogs to detect calling males. If bullfrogs are detected, additional monitoring or management actions may be recommended.
- High Water Monitoring (November–January):
 - Assess seasonal high-water levels relative to the grade control structure (95.0 m target, 95.5 m threshold).
 - Evaluate potential flooding impacts on planted vegetation.

Each inspection shall include:

- Plant survival assessment – Estimate percent survival of planted trees, shrubs, and groundcover.
- Invasive plant species assessment – Estimate percent cover of invasive species, particularly reed canarygrass.
- Invasive American bullfrog assessment – Conduct auditory surveys for bullfrog presence during the spring monitoring visit. If detected, recommendations for management actions will be included in monitoring reports.
- General plant health evaluation – Assess overall plant condition (poor, fair, moderate, good).
- Replanting recommendations – Identify species and numbers of replacement plants needed to achieve 80% survival.
- Invasive species management needs – Determine areas requiring control measures.

5.2 SUCCESS CRITERIA AND ADAPTIVE MANAGEMENT RESPONSES

The site will be considered successfully restored after Year 5 if the following performance-based thresholds are met:

- Plant survival rates meet or exceed 80 percent of installed stock in each treatment unit.
- If invasive plant species cover increases by more than 10 percent within a treatment unit from the previous year, or appears to be outcompeting native species (e.g., preventing establishment, reducing survival, or forming dense monocultures), additional suppression measures (e.g., mechanical removal, shading, or infill planting) will be implemented.
- Native vegetation must be dominant in all treatment units. Native species should represent 70% of the total vegetative cover of the planted area.



- If invasive bullfrogs are detected and pose a risk to native amphibians, management actions will be considered to prevent establishment.

If these targets are not met, monitoring may be extended beyond Year 5, and additional interventions such as replanting and invasive species control will be implemented.

5.3 REPORTING REQUIREMENTS

To ensure that restoration goals are being met and that necessary management actions are taken in a timely manner, annual monitoring reports will document site conditions, assess progress toward performance thresholds, and provide recommendations for corrective actions as needed.

- The QEP shall submit an annual summary report to the Regional District of Nanaimo (RDN) and the Province of BC (MWLRS) with:
 - Observations on plant survival, health, and invasive species coverage.
 - Assessment of performance thresholds.
 - Recommended maintenance actions (e.g., replanting, invasive species control).
 - A timeline for implementing recommendations.
- The RDN shall implement all recommendations outlined in each report.
- If the fifth-year inspection confirms restoration success, a final post-development report shall be submitted to RDN to complete the restoration requirements.
- If performance thresholds are not met, monitoring and maintenance shall be extended as necessary, with adjustments to restoration strategies to improve success.

5.4 POST-MONITORING STEWARDSHIP AND INVASIVE SPECIES MANAGEMENT

Following the completion of the five-year monitoring program, ongoing management of invasive species will be important to sustaining restoration success. While formal monitoring will conclude after five years, long-term site stewardship efforts can help maintain habitat improvements and prevent the spread of invasive species, particularly reed canarygrass and American bullfrogs.

Where possible, the involvement of local stewardship groups, volunteers, or community-led monitoring initiatives can support continued management and early detection efforts. Recommended long-term actions include:

- Invasive Plant Monitoring and Management – Conduct annual visual surveys for reed canarygrass and other invasive plants within the restoration area. Survey results should be used to identify areas where reed canarygrass cover is competing with native vegetation and prioritize those areas



for treatment. Targeted removal efforts (e.g., manual cutting, shading strategies) should be implemented based on these observations.

- **Bullfrog Monitoring and Response** – Although bullfrogs have not been observed at the site, they are present in nearby regions and could colonize over time. Community-led auditory and visual surveys during the breeding season (May–August) can help detect their presence early. If detected, coordination with regional invasive species management programs may be needed to prevent establishment.
- **Volunteer Involvement** – Local stewardship groups or community volunteers could be engaged in annual invasive species control days, focused on hand-removal of reed canarygrass or reporting bullfrog observations to land managers.
- **Habitat Observations** – General site observations can track native vegetation establishment, potential beaver impacts, and emerging invasive species, helping to identify areas where additional maintenance may be needed.

A summary of recommended long-term monitoring efforts and stewardship opportunities could be provided to local conservation groups or land managers at the conclusion of the formal monitoring period.

6 TENTATIVE SCHEDULE

Construction is scheduled to begin in late August 2025, with planting to follow in September/October 2025. Monitoring will occur annually in mid to late summer, with maintenance activities such as invasive species control and replacement planting implemented as needed. The five-year monitoring period will conclude in 2030, with a final assessment determining whether restoration targets have been met.



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APPENDICES



APPENDIX A SITE LAYOUT AND DESIGN





APPENDIX B GUIDANCE FOR LIVE STAKING



LIVE STAKING INSTALLATION GUIDE

The following instructions synthesize guidance from the *Riparian Areas Regulation Revegetation Guidelines* (Browning & Rosen, 2012) and *DFO's Operational Statement for the Use of Live Willow and Cottonwood Stakes* (Fisheries and Oceans Canada, 2007). These methods outline best practices for the installation of live stakes to support bank stabilization, erosion control, and riparian habitat restoration.

1. Species Selection

- Live stakes should be sourced from **native, riparian-adapted species** that can root readily from cuttings. Common species include **Pacific willow** (*Salix lucida*) and other regionally appropriate willows.
- Purchased stakes should be **fresh, healthy, and free of disease**. Stakes should be **at least 1 cm in diameter** and **60–100 cm long** to ensure adequate rooting potential.

2. Timing of Installation

- Install live stakes **during dormancy**, preferably in **late fall to early spring (October–March)**, before bud break, to maximize rooting success.
- Avoid installation during periods of drought or extreme heat.

3. Site Preparation

- Identify planting locations with **adequate soil moisture**, ensuring stakes are placed in areas with **intermittent to regular saturation** but not in permanently flooded conditions.
- Remove competing invasive vegetation, such as **reed canarygrass**, before planting to improve establishment success.

4. Installation Procedure

- **Orientation:** Insert live stakes **pointed-end down**, ensuring the buds face upward.
- **Depth:** Drive the stake **at least 2/3 of its length into the soil** to maximize contact with moisture and improve rooting (e.g., for a 90 cm stake, at least 60 cm should be underground).
- **Spacing:** Place stakes in **clusters of 3–5 stakes per planting location**, spaced **0.5–1.0 m apart** to create dense coverage and maximize shading effects.
- **Insertion Method:**
 - If soil conditions allow, **use a rubber mallet** to drive stakes directly into the ground.

- In compacted or rocky soils, **pre-drill pilot holes** using a metal rod or rebar to reduce splitting or damaging stakes.
- Ensure at least **2–3 live buds remain above the soil surface** to allow for sprouting.
- **Soil Firming:** After insertion, gently firm the soil around the stake to remove air pockets and improve soil contact.
- **Mulching (if applicable):** If invasive species competition is high, apply a **biodegradable weed barrier or mulch** around the base of stakes to suppress competing vegetation.

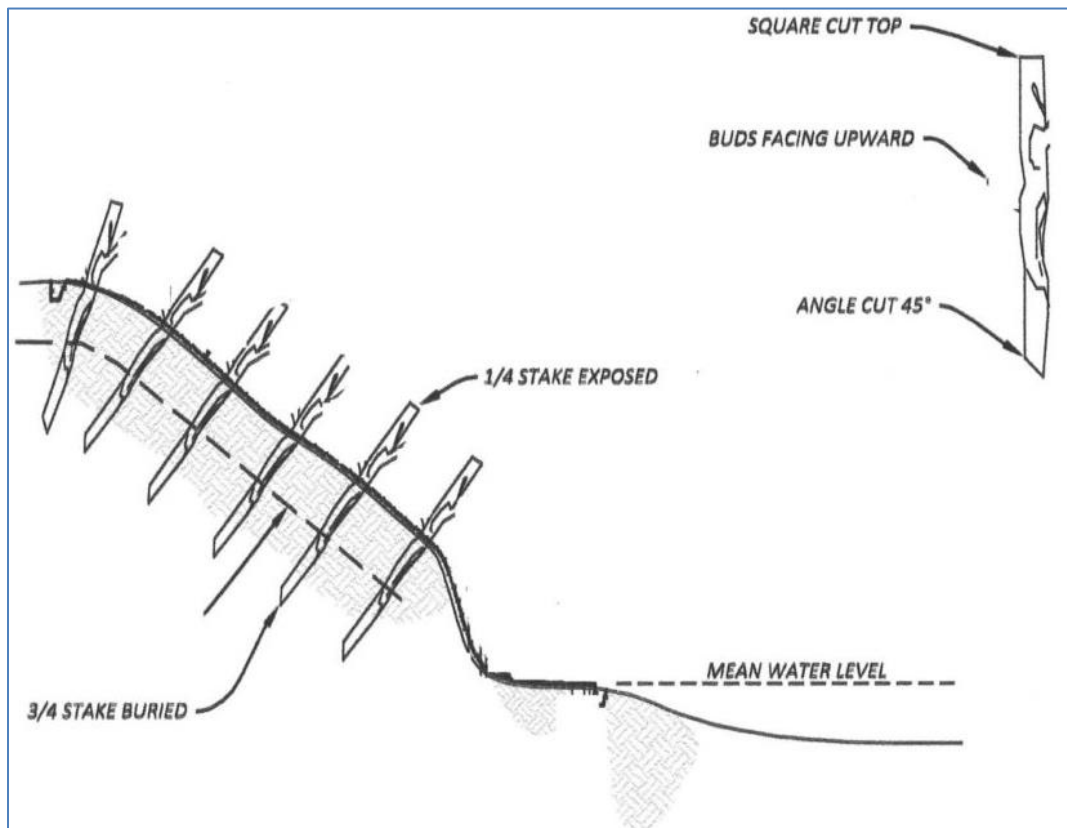


Figure 1 – Installation and orientation of live stakes

5. Post-Installation Care and Monitoring

- **Watering:** Supplemental watering **is not typically required** but may be beneficial in prolonged dry periods.
- **Protection from Browsing:** If deer or beaver browsing is expected, install **vole guards, wire mesh tree cages (1 cm mesh) or temporary fencing** around live stake clusters.
- **Inspection and Maintenance:**
 - Monitor staking sites **annually for five years** to assess survival and sprouting rates.



- Infill **replacement stakes** if initial plantings fail to establish.
- Continue to manage invasive species in planting areas as needed.

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