Wetland Conservation in Peace Country

Project No: PEA-F26-W-4273

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Executive Summary

Commencing April 1, 2025, the BC Wildlife Federation (BCWF) worked toward fulfilling the commitments outlined in the FWCP proposal *Wetland Conservation in Peace Country* (PEA-F26-W-4273). Training and collaborative field activities were hosted in partnership with Kwadacha First Nation, Tsay Keh Dene First Nation (Chu Cho Environmental), and McLeod Lake Indian Band.

The training focused on enhancing wetland identification, inventory, restoration monitoring, and wetland health assessments with and for First Nation community members, Land Guardians, and Technicians. This work built on capacity and partnerships developed in previous years and contributed to the strengthening of long-term relationships.

Project activities included collecting calibration data for the Wetland Ecosystem Services Protocol (WESP), gathering wetland mapping data using the Canadian National Wetlands Inventory (CNWI), monitoring the McIntyre Wetland Restoration Project, and conducting Road Impact Wetland Health Assessments (RIWHA) to identify priority wetland sites for restoration. Within the FWCP Peace Region focal area, a total of 17 WESP assessments, 42 wetland mapping points, and 25 RIWHA assessments were completed. This marked the first year that WESP, CNWI, and RIWHA were initiated within the Northern Boreal Mountains ecoprovince.

Training and project delivery in these regions have resulted in lasting partnerships and future workshop and project opportunities, supporting continued capacity building and stewardship by local community members.

Project Results Summary

- Engaged a total of six community members.
- Trained six community and environmental monitors from Kwadacha First Nation (2), Tsay Keh Dene First Nation (2), and McLeod Lake Indian Band through hands-on field participation (2).
- Continued monitoring of the McIntyre Wetland Restoration Project, including the installation of two additional downstream structures.
- Established foundational relationships with partner Nations to support ongoing wetland conservation and restoration within their traditional territories.

Alignment with the Peace Region Riparian and Wetlands Action Plan

Implementation of the Wetland Ecosystem Services Protocol (WESP), wetland mapping (CNWI), McIntyre Wetland Restoration Project monitoring, and Road Impact Wetland Health

Assessments (RIWHA) demonstrates strong alignment with the Peace Region Riparian and Wetlands Action Plan, addressing multiple key sub-objectives and actions:

Action #1: Prioritization of wetland and riparian habitats for conservation and/or enhancement

Wetland conservation was prioritized through the development and application of wetland mapping and assessment tools, alongside the evaluation of impacts and threats to wetland and riparian systems, in accordance with the Peace Region Riparian and Wetlands Action Plan (FWCP 2021). In 2025, 25 sites were field evaluated in the Williston Reservoir utilizing RIWHA. The average health score across all visited sites was 71%, placing them within the "Functioning but at Risk" category (healthy but with identified concerns). This suggests that while overall wetland condition was moderately high, several indicators show signs of stress or alteration. Based on the sites assessed no restoration candidates were proposed. Many exhibited impacts, and may have had potential if identified earlier, but the wetlands have adapted to the changes, and interventions now may not result in clear ecological gains.

Sub-Objective 1: Maintain and/or increase the resilience of riparian and wetland ecosystems

Water-level data was collected and analyzed to observe post-restoration hydrologic responses, including fluctuations in water levels, hydrologic gradients, and flow direction. The integrity and performance of the 17 beaver dam analogue (BDA) structures installed in October 2024 were assessed to confirm their ability to retain water and mitigate headcut erosion.

Two additional BDAs were installed downstream in September 2025 to further enhance ecological resilience. These structures mimic natural beaver activity by improving water retention, moderating stream flows, and stabilizing channels.

Sub-Objective 2: Restore natural wetland hydrology

- **Action #3:** Strategic placement of BDAs restored more natural hydrological function by slowing surface water movement, promoting sediment deposition, and encouraging shallow groundwater recharge. These improvements are foundational to long-term wetland health and resilience.

Sub-Objective 4: Maximize population viability of priority riparian and wetland species

- **Action #9 & #11:** Incidental wildlife observations of black bears, moose, and amphibians suggests that these species are benefiting from the restoration site near McIntyre Lake through the safeguarding of wetland features such as shrub forage, and increase in amphibian pond breeding area.

Sub-Objective 6: Increase opportunities for community engagement and resource stewardship

Throughout 2025, members of Kwadacha First Nation, Tsay Keh Dene First Nation, and McLeod

Lake Indian Band were engaged through training sessions and community consultations. These efforts fostered local stewardship and supported community-led conservation priorities within their traditional territories.

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Version Control

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1.0 INTRODUCTION

Wetlands provide disproportionately high ecological benefits relative to their size when compared to many other ecosystem types (MacKenzie and Moran, 2004). In the Williston Reservoir catchment, however, the abundance and distribution of wetland habitats have been substantially altered by hydroelectric development, particularly through dam construction and associated changes to flood regimes. The creation of large reservoirs eliminated extensive floodplain areas throughout the basin (FWCP, 2021). The Williston Reservoir continues to exert significant impacts on adjacent wetland ecosystems, with ongoing shoreline and tributary erosion contributing to wetland degradation.

The Peace Region east of the Williston Reservoir and areas along its southern extent are recognized as sites of Continental Significance for waterfowl habitat under the North American Waterfowl Management Plan (Davidson and Dawson, 1990). Despite their ecological importance, these regions are experiencing increasing pressure from industrial development and agricultural drainage, further threatening wetland function and persistence.

Undisturbed peatlands, including bogs and fens common within the Williston watershed, develop over centuries to millennia, and play a critical role in hydrologic regulation, carbon storage, and wildlife habitat provision. When peatlands are drained and water tables decline, they transition from carbon sinks to carbon sources as peat decomposes and releases carbon dioxide. Drained peatlands are also more vulnerable to wildfire, which accelerates carbon emissions and results in long-term ecological damage (Tarnocai, 2009).

The Fish and Wildlife Compensation Program's Riparian and Wetlands Action Plan seeks to address these challenges by restoring and enhancing the function of riparian and wetland ecosystems through habitat improvements, threat reduction, and the promotion of compatible land uses (FWCP, 2021). However, limited and declining provincial and federal funding means that wetland conservation increasingly depends on local stewardship efforts led by private landowners, First Nations, non-profit organizations, and community groups.

In response to this need, since 2017 the BC Wildlife Federation's Wetlands Education Program began to build local capacity for wetland protection, enhancement, and restoration across the Peace Region. Between 2018 and 2024, BCWF hosted eight workshops and outreach events, facilitated community meetings, and developed ten wetland restoration prescriptions. These efforts led to on-the-ground restoration at two sites: the Del Rio well pad, and the McIntyre Wetland (located approximately 1.1 km southwest of McIntyre Lake near Tudyah Lake). Two demonstration wetlands for educational purposes were also constructed at Morfee Elementary School and Mackenzie Secondary School in Mackenzie. Training of wetland habitat assessment

techniques by BCWF has, in part, supported further wetland assessment and restoration actions led by Tsay Keh Dene and Chu Cho Environmental (Khan et al. 2020).

2.0 GOALS AND OBJECTIVES

The goals and objectives of this project were built upon previous work completed in the region through Indigenous engagement and capacity building, wetland conservation, and the identification of candidate sites for future restoration. The following goals were achieved:

Goals Achieved:

1. Conducted Road Impact Wetland Health Assessments (RIWHA) at wetland sites, with a strategic focus on locations intersected by Forest Service Roads.
2. Initiated Wetland Ecosystem Services Protocol (WESP) site assessments within the Northern Boreal Mountains ecoprovince.
3. Completed wetland plot assessments using the Canadian National Wetlands Inventory (CNWI) within the Northern Boreal Mountains ecoprovince by visiting field sites to ground-truth existing mapping and collect supporting data.
4. Continued monitoring of the McIntyre Wetland Restoration Project and installed two additional beaver dam analogues to further enhance ecological function and hydrologic benefits.
5. Engaged and supported First Nations and local communities in wetland stewardship, identification of potential restoration sites, and implementation of conservation actions.

Collectively, these activities contributed to the restoration and enhancement of wetlands in the region, supported the development of a predictive wetland conservation tool, and advanced the Wetlands Education Program's mission to increase awareness and provide education on British Columbia's wetlands. Throughout the project, outcomes were achieved through meaningful engagement with local communities, strengthening their capacity and skills to steward wetlands over the long term.

2.1 OBJECTIVES

Table 1 summarizes how the FWCP action plan aligns with key sub-objectives and actions outlined in the *Peace Region Riparian & Wetlands Action Plan* (2020).

Table 1: Project Alignment with the Peace Region Riparian & Wetlands Action Plan Sub-Objectives.

Sub-Objective:	Project Activities	Relevance of Activities
1. Maintain and/or increase the resilience of riparian and wetland ecosystems to habitat disturbances, including climate change and other cumulative effects	1. Road Impact Wetland Health Assessments (IRHWA) 2. Wetlands Ecosystem Services Protocol (WESP) 3. Wetland Plots using the Canadian National Wetland Inventory (CNWI) 4. Monitoring the McIntyre Wetland Restoration Project	To assess impacts and threats to wetland and riparian areas and prioritize conservation and enhancement. This involved: (1) conducting a RIWHA to pinpoint priority wetland sites for restoration activities,(2) contributing to a wetland conservation and management tool for the region (WESP), (3) enhancing wetland mapping tools which could be used to identify priority sites in future, and (4) visiting the McIntyre Wetland site each spring and fall to collect data from the water levelloggers and to maintain the BDA structures.
2. Restore the natural hydrology of wetlands • Action 3: restore natural hydrology of wetlands	McIntyre Wetland Restoration Project	Aside from monitoring the site, an additional two structures were built downstream.
4. Maximize the population viability of priority riparian and wetland species • *Action 7: research priority species to identify limiting factors* • *Action 8: develop species-focused habitat restoration and protection plans.*	McIntyre Wetland Restoration Project	Incidental wildlife observations of black bears, moose, and amphibians anecdotally suggests that these species will benefit from the restoration site through improved shrub forage and larger and more stable amphibian pond breeding locations.
6: Increase opportunities for community engagement and resource stewardship through citizen science.	1. Road Impact Wetland Health Assessments (IRHWA) 2. Wetlands Ecosystem Services Protocol (WESP) 3. Wetland Plots using the Canadian National Wetland Inventory (CNWI) 4. Monitoring the McIntyre Wetland Restoration Project	Members of Kwadacha First Nation, Tsay Keh Dene First Nation, and McLeod Lake Indian Band were engaged through training sessions and community consultations. These efforts fostered local stewardship and supported community-led conservation priorities within their traditional territories.

3.0 STUDY AREA

The Focal Area of this project was the FWCP Peace Region boundary, as outlined in the Peace Region Riparian and Wetlands Action Plan (2021). Herein, this area is referred to as the Williston Basin, being the geographic extent of watersheds contributing to the Williston Reservoir. The location of wetland assessments within the overall Williston Basin study area were focused within the traditional territories of our Indigenous partners in the Omineca region. This includes the traditional territories of partnering indigenous communities: Kwadacha First Nation (Fort Ware), Tsay Keh Dene First Nation, and McLeod Lake Indian Band with whom we conducted field work.

The McIntyre Wetland restoration project is within this study area in the Regional District of Fraser-Fort George, on the traditional and unceded territories of the Tse'khene (Figure 3). More specifically, the project site is approximately 27 km south of the town of Mackenzie (55.066272°N, 123.075343°W).

4.0 METHODS

Each method used to achieve the project goals and objectives (Section 2.0: Goals and Objectives) is described below. Road Impact Wetland Health Assessments (RIWHA) were conducted to measure the health of wetlands adjacent to roads, and to inform potential restoration actions in future years.

The Wetland Ecosystem Services Protocol (WESP) was used to evaluate wetland functions and ecosystem services. Within this project, WESP data collection focused on establishing a baseline dataset in the Northern Boreal Mountains ecoprovince to support calibration of the tool for future regional application. Once calibrated, wetlands of interest can be compared against this baseline to inform management and restoration decision-making.

Although RIWHA and WESP serve different objectives within the project, the tools are complementary in their shared aim of prioritizing wetland health, conservation, and restoration across the region. RIWHA evaluates wetland health, whereas WESP characterizes functions and benefits performed by the wetland.

The Canadian National Wetlands Inventory (CNWI) methodology was applied to contribute to federal and regional wetland mapping and ecological classification efforts. While distinct from both RIWHA and WESP, CNWI data collection was coordinated with WESP site visits where feasible to maximize efficiency in the field.

Community engagement was integrated throughout the project and included training, field demonstrations, and hands-on application of each methodology, supporting capacity building and long-term wetland stewardship among project partners.

4.1 ROAD IMPACT WETLAND HEALTH ASSESSMENTS (RIWHA)

The intent of the Road Impact Wetland Health Assessment (RIWHA) is to identify priority wetland sites for restoration. This protocol was developed in-house through a review of existing wetland health assessment frameworks, including the Forest and Range Evaluation Program (FREP) Wetland Management Routine Effectiveness Evaluation (WMREE) and the Alberta Lentic and Lotic Wetland Health Assessment methodologies. RIWHA was designed as a rapid assessment tool that uses vegetation, soil, and hydrologic indicators to evaluate the impacts of roads on adjacent wetlands.

During the initial application of RIWHA, emphasis was placed on sites where a stream connecting to a wetland was intersected by a road and where current or imminent impacts were likely to affect wetland health. Candidate sites were selected through desktop mapping of

wetland polygons, streams, and road intersections, and prioritized according to the following criteria:

- **Priority 1:** Road–stream intersections located within 50 m of a wetland;
- **Priority 2:** Direct road–wetland intersections; and
- **Priority 3:** Roads located within 50 m of a wetland edge.

Following an initial field trial of the RIWHA methodology, the assessment form was refined and additional desktop screening steps were incorporated to better target field site selection.

The desktop screening process involved analyzing satellite imagery of wetlands to identify ecological stressors. Sites were excluded from further field investigation under two conditions: first, if they appeared to have reached a new ecological equilibrium where intervention would likely cause more disruption than benefit; and second, if they showed minimal impact overall. For example, a shallow open-water feature created by a road blockage might be excluded if it had since recovered and now displayed healthy wetland habitat characteristics.

Road accessibility was assessed using satellite imagery, supplemented by active and historical cut block data from the past ten years to help characterize road use and estimate the age of road–stream intersections. Recent and current wildfire data (within the past ten years) were also reviewed to identify broader landscape-level disturbances that could influence wetland condition.

During field assessments, the following observations were collected:

- **Disturbance indicators:** Observed activities and features contributing to wetland disturbance.
- **Vegetation impacts:** Changes in vegetation communities, stressed vegetation, invasive species presence, disturbance-associated vegetation, percentage of deep-binding roots along streams, regeneration of preferred tree and shrub species, standing dead or dying trees, and browsing of preferred species.
- **Soil impacts:** Evidence of stockpiling, exposed mineral soil or peat, compaction, and soil erosion.
- **Hydrologic impacts:** Changes to water levels, water quality, and hydrologic connectivity, including discrepancies between water levels and wetland type (current and historical), abnormal flooding, pH or electrical conductivity outside expected ranges for the wetland class, turbidity, sediment deposition, nutrient loading, contaminant inputs, groundwater disconnection, stream–wetland disconnection, evidence of stream downcutting, and altered flow patterns.

- **Road footprint:** Estimated area of road prism intersecting the wetland, where applicable.
- **Habitat fragmentation:** Estimated wetland visibility from the road, reflecting loss of wildlife screening, buffers, and habitat integrity.
- **Slope and elevation gradient:** Elevation profile where a notable slope existed between the road and the wetland or connecting stream.
- **Overall assessment:** Composite impact score, percentage of the wetland currently or imminently impacted, and restoration potential.

Sites exhibiting significant impacts and strong restoration potential received full evaluations. Sites that had adapted to disturbances or showed limited impacts did not undergo further assessment. Wetlands were assigned health scores based on observed indicators recorded in the field assessment form (Appendix C). At the conclusion of the field season, all sites were reviewed to identify priority restoration candidates based on impact severity, accessibility, and the feasibility and anticipated benefits of restoration. The ultimate objective of this process was to select suitable wetland restoration sites for future implementation.

4.2 WETLAND ECOSYSTEM SERVICES PROTOCOL (WESP)

The WESP utilizes observations and visual assessments of wetland characteristics and ecological indicators to rate particular wetland functions and benefits. Seventeen functions and benefits are included, such as: Stream Flow and Temperature Support, Carbon Stock, Fish Habitat, Fire Resistance, and Keystone Mammal Habitat. Collected information on wetland characteristics and indicators is scored within a statistical model. Scores are combined within the model to generate a total rating for each wetland function and benefit, which can be used to compare against the overall function and benefits of other wetlands within the region.

Sites were selected as a subset of mapped wetlands from the Fresh Water Atlas of BC and a wetland layer derived from the Vegetation Resource Inventory. Data relating to ecology, human disturbance, climatic and administrative variability, and other variables that were deemed functionally relevant were incorporated into the selection process. This was done to include the full range of disturbance conditions, wetland classes, hydroperiod, and wetland positions in a watershed present across the area. For safety and logistics, sites within 500 m of a road were prioritized.

The WESP tool utilizes approximately 60 field questions and 50 GIS questions completed in the office. Field data was collected during the summer season of 2025, with office data collected in fall and winter.

At each site, observations included items in the following categories:

- Vegetation characteristics, such as: percent coverage of vegetation classes such as evergreen and deciduous trees and shrubs, flowering shrubs, sedges, grasses, and forbs; interspersion of tall and short woody vegetation; tree diameters; shrub diversity; dense moss extent.
- Soil characteristics, such as: percent bare ground, soil surface texture, peat depth
- Hydrology, such as: percent with persistent surface water, percent flooded only seasonally, surface water fluctuation, pH and EC of water, channel connection and outflow duration.
- Habitat characteristics, such as: distance from open water to tall & dense woody cover, submerged and floating leaved aquatics, beaver probability, wildlife activity.
- Landscape factors, such as: type of cover in wetland buffer, domestic well proximity, land cover type uniqueness, road density, intactness of the landscape.
- Wetland disturbance, such as: sediment loading, inputs of contaminants and/or salts, wildlife disturbance potential.

Data collected in the northern portions of the Williston Basin will form a baseline dataset. This dataset will be used to calibrate the WESP model for the Northern Boreal Mountains ecoregion, enabling future assessments to compare wetlands in this region against established baseline conditions. An interim version of the tool is expected to be available as early as March 31, 2027.

However, because much of the Northern Boreal Mountains remains remote and field work outside the Williston Reservoir area is currently underfunded, full regional calibration may not be feasible in the near term. In that case, a modified calibration dataset would be developed for use specifically within the Peace-Williston area.

The WESP model scores each wetland function and benefit by ranking the wetland of interest against the baseline wetlands. It is intended to support informed wetland management decisions across the region.

4.3 WETLAND PREDICTIVE MAPPING (CNWI)

Wetland Predictive Mapping Data is intended for use in the training of AI predictive mapping models and for the ground-truthing of model results. Mapping data was collected during this project during the summer season. Detailed plot data were collected in conjunction with WESP data collection at the wetlands selected for WESP through a process initially developed for the Canadian National Wetland Inventory (CNWI). At each wetland site:

- Plots were chosen which were a minimum size of 10m x 10m and consistent in terms of vegetation groupings and coverage of vegetation versus water.

- Drone images and a 360° photo were taken of each plot.

Data were collected on wetland vegetation (species, % cover of different categories including trees, shrubs, herbaceous vegetation, mosses); soil type and indicators of wetland conditions (saturation, mottling, gleiing, organics); and hydrology (percent cover of standing water, indications of flooding or saturated conditions). These data were provided to Environment and Climate Change Canada to be used in the development of a CNWI federal predictive wetland map.

4.4 EFFECTIVENESS MONITORING METHODOLOGY (MCINTYRE WETLAND)

As explained through the McIntyre Lake Wetland Restoration FWCP report (PEA-F25-W-4035) (Sofos and Pagliaro 2025), the project involved the restoration of a peat-based wetland using Beaver Dam Analogues (BDA) as well as the establishment of monitoring protocols for assessing its efficacy.

Data was collected before restoration to serve as a baseline compared to post-restoration data. A combination of instream loggers and field data collection has been used to infer restoration impacts on surface flow, shallow groundwater levels, surface water-groundwater interactions, and water quality.

This configuration of the effectiveness monitoring wells allowed observation of how water was moving from the stream into adjacent wetland areas. Each groundwater well was equipped with a water level logger to record fluctuations in water levels. Additionally, one of the groundwater wells contained a barologger to record atmospheric pressure, which was necessary to correct the water level data. Data were retrieved twice in 2025, in the spring and fall. Refer to Table 2 for the monitoring schedule.

Table 2: Project Site Monitoring Schedule.

Site Visit Dates	Monitoring Activity
June 11th, 2023	**Pre-Restoration**: initial site assessment and drone imagery collection.
April 24th to 25th, 2024	**Year 1 Pre-Restoration:** Conducted additional site assessments during freshet, including the identification of the upwelling water source (located at the headwaters of the wetland), elevation measurements to approximate the slope at the start of the wetland, and installation of a wildlife camera.
July 6th to 7th, 2024	**Year 1 Pre-Restoration:** Installation of monitoring equipment, including groundwater wells and an instream well. Additional assessments and measurements were conducted, including ground-truthing the location of the stream, headcuts, undercut banks, and the connectivity of the stream to McIntyre Lake (to assess potential aquatic activity, e.g., fish), plant

	associations, stream substrates, benchmark establishments, and the creation of orthophotos.
September 5th, 2024	**Year 1 Pre-Restoration:** Installation of monitoring equipment, including deployment of water level loggers and a barologger within the groundwater wells. Note: This was delayed due to the late arrival of the equipment. Measurements of current groundwater and surface water depths were also taken.
October 2nd-5th, 2024	**Year 1 Restoration:** monitoring during construction activities (e.g., ground photos, and videos)
October 9th, 2024	**Year 1 Post-Restoration Monitoring:** winterized data loggers and removed wildlife cameras.
May 23-24, 2025	**Year 2 Spring Post-Restoration Monitoring:** Check structures, check stream and water level, re-install wildlife camera, retrieve level logger data, and collect drone imagery.
September 24-25, 2025	**Year 2 Fall Post-Restoration Monitoring**: Additional builds and end of season retrieval: winterize or collect data loggers and download level logger data.

5.0 RESULTS AND OUTCOMES

Table 3: Number of Assessments Completed by Project.

Project	# of Assessments	Collaborators	Number of Participants
Road Impact Wetland Health Assessment (RIWHA)	27	Kwadacha FN; Tsay Keh Dene FN; McLeod Lake Indian Band	5
Wetlands Ecosystem Services Protocol (WESP)	17	Kwadacha First Nation; Tsay Keh Dene First Nation	4
Canadian National Wetland Inventory (CNWI)	42	Kwadacha First Nation; Tsay Keh Dene First Nation	4

5.1 WESP & CNWI

Within the focal area, 17 WESP assessments and 42 CNWI wetland plots were completed. Data collected through the WESP assessments will contribute to the WESP calibration dataset for the Northern Boreal Mountains ecoregion, while the CNWI wetland plots will be available for incorporation into future iterations or refinement of the Canadian National Wetland Inventory as mapping points.

Table 4: Number of Wetland Classes Assessed.

Wetland Type	# of Plots	Frequency (% of sites)
Swamp	9	21
Marsh	6	14
Bog	2	5
Fen	24	57
Shallow Open Water	1	2

Fen wetlands were the dominant class sampled, representing 24 plots (57% of sites). Swamps were the second most common class, with 9 plots (21%), followed by marshes with 6 plots (14%). Bogs were observed less frequently, accounting for 2 plots (5%), while shallow open water was represented by only 1 plot (2%) (Table 4)

The Northern Boreal Mountains ecoprovince has not yet been calibrated, as only 17 out of 100 sites have been assessed to date.

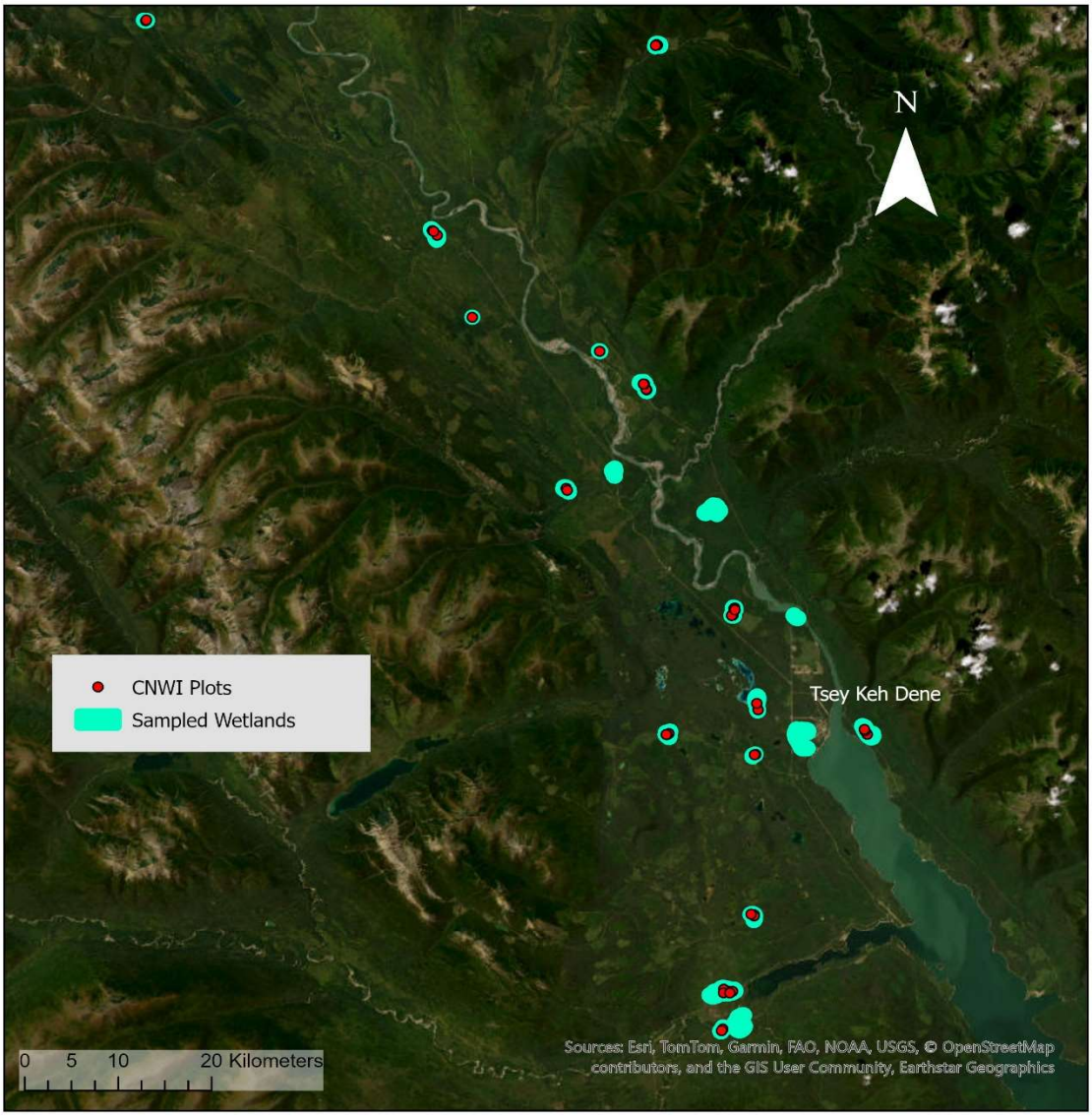


Figure 1: Completed WESP & CNWI plots of 2025.

5.2 ROAD IMPACT WETLAND HEALTH ASSESSMENTS (RIWHA)

The average health score across all visited sites was 71%, placing them within the “Functioning but at Risk” category (healthy but with identified concerns). This suggests that while overall wetland condition was moderately high, several indicators show signs of stress or alteration that could affect long-term function if pressures persist.

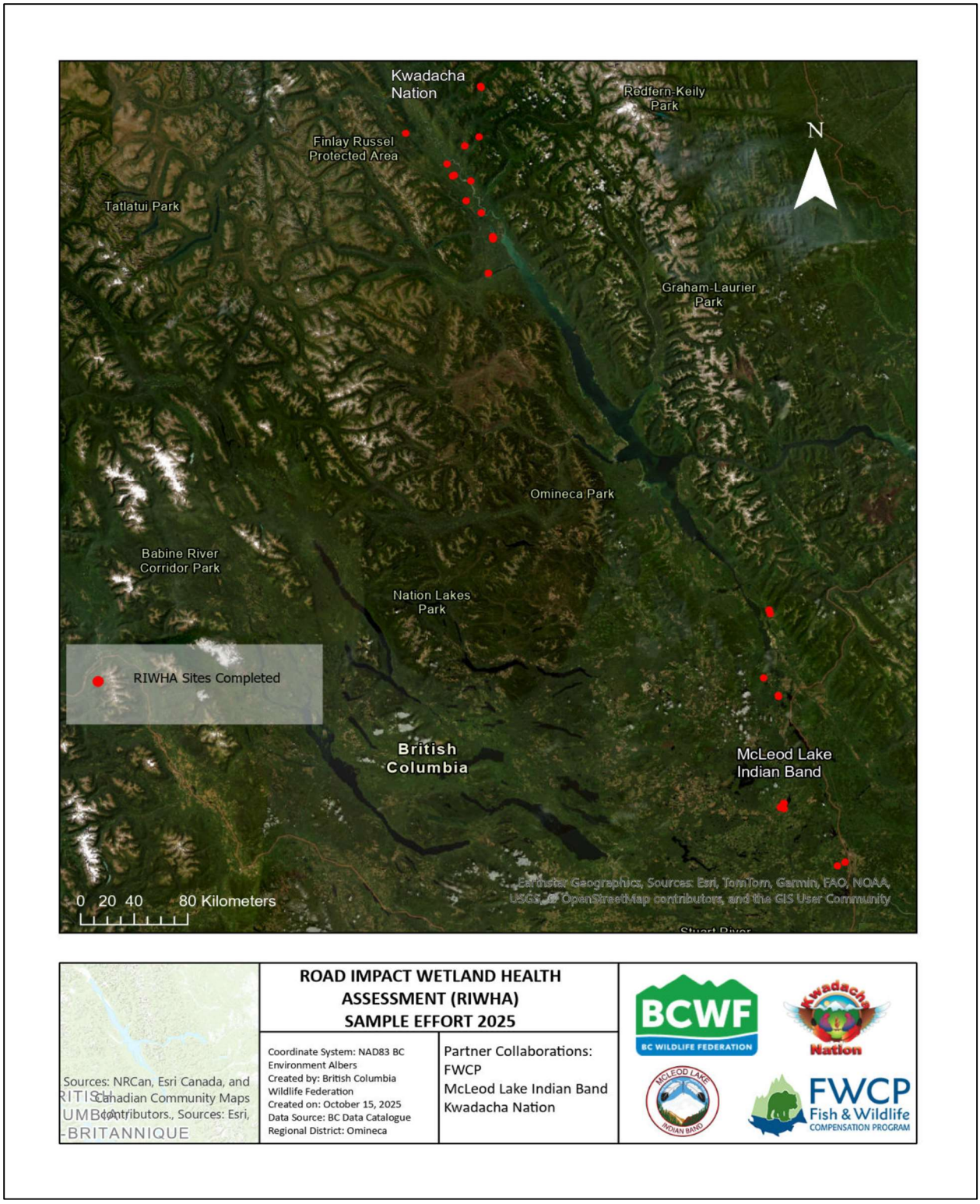


Figure 2. Completed RIWHA site assessments 2025.

It is also important to note that during the site selection process, which occurred throughout the winter and early spring, none of the selected sites had been previously visited, and

interpretations are therefore based on a single assessment per site. Table 5 summarizes key statistics calculated for the assessed sites.

Table 5: RIWHA Assessment Scores and Percentages.

Score Category	Average (%)	Minimum (%)	Maximum (%)
Vegetation	80	43	100
Soil Score	80	50	100
Water Level	69	40	100
Water Quality (WQ)	87	58	100
Hydrological Connectivity Score	58	28	100

Overall, vegetation and soil indicators scored relatively high compared to other metrics, with average scores of approximately 80% for both categories. These results suggest that plant communities and soil structure at many sites remain relatively resilient. However, the wide range in vegetation scores (43–100%) indicates that some sites are experiencing notable vegetation stress, likely linked to altered hydrology, clearing, or edge effects associated with road infrastructure.

In contrast, hydrological indicators showed comparatively lower and more variable performance. Water level scores averaged 69%, with a broad range from 40% to 100%, reflecting site-specific differences in flow restriction, drainage concentration, or water retention. Hydrological connectivity scored lowest overall, averaging 58%, highlighting frequent disruptions to natural surface and subsurface flow pathways were observed.

Water quality scores were consistently high, averaging 87%, suggesting that despite physical and hydrologic disturbance, water quality parameters at most sites remain relatively intact.

Table 6: Impacts Between Sites.		
Impact Type	**# of Sites (27)**	**Frequency (% of sites)**
Defective Culvert	7	26
Erosion (i.e. exposed soil, stream incision, headcuts)	3	11
Ditches	3	11
Habitat Fragmentation	15	56
Beaver Activity *(Natural process)*	12	44
None	4	14

Table 7: Disturbances Between Sites.		
Disturbance Type	**# of Sites (27)**	**Frequency (% of sites)**
Wildfire *(Natural disturbance)*	1	4
Cutblock/Logging	3	11
Road Prism	16	59
Oil and Gas	0	-
Cattle	0	-
None	4	14

Frequent stressors among the sample sites include: direct footprints from the road prisms in the wetland, habitat fragmentation (lack of buffer and visual screening), and impacts from beaver activity. Beaver activity was observed at many sites, emphasizing the strong presence of natural ecological processes interacting with road-altered landscapes. While beaver activity can enhance water retention and habitat complexity, its interaction with culverts and road prisms may also contribute to localized management challenges. Defective culverts, erosion, and

ditching were observed at fewer sites but were important contributors to altered hydrologic flow and sediment dynamics where present.

Other disturbances, including cutblock/logging and wildfire, were not observed among the sample data set, and no oil and gas or cattle-related disturbances were observed within the assessed sites. Overall, these patterns suggest that while natural processes continue to play a significant role in shaping wetland conditions, road-related impacts represent the most consistent and influential driver of wetland impacts throughout the assessment areas.

At this time, based on the sites assessed no restoration candidates were proposed. There were some that might have had potential, but the wetlands have adapted to the changes, and interventions now may not result in clear ecological gains.

5.3 MCINTYRE MONITORING RESULTS

The McIntyre Wetland Restoration Project began in the fall of September 2024 and restoration activities were originally detailed in the report FWCP PEA-F25-W-4035: McIntyre Lake Wetland Restoration (Sofos and Pagliaro 2025). This year's report will discuss the first year's monitoring phase and results.

The project consisted of constructing a complex of 19 beaver-dam analogues (BDAs) (constructed 17 in 2024 and an additional 2 in 2025) over approximately 1.1 km of an unnamed stream tributary to McIntyre Lake. The project's aim was to restore a wetland that was experiencing erosion and stream incision due to an advancing headcut, which threatened the wetland's integrity and ecological health. The project site was recognized as a restoration candidate when it was first visited in June 2023 for an assessment of road impacts on wetlands and connected streams by BCWF staff and monitors from McLeod Lake Indian Band.

To assess the project's impact on local hydrology, a comprehensive monitoring program was implemented. Data was collected before restoration to serve as a baseline compared to post-restoration data. A combination of instream loggers and field data collection has been used to infer restoration impacts on surface flow, shallow groundwater levels, surface water-groundwater interactions, and water quality.

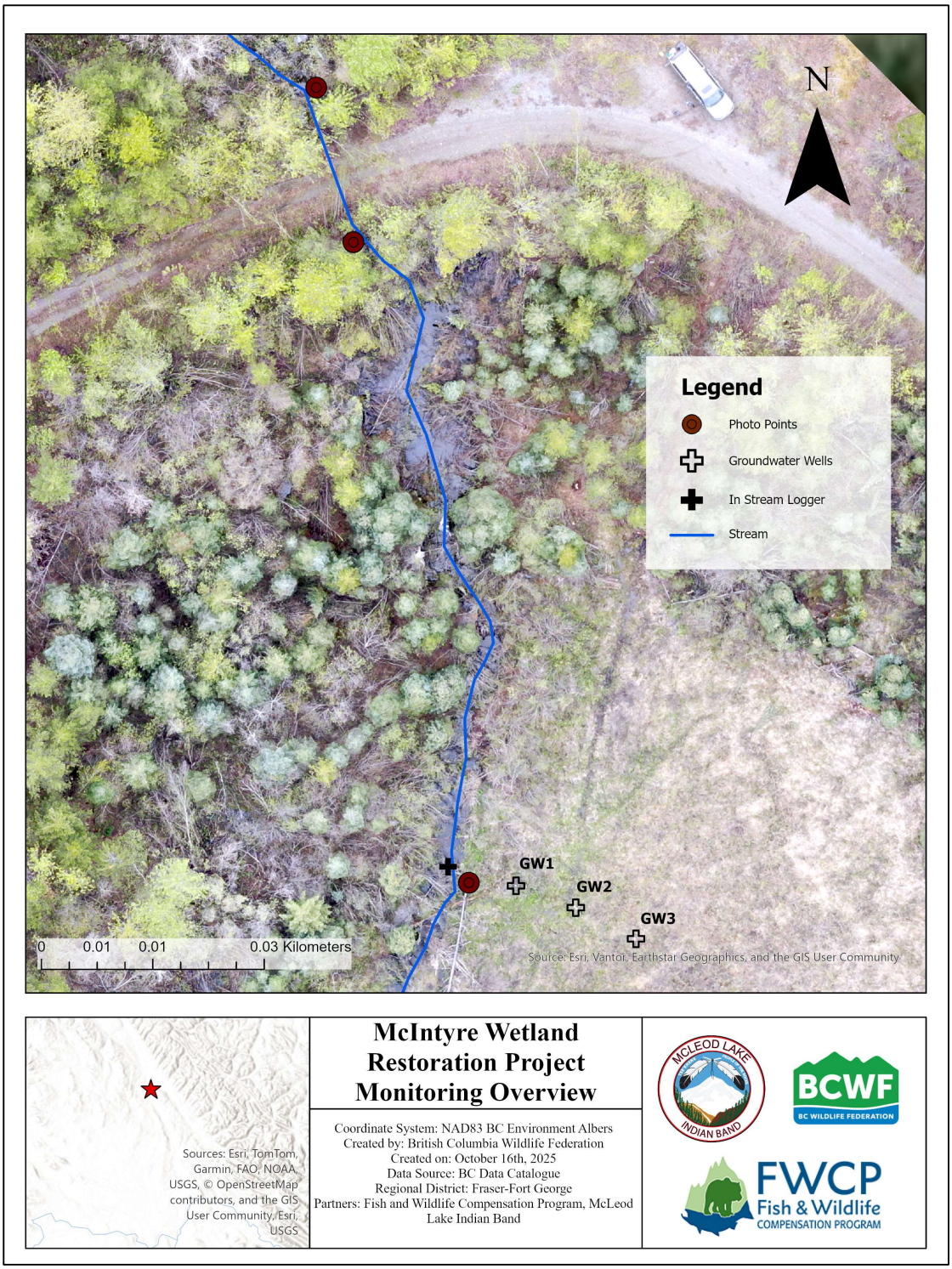


Figure 3. McIntyre wetland restoration project monitoring parameters.

Furthermore, field and drone surveys were conducted to monitor qualitative and quantitative changes to channel form, erosion and deposition processes, floodplain connection, and riparian

vegetation extent pre- and post-restoration. Surveys of instream structures were conducted post-restoration to assess form, functionality, risk, and identify opportunities for maintenance and adaptive management.

5.3.1 GROUNDWATER LEVELS

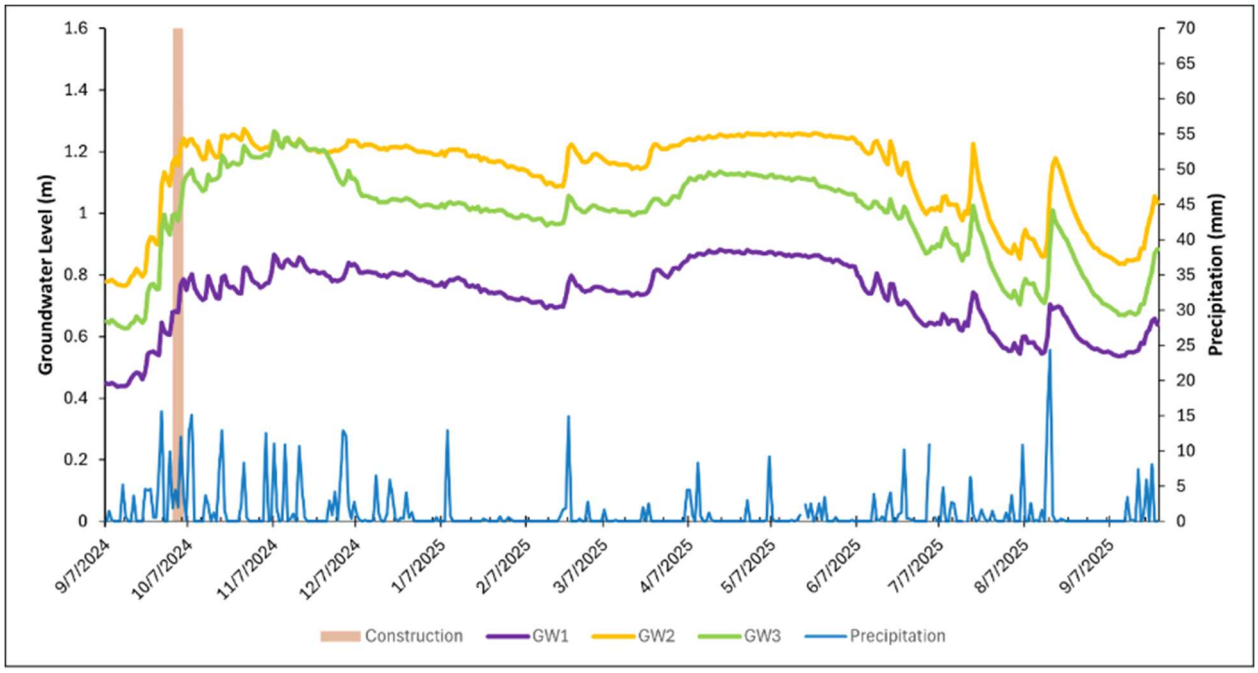


Figure 4. Time series of groundwater level (m).

Recorded at the project site at GW1 (5m from HS3; purple), GW2 (10m from H3; orange), and GW3 (15m from H3; green) between September 7, 2024, to September 24, 2025. Hourly precipitation (mm) for the Mackenzie Weather Station, approximately 27 km northwest of the project site, is shown for reference.

The hydrograph in Figure 4 depicts the time series of groundwater levels from pre-restoration, during, and post-restoration for the three monitoring wells. Although there is limited data prior to restoration, the pre-restoration (month of September 2024), has the lowest water levels observed to date. After the build, the water levels fluctuated but they have yet to reach as low as Sept 2024. I.e GW1 lowest in 2024 was 0.43, and lowest in 2025 was 0.52. GW2 2024 lowest was 0.75, lowest in 2025 was 0.82, and GW3 2024 lowest was 0.61, lowest in 2025 was 0.66.

Groundwater levels at all wells exhibit clear seasonal variability and respond to precipitation events, with the lowest levels occurring in late summer (September). However, interpretation of relative groundwater elevations between wells is uncertain due to ambiguity in how measurements were recorded. As a result, comparisons of hydraulic gradients between wells cannot be made with confidence at this time.

Given these uncertainties, the influence of the BDA treatment on the adjacent groundwater remains inconclusive. Additional monitoring in 2026 is recommended to clarify groundwater response curves.

5.3.2 SURFACE WATER LEVEL

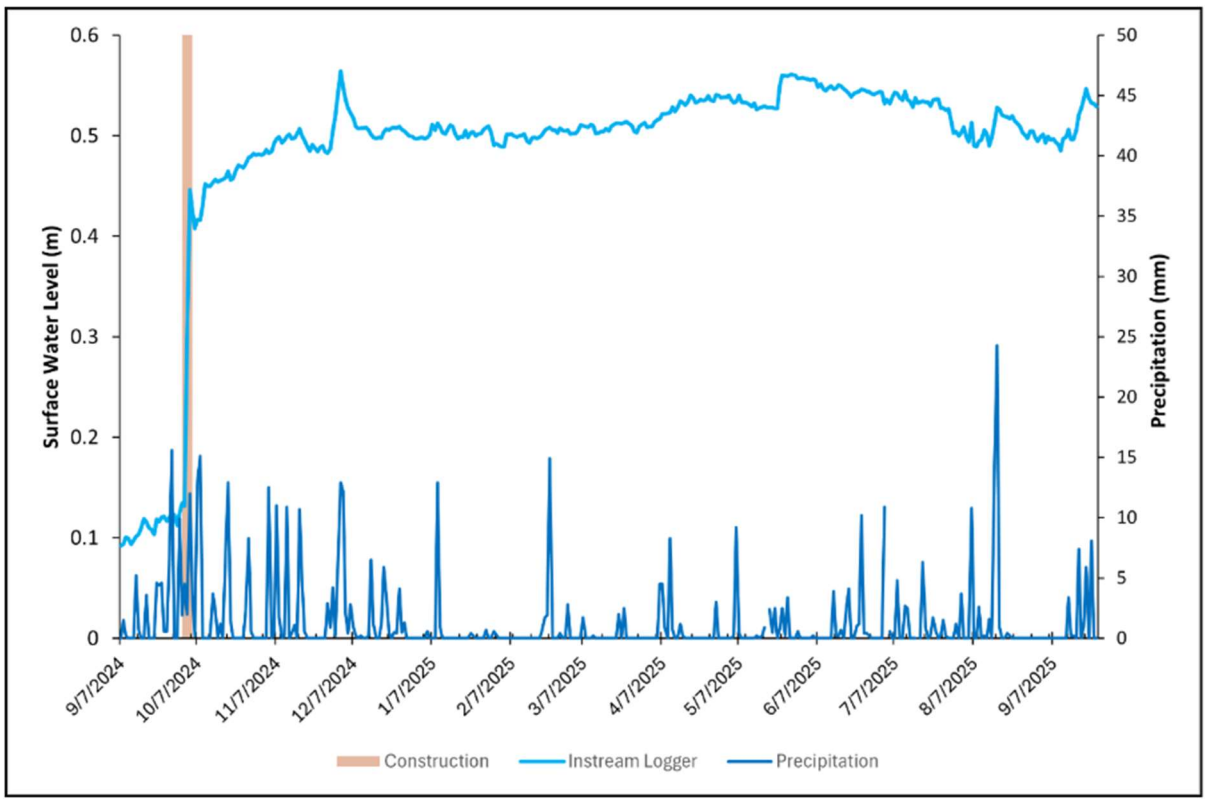


Figure 5. Time series of surface water level (m).

Recorded by the downstream data logger at the project site between September 7, 2024, to September 24, 2025. Hourly precipitation (mm) for the Mackenzie Weather Station, approximately 27 km northwest of the project site is shown for reference.

Figure 5 depicts in stream water level fluctuations from pre-restoration, during, and post-restoration. Key observations include:

- During the monitoring phase, prior to construction, the instream logger exhibited minor fluctuations in water levels, likely influenced by rainfall, and evapotranspiration.
- During the construction window, water levels increased substantially, from an average of 0.11 m prior to construction to 0.51 m after construction. This suggests that the construction activities (i.e., installation of the BDAs) altered local hydrology and enhanced surface water retention within the channel.

- Post-construction, the logger continues to show higher water levels compared to the pre-construction period, which suggests that the restoration efforts have effectively increased water retention throughout the monitoring period.

5.3.3 WATER TEMPERATURE

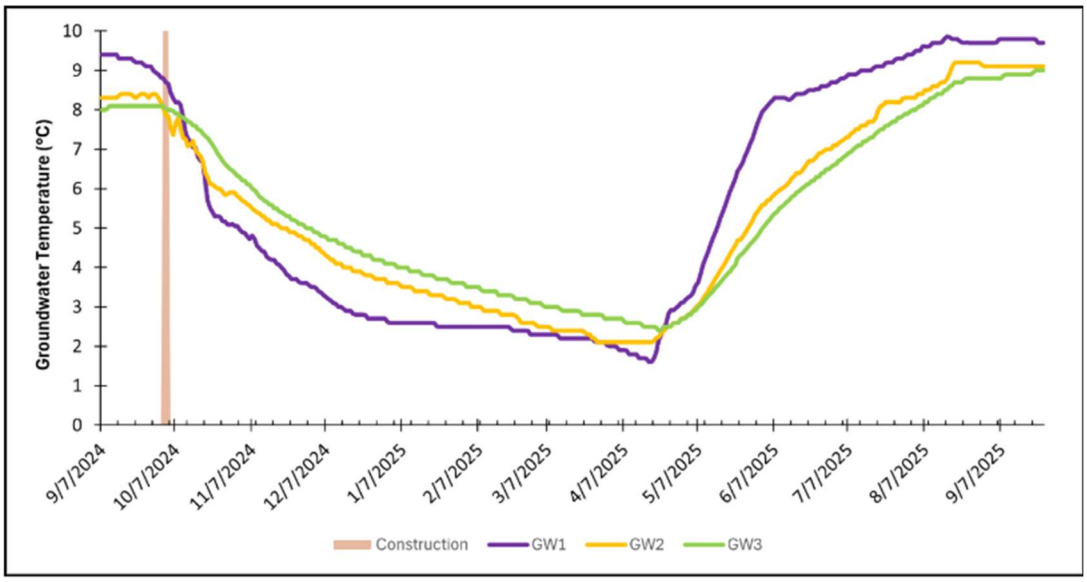


Figure 6. Time series of groundwater temperatures.

Recorded at the project site with the Solinst Junior Level Loggers between September 7, 2024, to September 24, 2025.

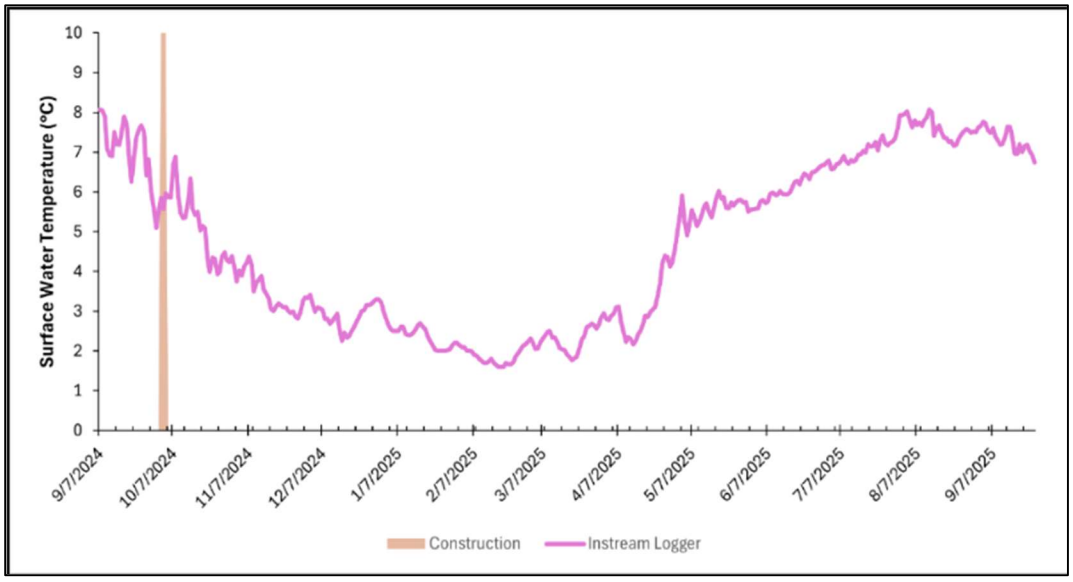


Figure 7. Time series of daily average surface water temperature (°C).

Recorded with a Solinst Junior Level Logger at the project site between September 7, 2024, to September 24, 2025.

Figure 6 presents the water temperature data collected at GW1-GW3 and Figure 7 depicts the water temperature data collected from the instream logger as shown in Map 1 in Appendix-A. Key observations include:

- All wells (Figure 6) show relatively high temperatures (8–10 °C) in early fall, gradually cooling through winter (down to ~2 °C by February 2025). Groundwater wells remain warmer and more stable, typical of subsurface flow buffered by the ground. After spring 2025 (especially around May–June 2025), groundwater temperatures increase more gradually, where GW1 temperatures are the coldest throughout the winter, and are the warmest during the spring and summer months.
- In comparison from September 2024 to 2025, GW1 (5m) shows an increase, from 9.24°C to 9.77°C, while GW2 (10m) experienced the largest change, increasing from 8.35°C to 9.10°C. GW3 (15m) also warmed, from 8.09°C to 8.89°C. Overall, all four stations recorded higher average temperatures in September 2025, with increases ranging from approximately 0.25°C to 0.75°C.
- The stream cools faster and reaches lower winter temperatures than the groundwater wells, which reflects its exposure to air temperature and freezing processes—typical of surface water (Figure 7). After spring, the instream logger temperatures rise more quickly, showing strong influence from surface heating and potentially slower, shallower flow conditions following BDA construction. The instream well rose slightly from 7.08°C in September 2024 to 7.33°C in September 2025, indicating a small warming trend.
- Overall, surface water temperatures remained within a normal seasonal range during and after construction. This suggests that, so far, the BDAs have not caused significant warming or cooling of the stream at this monitoring location.
- All observed temperature differences between 2024 and 2025 in both groundwater and surface water loggers were less than 1 °C and may be attributable to broader interannual temperature variability rather than restoration effects.
- Water temperature data were collected opportunistically using the same data loggers deployed for water-level monitoring; therefore, these temperature observations should be considered anecdotal. A more robust assessment of thermal dynamics within the stream system and adjacent groundwater would require additional, dedicated temperature loggers and expanded spatial coverage.

Overall, the preliminary effectiveness monitoring completed in 2024–2025 indicates that the LTPBR treatments implemented within the restored reach at McIntyre Wetland are progressing toward early hydrologic, geomorphic, and ecological responses consistent with the project's goals

and objectives. The installation of BDAs in headcut-impacted areas directly addressed objectives related to increasing surface water pooling, supporting early-stage headcut stabilization and recovery.

5.4 COMMUNITY ENGAGEMENT

Indigenous engagement for the project began during the application phase and continued throughout the field season. Based on responses from Nations, additional information sharing and planning meetings were held with McLeod Lake Indian Band, Kwadacha First Nation, and Tsay Keh Dene First Nation (Chu Cho Environmental).

Collaborative wetland site visits were conducted with environmental monitors from each Nation during fieldwork. During these visits, monitors generously shared cultural knowledge of the wetlands, while BCWF contributed technical expertise while completing wetland assessments. The project team had the privilege of working with two monitors from Kwadacha First Nation, one monitor from Tsay Keh Dene First Nation (alongside a biologist from Chu Cho Environmental), and two monitors from McLeod Lake Indian Band (one during RIWHA assessments and one during McIntyre Wetland monitoring visits). These collaborations were mutually informative and strengthened relationships, with monitors expressing ongoing interest in future partnerships.

This marked the third field season working with an environmental monitor from McLeod Lake Indian Band, further strengthening relationships with the Nation. Relationship building was an important component of the field season and contributes meaningfully to the long-term success of wetland enhancement efforts. In the fall, additional site visits were completed at locations of interest to McLeod Lake Indian Band. Although these sites fell outside the FWCP focal area, visiting them provided valuable context for understanding wetlands impacted by roads and other linear disturbances.

Similar work was also carried out in the Peace Region outside of the Williston Basin with additional First Nation communities that are members of the FWCP Working Group, supported through alternate funding sources. This included Doig River First Nation, Saulteau First Nations, and Halfway River First Nation. Wetland profiles and a project summary report will be shared with First Nation partners once additional work is completed and the WESP model has been calibrated for the region.

6.0 DISCUSSION

This field season advanced wetland assessment, monitoring, and relationship-building objectives within the Williston Basin and surrounding Peace Region were completed by integrating multiple complementary assessment tools, long-term restoration monitoring, and

Indigenous and community engagement. Collectively, the results provide a clearer understanding of wetland condition, dominant stressors, and restoration potential, while also establishing datasets to support future conservation planning.

Results from the RIWHA assessments indicate that many wetlands within the study area remain generally functional but are vulnerable to ongoing disturbance. Hydrologic alteration and disrupted connectivity emerged as the most consistently affected components, reflecting the influence of roads, culverts, and associated linear infrastructure. In contrast, vegetation, soils, and water quality indicators were comparatively resilient across many sites.

The WESP and CNWI assessments contributed important information for the Northern Boreal Mountains ecoprovince. By capturing a range of wetland classes, disturbance conditions, and landscape contexts, the collected data will support calibration of the WESP model and improve the accuracy of future wetland function comparisons and management decisions. Similarly, CNWI plot data will strengthen predictive wetland mapping efforts at regional and national scales, improving the ability to identify priority wetlands for conservation and restoration.

Early effectiveness monitoring at the McIntyre Wetland suggests that beaver dam analogue (BDA) installation is contributing to positive hydrologic responses, including increased surface water retention. These changes align with the project's goal of slowing flow, reducing erosive energy, and re-establishing wetland–floodplain connectivity.

Community and Indigenous engagement were integral to the success of the 2025 field season. Collaborative fieldwork supported knowledge exchange, built local capacity for wetland stewardship, and fostered trust and long-term relationships with participating Nations. Continued interest in future collaboration underscores the value of sustained engagement and reinforces the role of community-led stewardship in wetland conservation.

7.0 RECOMMENDATIONS

Continued investment in training and capacity-building initiatives is recommended to support communities, local stewardship groups, First Nations, and environmental professionals in advancing wetland conservation and protection across British Columbia. In the Peace Region, where wetlands face increasing pressure from climate change and linear infrastructure, community-based workshops and hands-on restoration activities have demonstrated strong potential to deliver lasting and meaningful conservation outcomes. Ongoing communication through regular stakeholder updates is also recommended to ensure that local partners and rights holders are informed of project progress, findings, and emerging opportunities for collaboration.

The data generated through RIWHA, WESP, CNWI, and restoration monitoring highlights the widespread influence of road infrastructure on wetland hydrology and connectivity. Continued application of these assessment tools would improve understanding of cumulative road-related impacts and support more informed land-use planning and infrastructure design. Incorporating wetland health and connectivity considerations into the early stages of road planning, maintenance, and deactivation could help reduce future impacts and long-term restoration costs.

In an effort to identify restoration candidates, future assessments will prioritize:

- Road–stream intersections within 50 metres of wetlands where head-cuts may be present. These sites are of particular concern because a head-cut can advance progressively into a wetland, posing a threat that may not yet be fully apparent.
- Spur roads in old cutblocks and partially deactivated roads**,** as they represent strong restoration opportunities, as these roads are no longer in active use.

Finally, it is recommended that assessment and monitoring data collected through the McIntyre Wetland be used to guide the identification and prioritization of future restoration opportunities. Ongoing monitoring, reporting, and adaptive management will be essential to evaluate restoration effectiveness, refine best practices, and ensure that conservation actions remain responsive to changing environmental conditions.

8.0 ACKNOWLEDGEMENTS

We would like to acknowledge the following financial supporters:

- Fish and Wildlife Compensation Program
- Province of BC - Watershed Security Fund

We would also like to thank the following project partners for their support:

- McLeod Lake Indian Band
- Kwadacha First Nation
- Tsay Keh Dene First Nation
- Chu Cho Environmental
- Fish and Wildlife Compensation Program
- Ministry of Water, Land and Resource Stewardship

9.0 CLOSURE

Respectfully,
B.C. Wildlife Federation

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APPENDIX-A. FIGURES AND ILLUSTRATIONS OF RIWHA

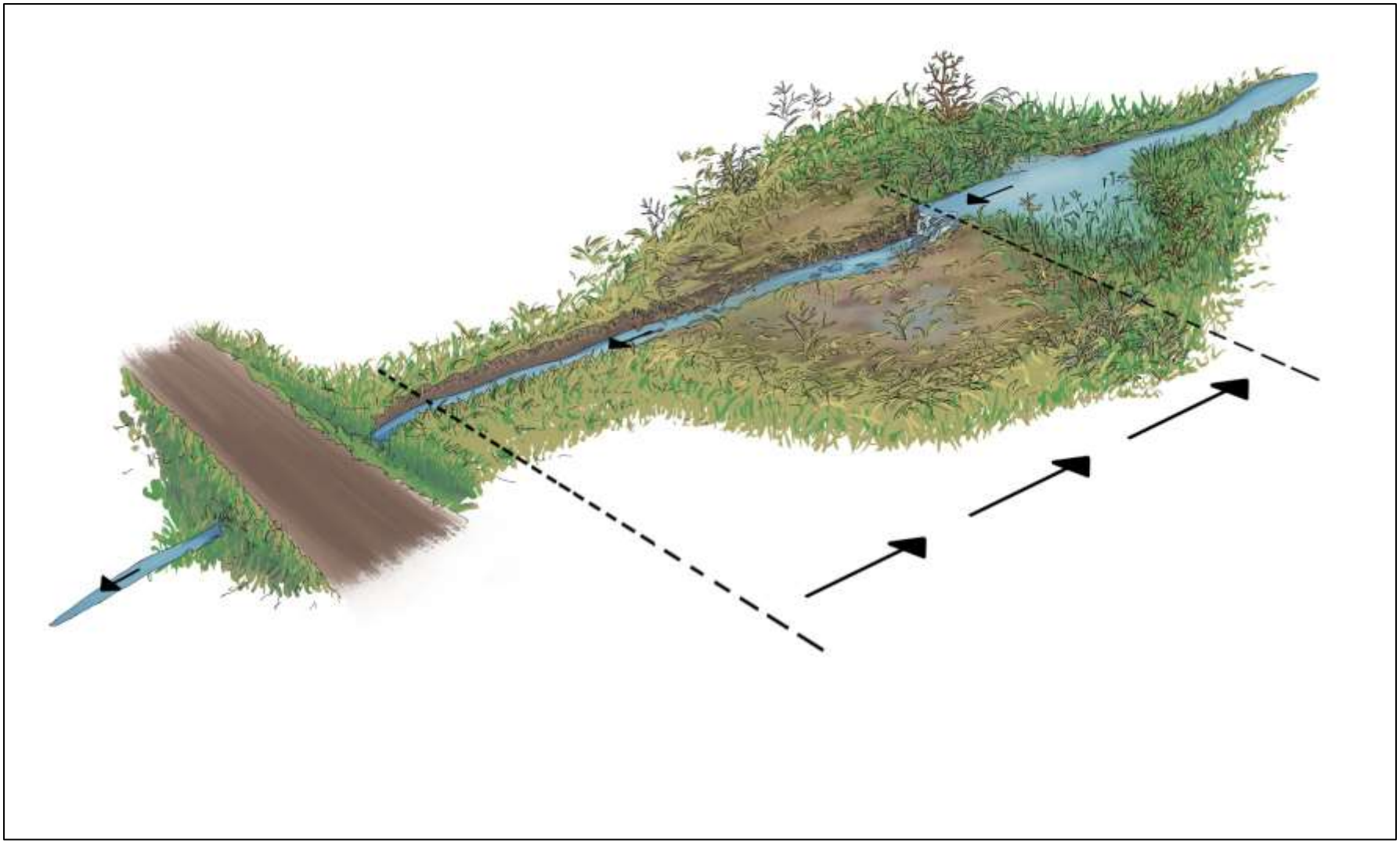


Figure 1:Scenario 1: Conceptual diagram illustrating headcut formation and upstream channel erosion following wetland and stream intersection by a road prism.

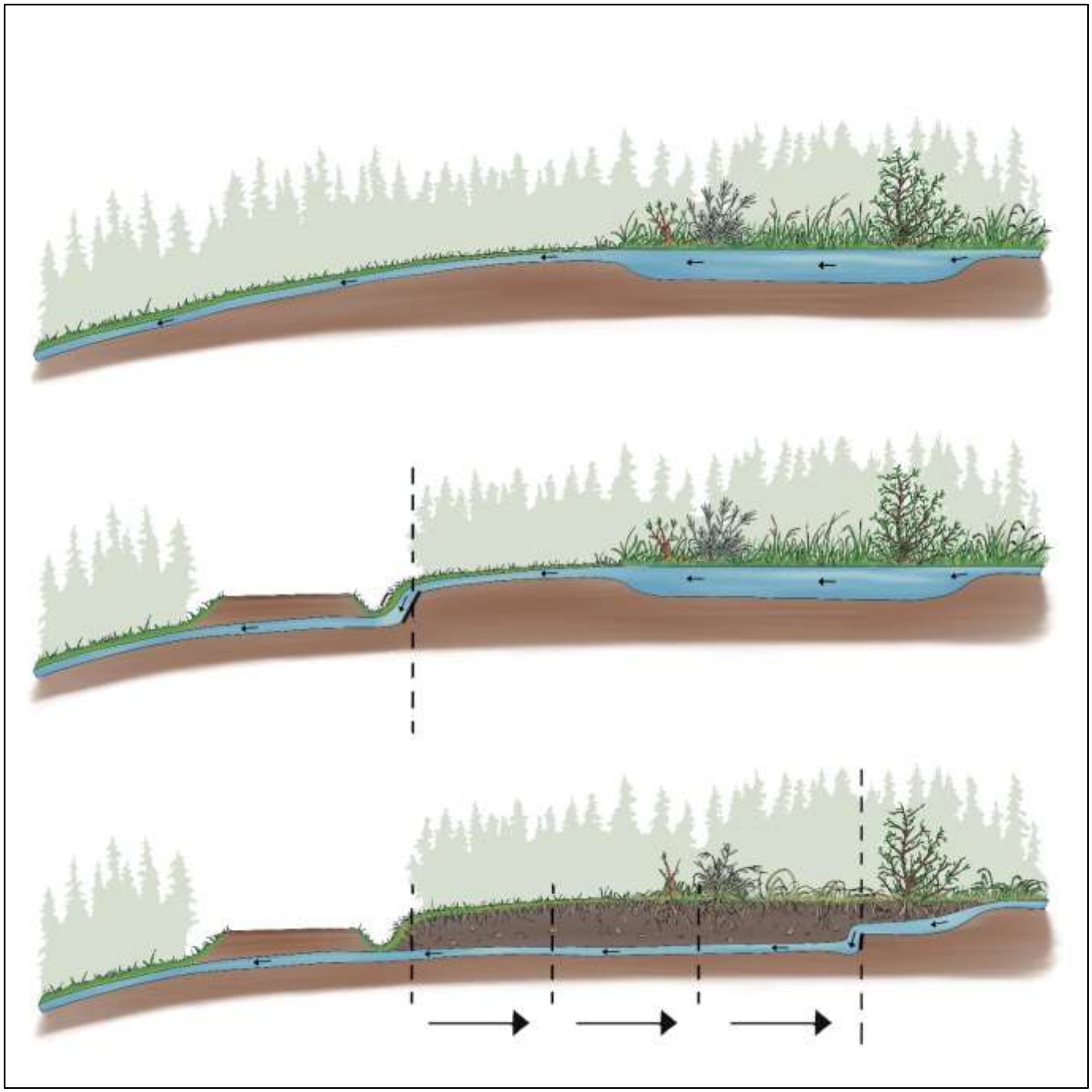


Figure 2: Representation of Scenario 1 showing the progression of headcut impacts over time.

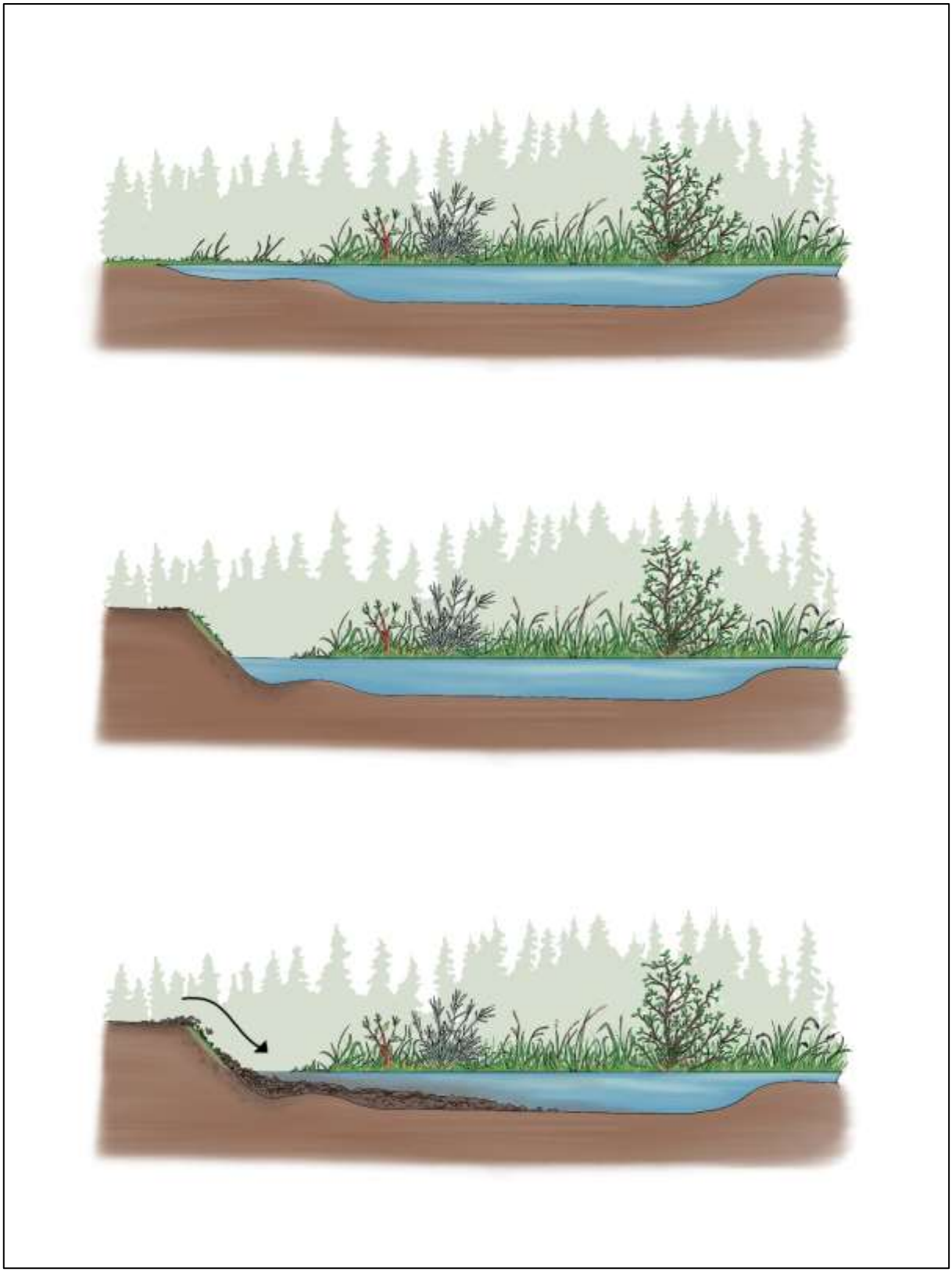


Figure 3: Scenario 2: Conceptual diagram demonstrating how runoff from road prisms can redirect surface water and introduce sediment into adjacent wetlands.

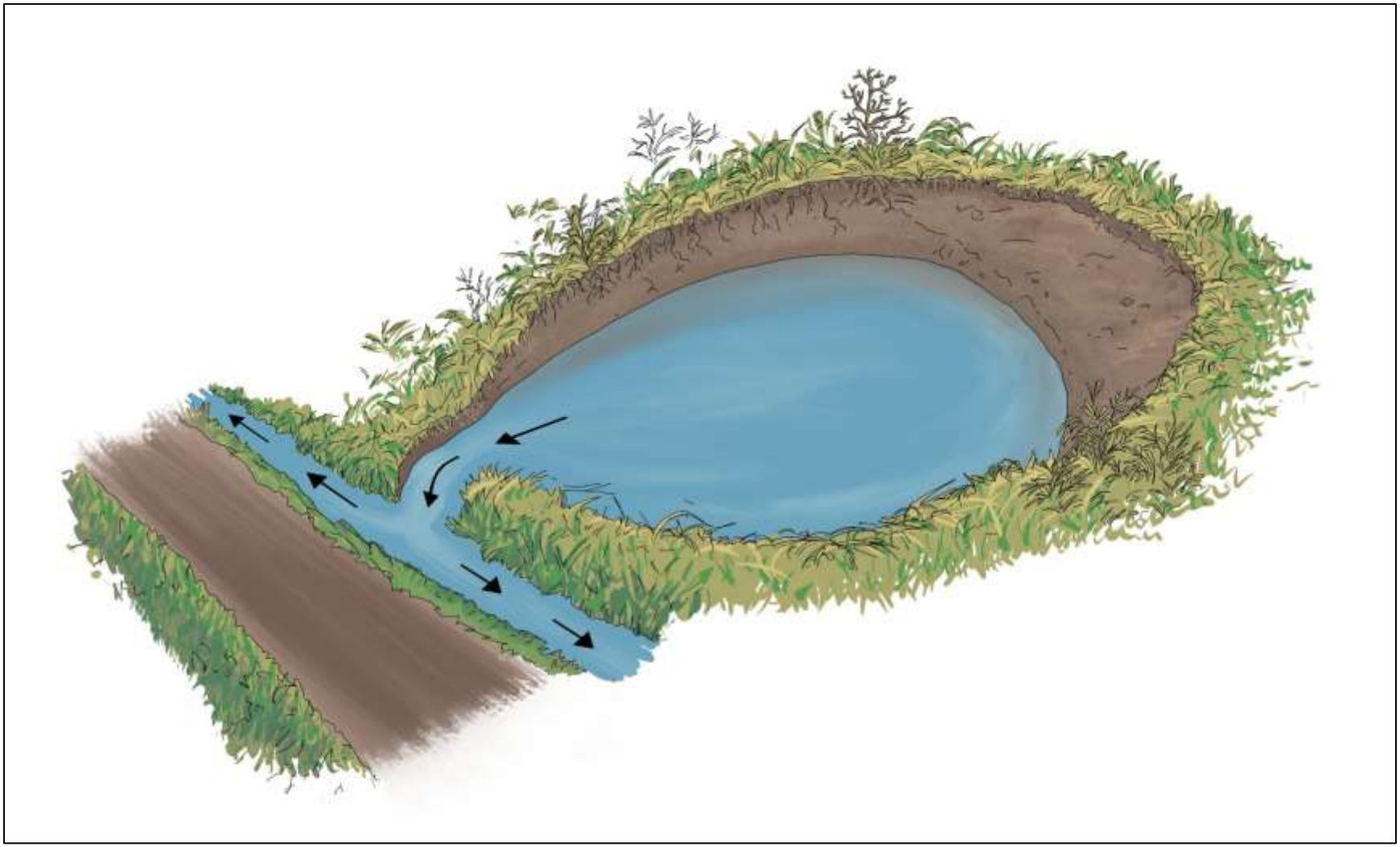


Figure 4: Scenario 3: Conceptual diagram illustrating wetland drainage resulting from roadside ditching that intercepts and redirects surface water away from the wetland.

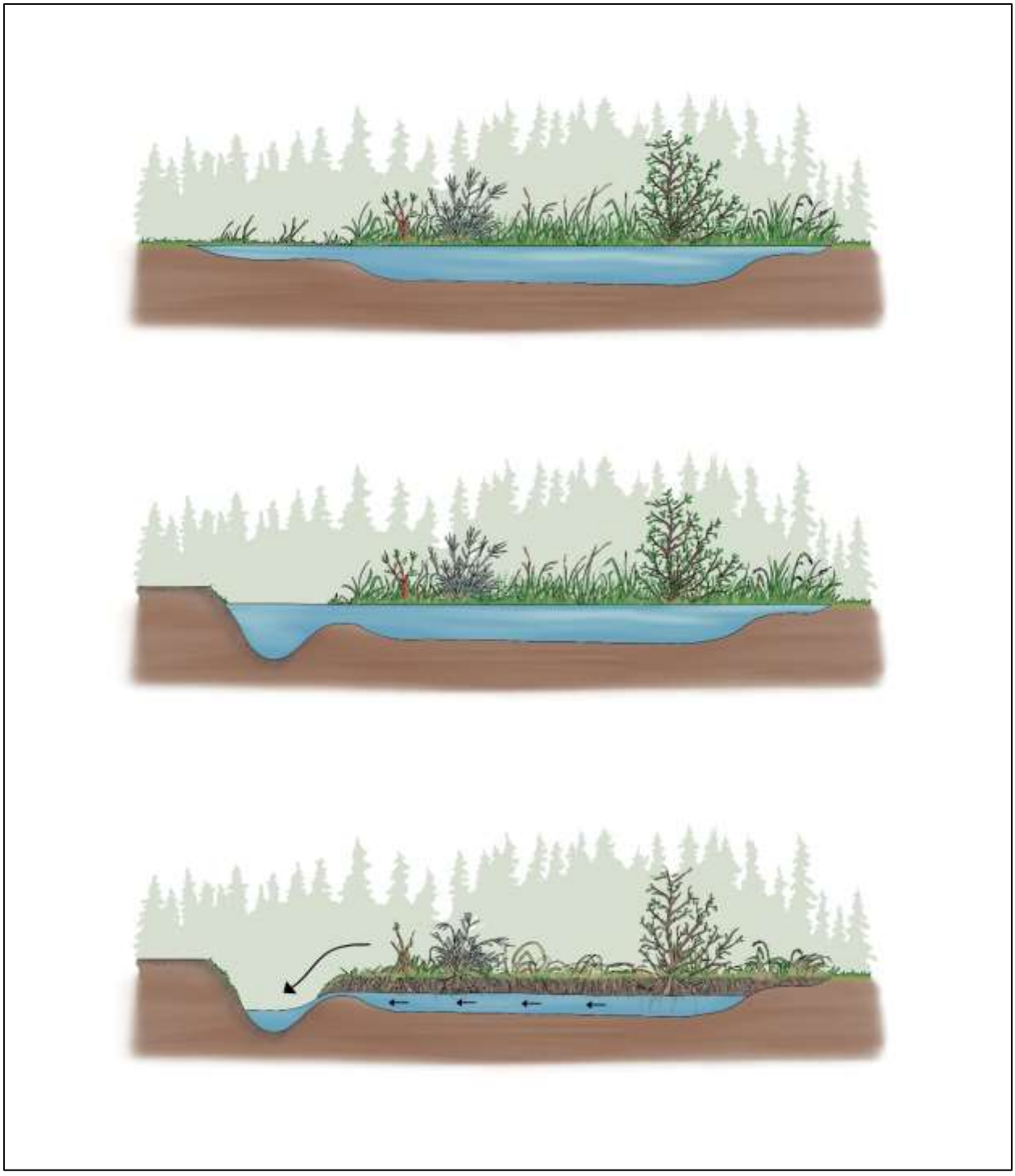


Figure 5: Representation of Scenario 3 showing the progression of impacts over time.

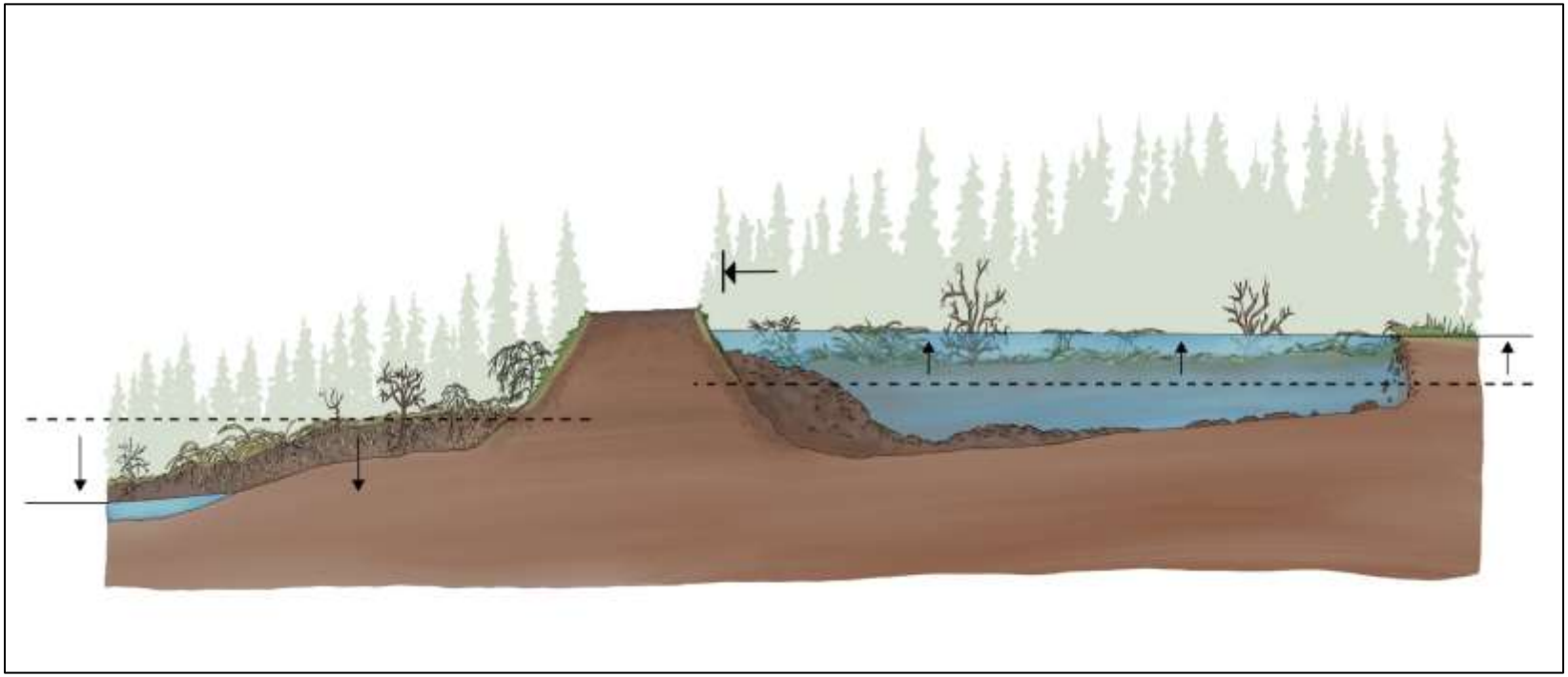


Figure 6: Scenario 4: Conceptual diagram showing how road prisms intersecting streams and wetlands can alter groundwater and surface water flow paths, influencing hydrologic connectivity and water movement.

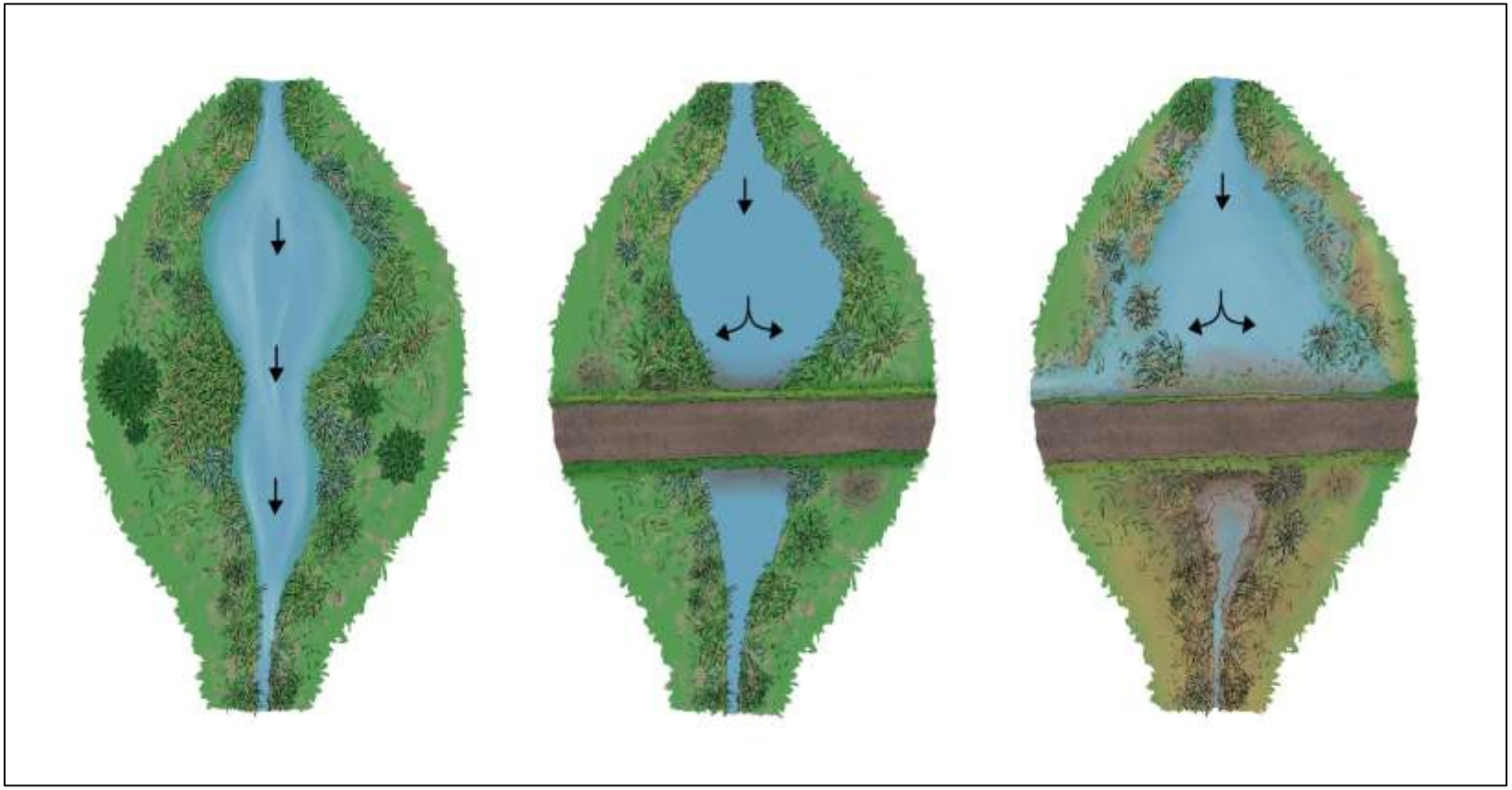


Figure 7: Representation of Scenario 4 showing the progression of impacts over time.

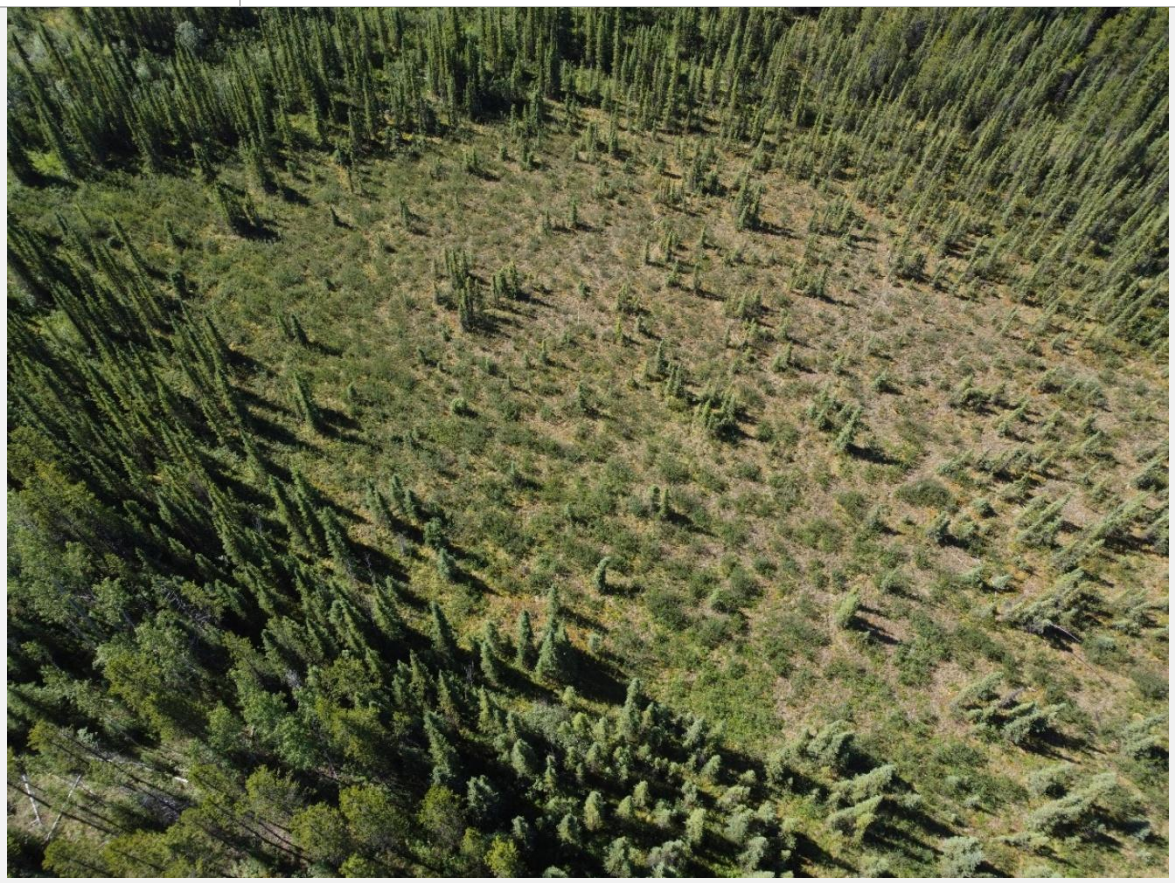
APPENDIX-B. RIWHA SITE ASSESSMENTS AND PHOTOS

Site ID	Vegetation (score/pot.)	Soil (score/pot.)	Hydrologic Impact (score/pot.)	Water Quality (score/pot.)	Hydrological Connectivity (score/pot.)	Total Score	Score (%)	Identified Impacts	Field Notes
NBM_2940	24/28	30/30	–/15	–/12	–/18	54	93.1%	N/A	Wetland overall healthy. Adjacent to road.
NBM_2939	22/28	26/30	15/15	12/12	15/18	90	87.4%	Road prism, habitat fragmentation	Road-related impacts are minimal.
NBM_9169	24/28	26/30	14/15	12/12	13/18	89	86.4%	Road prism	Wetland overall healthy.
NBM_77777	20/28	15/30	10/15	8/12	9/18	62	60.2%	Logging, habitat fragmentation	Small wetland impacted by logging with visible skid tracks and heavy compaction from machinery.
NBM_466	23/28	27/30	11/15	10/12	13/18	84	81.6%	Road prism, habitat fragmentation	Recent and older logging activity present. Wetland overall healthy.
NBM_9201	28/28	29/30	13/15	11/12	15/18	96	93.2%	N/A	Road adjacent to wetland. Relatively healthy.
NBM_2935	25/28	23/30	11/15	11/12	13/18	83	80.6%	Ditching, habitat fragmentation	Source of flow not confirmed; wetland is mostly healthy.
NBM_464	21/28	24/30	11/15	11/12	11/18	78	75.7%	Beaver activity, road prism, habitat fragmentation	Relatively healthy. Stream is monitored with silt fencing and water quality measurements.
NBM_66666	21/28	24/30	10/15	–/12	9/18	64	70.3%	Road prism, logging, beaver activity	Rapid assessment due to unsafe site access. Ponded water and dead trees indicate major hydrological impacts.
NBM_2953	18/28	22/30	10/15	10/12	6/18	66	64.1%	Habitat fragmentation, erosion (headcut), blocked culvert, ditching, road prism	Road-intersected wetland with partially blocked culvert. Ponded water upstream with dead trees; headcuts downstream from culvert placement.
NBM_33333	17/28	19/30	6/15	10/12	9/18	61	59.2%	Habitat fragmentation, road prism, beaver activity, cutblock	Heavily impacted by historic beaver activity and road placement. Ponded water from beaver dams; possible blocked culvert. Road is deactivated.
NBM_1930	19/28	20/30	6/15	11/12	9/18	65	63.1%	Road prism, beaver activity, habitat fragmentation	Wetland has adapted to disturbances and remains functional. Wildfire history. Wide road intersects wetland.
NBM_9177	18/28	20/30	11/15	12/12	5/18	66	64.1%	Habitat fragmentation, road fill, soil erosion	Impacts possibly natural. Extreme exposed soil and small-medium headcuts. Wetland on a slope; not road-intersected.

Site ID	Vegetation (score/pot.)	Soil (score/pot.)	Hydrologic Impact (score/pot.)	Water Quality (score/pot.)	Hydrological Connectivity (score/pot.)	Total Score	Score (%)	Identified Impacts	Field Notes
SBI_0	20/28	18/30	6/15	9/12	9/18	62	60.2%	Habitat fragmentation, road fill, beaver activity, road prism, ditching	Historic and recent beaver activity. Road ditches influence water input. No culvert found. Vegetation mostly healthy aside from ponded areas.
BP_22222	21/28	22/30	7/15	7/12	6/18	63	61.2%	Road prism, beaver activity, habitat fragmentation, erosion	Severe downstream erosion with high exposed banks. Very little water flow. Old beaver activity. Culvert poorly maintained or installed.
SBI_11111	22/28	26/30	11/15	9/12	9/18	77	74.8%	Road prism, beaver activity, partially blocked culvert	Old strong beaver activity visible via drone. Healthy vegetation cover. Poorly maintained, partially blocked culvert with turbid water near road.
SBI_313	25/28	30/30	–/15	–/12	–/18	55	94.8%	–	Healthy wetland adjacent to road.
SBI_8162	26/28	27/30	–/15	–/12	–/18	53	91.4%	Minor: windfall, habitat fragmentation	Overall healthy with minor impacts including visual screening loss and windfall from nearby cutblock.
SBI_165	12/28	19/30	6/15	9/12	9/18	55	53.4%	Habitat fragmentation, road prism, road fill, beaver activity, blocked culvert	Road intersects wetland; different plant communities on each side. Blocked, crushed culvert from beaver activity. Vegetation stressed from ponding.
SBI_7377	28/28	30/30	15/15	12/12	18/18	103	100%	–	Healthy wetland adjacent to road with no apparent signs of impact.
SBI_211	24/28	22/30	11/15	11/12	9/18	77	74.8%	Road prism, beaver activity	Hard-to-reach site assessed via drone. Impacts from old overgrown road intersecting wetland and high beaver activity. Dead trees visible.
SBI_8937	24/28	19/30	10/15	11/12	9/18	73	70.9%	Road prism, beaver activity	Large swamp complex intersected by busy forest service road. Old beaver activity with some dead vegetation. Wetland has overall adapted.
SBI_2775/6954	23/28	26/30	13/15	12/12	15/18	89	86.4%	Road, cutblock, habitat fragmentation, beaver activity, wildfire	–
SBI_204	24/28	22/30	11/15	–/12	9/18	66	72.5%	Road prism, cutblock, habitat fragmentation, poor culvert placement	Hydrological system heavily impacted despite older disturbances (>15 yrs). Unlevelled culvert with no water flow. Compacted soil with evidence of machinery.

Site ID	Vegetation (score/pot.)	Soil (score/pot.)	Hydrologic Impact (score/pot.)	Water Quality (score/pot.)	Hydrological Connectivity (score/pot.)	Total Score	Score (%)	Identified Impacts	Field Notes
SBI_7110	27/28	30/30	–/15	–/12	–/18	57	98.3%	N/A	Difficult site access. Drone imagery shows relatively healthy wetland with no major impacts.
SBI_205	26/28	29/30	–/15	–/12	–/18	55	94.8%	N/A	Healthy wetland adjacent to road and old cutblock with no major impacts.
SBI_439	20/28	19/30	10/15	11/12	9/18	69	67.0%	Road prism, blocked culvert, beaver activity	Elevated water levels from blocked, crushed culvert. Dead trees visible in imagery from hydrological changes.

Site ID	**NBM_2940**
Coordinates:	57°09'57.6"N 125°20'21.5"W
Description	The wetland complex consists of fen and swamp associations located approximately 20 m west of the Finlay–Russell Forest Road, which runs north–south, supports significant logging traffic, and is separated from the wetland by a vegetated buffer and a slope greater than 5 degrees descending into the site. Selected as an introductory assessment location to examine potential road-related effects, the wetland's vegetation and soils appear relatively healthy, with the most likely impacts being dust deposition from traffic and possible fill material introduced during road construction.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	93%
Potential Restoration and benefit	None



Site ID	**NBM_2939**
Coordinates	57°16'50.9"N 125°36'52.5"W
Description	This fen complex is intersected by Stelkuz Road, with hydrologic connection to Stelkuz Lake and Creek, and shows minimal road-related impacts limited to edge disturbance species and minor sediment deposition. Vegetation shifts north and south of the road are slight and remain within the same overall plant community, and the wetland appears healthy.
Observed Activities & Features leading to Impacts	Logging, Road Prism
System Impacted	Wetland
Health Score	87%
Potential Restoration and benefit	None



Site ID	**NBM_9169**
Coordinates	57°07'19.6"N 125°17'20.1"W
Description	This fen–swamp complex is intersected by an older corduroy road and was likely hydrologically connected prior to construction, with surface water present around the culvert but no active flow. Despite nearby cutblocks, the wetland appears healthy and requires no restoration.
Observed Activities & Features leading to Impacts	Logging, Road Prism
System Impacted	Wetland & stream
Health Score	86%
Potential Restoration and benefit	None



Site ID	**NBM_77777**
Coordinates	57°07'10.1"N 125°18'11.7"W
Description	This small, previously unmapped fen adjacent to the road shows soil disturbance and compaction from old skid tracks, with shallow ponding and localized edge impacts. Although disturbance is evident, vegetation has largely adapted and restoration opportunities are limited.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	60%
Potential Restoration and benefit	None



Site ID	**NBM_466**
Coordinates	57°14'01.5"N 125°13'09.3"W
Description	This swamp complex extends from Dell Logging Road and contains a small stream conveyed through a functional culvert, with minimal slope change and no major hydrologic alteration. Minor sediment deposition and disturbance-tolerant species occur along the road, but the wetland remains healthy.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland & stream
Health Score	82%
Potential Restoration and benefit	None



Site ID	**NBM_9201**
Coordinates	57°05'59.1"N 125°10'43.8"W
Description	This marsh complex adjacent to the road and an active cutblock shows windfall and slight edge drying, likely influenced by drought rather than disturbance. Overall, the wetland appears healthy with minimal observable impact.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	93%
Potential Restoration and benefit	None



Site ID	**NBM_2935**
Coordinates	57°16'02.3"N 125°07'22.7"W
Description	This bog–fen complex south of Aikee Road receives minor flow through a culvert from an eroded ditch north of the road, though the true stream origin remains uncertain. While vegetation and soils appear healthy, limited buffering and sediment input from the road and recent cutblocks present potential concerns.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	81%
Potential Restoration and benefit	None



Site ID	**NBM_464**
Coordinates	57°27'15.4"N 125°06'30.5"W
Description	This swamp wetland, connected to the Paul River system, shows localized disturbance near culverts, mineral deposition, and possible headcutting upstream and downstream, with active beaver presence influencing flow. Despite these features, the broader wetland remains healthy and dominated by woody vegetation.
Observed Activities & Features leading to Impacts	Logging, Road Prism, Beaver Activity
System Impacted	Wetland & stream
Health Score	76%
Potential Restoration and benefit	None



Site ID	**NBM_66666**
Coordinates	56°58'20.5"N 125°05'51.8"W
Description	This large marsh–fen system adjacent to the high-traffic Finlay Russell FSR shows ponding and dead trees west of the road likely influenced by historic beaver activity and road effects. The site is clearly impacted and would benefit from further assessment in coordination with Kwadacha Nation.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	70%
Potential Restoration and benefit	None



Site ID	**NBM_2953**
Coordinates	56°52'42.1"N 125°01'42.1"W
Description	This marsh–fen–swamp complex is intersected by a road with a partially blocked culvert and upstream headcutting, indicating altered hydrology and restricted flow. Dead trees upstream and reduced conveyance suggest road-related impacts.
Observed Activities & Features leading to Impacts	Logging, Road Prism
System Impacted	Wetland & stream
Health Score	64%
Potential Restoration and benefit	None



Site ID	**NBM_33333**
Coordinates	56°53'09.5"N 125°01'34.4"W
Description	This large wetland system appears hydrologically altered by an overgrown east–west road acting as a partial dam, with ponding on both sides and no visible culvert. Historic cutblocks and mapped stream alignment suggest the road has modified natural flow patterns.
Observed Activities & Features leading to Impacts	Logging, Road Prism, Beaver Activity
System Impacted	Wetland & stream
Health Score	59%
Potential Restoration and benefit	None



Site ID	**NBM_1930**
Coordinates	56°44'48.6"N 125°02'53.9"W
Description	This fen–swamp complex near Tsay Keh Dene is intersected by Thomas Trail, where a bridge and functional culvert maintain stream connectivity to Isola Creek and the Williston Reservoir. Although buffering is limited and habitat fragmentation is present, hydrologic function appears intact.
Observed Activities & Features leading to Impacts	Logging, Road Prism
System Impacted	Wetland & stream
Health Score	63%
Potential Restoration and benefit	None



Site ID	**NBM_9177**
Coordinates	57°01'25.0"N 125°12'34.9"W
Description	This fen complex east of the 15,000 Road contains multiple surface flow channels, including active outflow with small headcuts along a steep slope. Minor sediment input may occur from an adjacent pullout, but the wetland remains saturated and consistent with fen conditions.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	64%
Potential Restoration and benefit	None



Site ID	**SBI_0**
Coordinates	55°09'57.8"N 121°47'54.2"W
Description	This wetland is actively influenced by beaver dams adjacent to Sukunka FSR, resulting in significant roadside ponding and overflow into ditches with no culvert at the main pooling area. Beaver activity, combined with ditching, is the primary driver of hydrologic change.
Observed Activities & Features leading to Impacts	Logging, Ditching, Beaver activity
System Impacted	Wetland & stream
Health Score	60%
Potential Restoration and benefit	None



Site ID	**BP_22222**
Coordinates	56°01'08.8"N 121°08'33.8"W
Description	This marsh–swamp complex near the Eego FSR shows significant hydrologic alteration from historic beaver dams and road influence, with minimal flow through a large culvert and evidence of channel incision downstream. The site may be suitable for future beaver dam analog restoration discussions.
Observed Activities & Features leading to Impacts	Logging, Road Prism, Beaver activity
System Impacted	Wetland & stream
Health Score	61%
Potential Restoration and benefit	While the downstream area is very dry, erosion control will be necessary before determining appropriate actions. Beaver Dam Analogs, and replacing the culvert with a bridge would be the next steps.



Site ID	**SBI_11111**
Coordinates	55°25'41.3"N 123°10'45.1"W
Description	This swamp complex intersected by Parsnip Road has a beaver dam built above the culvert, severely restricting flow and creating extensive upstream ponding with dead standing trees. Downstream flow is minimal, indicating strong combined road and beaver influence.
Observed Activities & Features leading to Impacts	Road prism, Beaver activity
System Impacted	Wetland & stream
Health Score	75%
Potential Restoration and benefit	None as the wetland has adapted.



Site ID	**SBI_313**
Coordinates	55°25'42.8"N 123°10'50.8"W
Description	This fen–bog wetland adjacent to Parsnip FSR shows moderate visual screening and no observable impacts, appearing healthy and separate from a nearby beaver-influenced system.
Observed Activities & Features leading to Impacts	Road (minor)
System Impacted	Wetland
Health Score	95%
Potential Restoration and benefit	None.



Site ID	**SBI_8162**
Coordinates	55°24'44.7"N 123°10'20.3"W
Description	This wetland appears healthy despite proximity to past cutblocks and road access, with likely minor sediment transfer but no evident hydrologic alteration. Vegetation and soils show no significant stress.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	91%
Potential Restoration and benefit	None.



Site ID	**SBI_165**
Coordinates	54°24'46.7"N 122°40'06.0"W
Description	This intersected marsh–swamp–fen system has a completely blocked and possibly crushed upstream culvert due to beaver activity, resulting in full upstream ponding and minimal downstream flow. Despite altered hydrology, downstream vegetation remains largely adapted.
Observed Activities & Features leading to Impacts	Logging, Road Prism, Ditching, Beaver activity
System Impacted	Wetland & stream
Health Score	53%
Potential Restoration and benefit	None as wetland adapted and stabilized around long-established beaver dams; however, clearing the blocked culvert may be important to prevent ponded water from flooding the road.



Site ID	**SBI_7377**
Coordinates	54°24'50.3"N 122°40'00.0"W
Description	This separate wetland system located 42 m from the road shows partial drying but maintains healthy vegetation with no apparent road-related impacts.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	100%
Potential Restoration and benefit	None



Site ID	**SBI_211**
Coordinates	54°23'54.6"N 122°43'06.6"W
Description	This large marsh–swamp complex intersected by an overgrown north–south road shows older beaver activity and possible partial culvert blockage, with denser downstream vegetation suggesting reduced flow. Overall, the wetland appears adapted and in healthy condition.
Observed Activities & Features leading to Impacts	Logging, Beaver activity, Road Prism.
System Impacted	Wetland
Health Score	75%
Potential Restoration and benefit	None.



Site ID	**SBI_8937**
Coordinates	55°09'25.9"N 123°12'39.8"W
Description	This swamp complex intersected by the Finlay Connector FSR contains older beaver dams and a functional, unblocked culvert, with minor tree mortality near the road. Despite adjacent cutblocks, the wetland remains healthy and stable.
Observed Activities & Features leading to Impacts	Logging, Road Prism
System Impacted	Wetland & stream
Health Score	71%
Potential Restoration and benefit	None



Site ID	**SBI_2775/6954**
Coordinates	55°05'00.6"N 123°06'47.8"W
Description	This fen complex intersected by the old Sabai Road shows minor vegetation shifts and disturbance species along road edges, with beaver activity present upstream and downstream. The wetland has adapted well and remains in good condition.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	86%
Potential Restoration and benefit	None.



Site ID	**SBI_204**
Coordinates	54°38'18.2"N 123°05'56.6"W
Description	This swamp complex along Davie Weedon Road FSR shows ineffective, dry culverts and evidence of past hydrologic alteration likely associated with road and cutblock development. Despite saturated fen conditions downstream, the system appears disconnected from historic flow patterns.
Observed Activities & Features leading to Impacts	Logging, Road Prism
System Impacted	Wetland & stream
Health Score	73%
Potential Restoration and benefit	None as wetland has adapted to impacts.



Site ID	**SBI_7110**
Coordinates	54°39'10.6"N 123°04'39.2"W
Description	This fen–bog basin east of Davie Weedon Road appears separate from adjacent wetlands and shows no surface water or observable impacts despite nearby cutblocks. The site appears healthy and does not require restoration.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	98%
Potential Restoration and benefit	None.



Site ID	**SBI_205**
Coordinates	54°39'10.8"N 123°04'39.2"W
Description	This large fen complex west of Davie Weedon Road shows no confirmed stream crossing or culvert, and wetlands on either side of the road appear naturally separated. Vegetation remains healthy, with only minor potential sediment input from adjacent road and cutblock activity.
Observed Activities & Features leading to Impacts	Logging
System Impacted	Wetland
Health Score	95%
Potential Restoration and benefit	None



Site ID	**SBI_439**
Coordinates	54°37'56.0"N 123°04'22.6"W
Description	This swamp complex intersected by Davie Weedon Road FSR is primarily influenced by active beaver dams that are blocking the upstream culvert and increasing ponding, though partial flow persists. While the wetland has largely adapted, culvert clearing would improve hydrologic function.
Observed Activities & Features leading to Impacts	Road prism, Logging, Beaver activity.
System Impacted	Wetland
Health Score	67%
Potential Restoration and benefit	None as wetland adapted to impacts.



APPENDIX-C. RIWHA ASSESSMENT FORM USED IN 2025

Road Impact and Wetland Health Assessment (RIWHA)

Surveyors:	**Date/Time:**
Site ID:	**UTM Coordinates:**

Site Description:

Photo Log:

□ If stream is present, inlet (culvert)
□ If stream is present, outlet
□Representative photo(s) of vegetation communities
□ Road
□ Road impacts
□ Impact of other activity/feature (on each side of feature if applicable – **indicate direction**
□ Drone images/videos
□ 360 images

Site Sketch (Include measurements useful for restoration). Follow the legend format seen on the score page.

Area (size of wetland observed):

Which part of the assessment area are you observing or assessing? (Select direction)

☐ Entire wetland polygon N/E/S/W
☐ Partial of wetland polygon N/E/S/W
☐ Floodplain area N/E/S/W

Describe:_____

Other: _____

Observed Activities & Features Leading to Impacts

Observed Activities & Features Leading to Impacts: How close is the road to the wetland?

□ < 30m □ 30-50m □ >50m □ Intersects- □ Actual _____m

Select each activity below which is present within the wetland and may have caused impacts to the wetland:

□ Logging	□ Agriculture	□ Mining	□ Oil & Gas
□ Utilities	□ Recreation	□ Wetland Restoration	□ Other: _____
□ Logging road	□ Forest Service Road	□ Highway	□ N/A

Indicate if any of the following linear impacts are present in or directly adjacent to wetland: Circle if Upstream **(U)** or Downstream **(D)** of road or **I** (Intersects) or **(A)** adjacent. You can select more than one

□ Road **U D I A**	□ Constructed Trails **U D I A**	□ Winter Road **U D I A**	□ Cutline **U D I A**
□ Well Pad **U D I A**	□ Utility Corridor **U D I A**	□ Informal Trails **U D I A**	□ Other: ____ **U D I A**

Are there known or suspected impacts to vegetation on site? □ yes □ no □uncertain
If yes or uncertain, please answer V1-V9.

Indicate below if any of the following vegetation impacts are observed:

□ Vegetation Clearing	□ Habitat fragmentation	□ Seeding □ Cultivation	□ Other: _____

If the road intersects the wetland, what is the area of the road footprint within the wetland? (Measure the length and width of the road prism within the wetland boundary).

Length: _____	Width: _____	Area: _____

Are there indicators of physical impacts to soils in or immediately adjacent to the wetland?

☐ yes ☐ no ☐Uncertain **If yes or uncertain, please answer SI1-SI4.**

Indicate below if any of the following soil impacts are observed:

□ Excavation	□ Stockpiling	□ Addition of Fill	□ Tillage
□ Heavy Machinery Tracks	□ Truck or Off-Road Vehicle Tracks	□ Hummocking and Pugging	□ Land Clearing or Contouring
□ Fire	□ Road Prism	□ Other: _____	

Are there known or suspected impacts to the amount or quality of water on site?

☐ yes ☐ no ☐ uncertain. **If yes or uncertain, answer WL, WQ and HC questions**.

Select each item below which is present and likely to have disturbed the amount of water (surface and/or subsurface flows):

Circle IF Upstream **(U)** or Downstream **(D)** of road.

□ Obstruction of surface/subsurface flow from road prism **U D**	□ Culvert (obstruction/maintenance) **U D**	□ Culvert (poor installation) **U D**
□ Water Removal (i.e., Pumping) **U D**	□ Stream Diversion **U D**	□ Dam or Weir **U D** □ man-made
□ Stream Incision **U D**	□ Inundation **U D**	□ Ditching □ water input to wetland **U D** □ water removal from wetland **U D**
□ Other: _____ **U D**		□ Not applicable

Select each item below which is present and likely to have disturbed the water quality within the wetland:

Circle IF Upstream **(U)** or Downstream **(D)** of road.

□ Overland Flow from Anthropogenic Feature (Feature:_____) **U D**	□ Contaminant Source or Presence **U D**
□ Excess Sediment Input **U D**	□ Beaver Activity due to human features (ex: culvert) **U D**
□ Other: _____ **U D**	□ No impacts on water quality

Are the observed impacts to wetland health due to natural processes?

☐ yes ☐ no ☐ uncertain Circle if Upstream **(U)** or Downstream **(D)** or both **(B)** of road.

☐ Wind **U D B**	☐ Fire **U D B**	☐ Insects **U D B**	☐ Diseases **U D B**
☐ Mass wasting **U D B**	☐ Floods **U D B**	☐ Beaver Activity **U D B**	☐ Other: _____ **U D B**

Vegetation Impacts

Are there clear impacts to vegetation health, quantity, or community within or immediately adjacent to the wetland?

□ yes □ no **(if no, skip VI1 – VI9)**

V1. Has a shift in vegetation occurred to another wetland or upland community from what would be the expected wetland class for the site? Rate the severity and recency of the shift.

0= Severe (No longer a wetland) **/ 1= Moderate** (Some shift from one wetland class to another) **/ 2= None-minimum** (Veg community the same with minimal impact)	_____
0*= 0-5 years* **/** ***1****=6-15 years* **/** ***2****= >15 years*	_____

V2. What percentage of vegetation is exhibiting signs of stress? (*think of how this correlates with the road, is there too much or too little water?)*

0 *= >50% |* ***1*** *= 25-50% |* ***2*** *= 5-25% |* ***3*** **=** *<5%* □ *Seasonal Drought*	_____

V3. Total % cover of invasive species **(see in Supplement Guide).**

0 *= >15% |* ***1*** *= 1-15% |* ***2*** *= <1% |* ***3*** *no invasives*	_____

Species	%Cover	Distribution code	Species	%Cover	Distribution code

V4. What is the percent cover of disturbance-caused species within the wetland?

0 *= >50% |* ***1*** *= 25-50% |* ***2*** *= 5-25% |* ***3*** **=** *< 5%*	_____

Disturbance-caused species observed: _____

V5. What is the average width of the road where species disturbance is observed? *(Once you have calculated the area of the road prism, calculate the portion of the disturbed area.)*

Area: _____	Note:

V6. If there is a stream in or connected to the wetland, what percentage of the streambank is covered by deep, stabilizing roots? *(For example, consider how plants like sedges can help hold and stabilize soil. Are shrubs or willows present? These types of vegetation can also help stabilize the bank and support water retention.)*

0 *= <35% |* ***1*** *= 35 - 65% |* ***2*** **=** *65 - 85% |* ***3*** **= >** *85%*	_____

Are there woody species present on site or potential for woody species?
□ yes □ no **(if no, skip V6 – V9)**

V7. What percentage of woody vegetation is impacted by browsing and grazing?

0 *= >15%- (excessive) |* ***1*** *= 5-15% (moderate) |* ***2*** *= <5% (minimal) |* ***3*** **=** *absent (no impact)*	_____

V8. Are there many dead or dying trees or shrubs, suggesting a recent change in water levels? What percentage of the tree/shrub cover is dead or dying? (Examples: look for decay or decline, or too much or too little water).

0 *=>75% |* ***1*** *=50-75% |* ***2*** *= 25 – 50 % |* ***3*** *=<15%*	_____

V9:Assess how much of the wetland is visible from the road in terms of distance and estimated percentage of the wetland area.*(Assessing how much of the wetland is observable from the roadway is crucial, as increased visibility can lead to heightened impacts on the wetland ecosystem, such as cattle accessing the road and trampling vegetation, increased predation pressure on wildlife due to reduced cover, and higher hunting pressure from human activity.)*

0 *= >100m |* ***1*** *= 50-100m |* ***2*** **=** *10-50m |* ***3*** **=** *<10m*	_____
0 *= >25% |* ***1*** *= 10-25% |* ***2*** **=** *0-10% |* ***3*** **=** *0%*	_____

V10: How much of the wetland edge is buried by the road or associated fill? *(This refers to how much of the natural edge is obscured or replaced, which can act as a visual and physical barrier, contributing to habitat fragmentation.)*

0 *= >25% |* ***1*** *= 10-25% |* ***2*** **=** *0-10% |* ***3*** **=** *0%*	

Soil Impacts

Are there indicators of physical impacts to soils in or immediately adjacent to the wetland?
□ yes □ no **(if no, skip SI1 – SI4)**

SI1. If the road intersects the wetland, estimate the percentage of additional fill/soil extending beyond the width of the road prism. Estimate the areal extent of the soil prism.

0 *= >100% |* ***2*** *= >25% |* ***4*** *= >5% |* ***5*** *= >1% |* ***6*** **=** *0%*	_____

SI2. % of polygon where fill has been added to or stockpiling has occurred within wetland *(The percentage of the polygon affected should focus on direct impacts, like added soil that creates a non-wetland area or leads to a highly modified wetland or plant community i.e., construction of road, well pad, berm, or building).*

0 *= >35% |* ***2*** *= 6-35% |* ***4*** *= 1-5% |* ***6*** **=** *<1%*	_____

SI3. % of polygon where wetland soil, bare soil, or exposed peat is present due to human activity (*Human land uses causing bare ground include livestock grazing, recreation, roads, and industrial activities. The evaluator should consider the causes of all bare ground observed and estimate the fraction that is human-caused,e.g., fresh exposure of soil due to excavation, stockpiling of soil, vehicle use within wetland, forestry land prep, compaction).*

0 *= >15% |* ***2*** *= 5-15% |* ***4*** *= 1-5% |* ***6*** **=** *<1%*	_____

SI4: % of polygon where soil is likely to have been compacted due to human activity *(Estimate the amount of area that has been physically altered by human causes. The purpose of this question is to evaluate physical change to the soil, hydrology, e.g., presence of hummocking and pugging, heavy machinery tracks, cutlines, recreational tracks, could include cattle).*

0 *= >15% |* ***2*** *= 5-15% |* ***4*** *= 1-5% |* ***6*** **=** *<1%*	_____

S15: **a)** Is there any sign of erosion moving soil to or from the wetland? How severe is the sediment gain/loss? (Consider the amount of exposed soil you observe (e.g., if sand or material from a road is washing down and spreading out). A small amount, such as just a few centimeters, may not affect the vegetation, but if the sediment spreads further, it could impact or shift the plant community).

***0** = severe **>30cm**	**1** =10-30 cm moderate	**2** = 0-10cm slight	**3** = None*	_____

S15: **b)** % polygon with sediment deposits (*i.e sand, mud, pebbles*) on top of vegetation or ground surface? (Look for deposits of sediment on top of the ground surface, leaf litter, or living vegetation.)

***0** = >35%	**1** = 15-35%	**2** =5-15%	**3** <5%*	_____

Hydrologic Impacts

Water Levels: Is the water level in the wetland higher or lower than expected for natural conditions? *(Briefly assess the area upstream and downstream. If only one side is affected, summarize the impact. Is the wetland acting as a dam or causing dewatering downstream? Look for features like ditches or noticeable slope differences.)*
□ yes □ no **(if no, skip WL1 – WL4)**

WL1**. a)** % of polygon that shows a recent hydrological shift?

***0** = >35%	**1** = 15-35%	**2** =5-15%	**3** <5%*	_____

WL1**: b)** Rate the extent and recency of the shift. *(Based on your knowledge and understanding of these different wetland types, is the hydrology different than expected for the wetland type? Examples can include evidence of abnormal flooding if present (water marks or silt deposits on trunks, moss growth on trunks, silt deposits on ground surface/leaves, flood debris, drowned out trees or shrubs).*

***0** = 0 -5yrs	**5** = 5-20 yrs	**9** = >20 yrs*	_____

WL2: Severity of human caused alteration to current or previous water levels.

***0** = Extreme (non-wetland to wetland)	**1** =Moderate (change of plant community)	**2** = Minor (minimum impact to veg community)	**3** = None*	_____

Elevation measurements: It is encouraged to take elevation measurements when the wetland and/or a stream is intersected by the road.

Upstream (suffix u)

- **Lu =** Average height of land (surface elevation) in wetland *(upstream)*
- **Wu** = Average water level in wetland *(upstream)*
- **LTu =** Top of land surface elevation range *(upstream)*
- **LBu =** Bottom of land surface elevation range *(upstream)*
- **W1u, W2u, etc.** = Additional surface water level measurements *(upstream)*
- **WCu =** Culvert invert elevation or water level at culvert *(upstream)*
- **BLu =** Crest elevation of beaver dam *(upstream)*
- **BWu =** Water level behind beaver dam *(upstream)*
- **PWu-** Perched water

Downstream (suffix d)

- Use the same codes, replacing **u with d** (e.g., Ld, Wd, Wcd, etc.)

Elevation profile: Draw out your elevation profile view here:

Water Quality

Water Quality: Is the water quality of the wetland outside of the reasonable range of natural variation or are there other obvious impacts to water quality on site?
□ yes □ no **(if no, skip WQ1 – WQ5)**

Water Quality Measurements (on each side of feature if relevant):

Side (circle): N/W/S/E pH: _____ EC: _____ EC units: _____ Temperature: ___ _____
Side (circle): N/W/S/E pH: _____ EC: _____ EC units: _____ Temperature: _____

WQ1: How do the measured pH, EC and/or temperature compare to the expected natural conditions for the wetland class? Answer for whichever side of feature is most impacted.

***0** = pH/EC well within range for a different wetland class | **1** = pH/EC just within range for a different wetland class | **2** = pH/EC at high/low end of range but still within | **3** = pH/EC as expected for natural conditions |*	_____

WQ2: What is the average turbidity of surface water within the wetland? If the water is clear from lack of recent rainfall, look for silt deposits on the ground surface/at the base of any temporary ponded water. *(Note: You may want to look downstream from the road, as roads can increase turbidity through erosion and sediment deposition.)*

***0** = turbid (cloudy or thick with suspended matter) | **1** = moderately turbid (*visibly cloudy or murky*) | **2** = lightly turbid (mostly clear) | **3** = clear or N/A*	_____

WQ3: Does the wetland have any signs of excessive nutrient loading such as algae matts, blooms, or fish kills?

***0** = severe (>60%) | **1** = moderate (25-60%) | **2** = slight (<25%) | **3** = No evidence*	_____

WQ4: % Polygon with evidence of past, present, or imminent contaminant input to the wetland? (*Look for signs of contamination such as visible contaminants from industry/recreation/agriculture/livestock, unusual odor of water, non-organic sheen on water, chemical/contaminant/pollution deposits on ground or vegetation.)*

***0**= >35% (Significant) | **1**=15-35% (Moderate) | **2**=5-15% (Minor) | **3**=<5% (None)*	_____

Hydrologic Connectivity

Are surface and/or subsurface flows to the wetland currently disturbed or is disturbance imminent?
□ yes □ no **(if no, skip HC1-HC5)**

Water flow description: Check the items below and indicate flow direction (U = upstream, D = downstream). Circle the side the water is entering from (N / W / S / E).

□ Firehose or greater **U D** *Side (circle): N/W/S/E*	□ Trickle **U D** *Side (circle): N/W/S/E*	□ Lentic **U D** *Side (circle): N/W/S/E*	□Garden hose **U D** *Side (circle): N/W/S/E*

HC1: Has there been a disruption to the groundwater/surface water input/export from the wetland?

***0** = Yes | **3** =No*	_____

HC2: Is a stream present that is or soon will be disconnected from contributing surface water to the wetland**?**

***0** = Yes | **3** =No*	_____

HC3: Is there evidence of downcutting? Check the items below which apply. (Refer to Supplement Materials for detailed descriptions)

***0** = Yes | **3**= Moderate **6** =No*	_____

☐ Steep, Unstable Stream Banks
- □ Sloughing
- □ Unvegetated
- □ Exposed Roots Along Stream Bank (eroded roots)

☐ Disconnection of Stream from Wetland and/or Floodplain (Incised/Degraded Channel)
- ☐ Not entrenched
- ☐ moderately entrenched/incised
- ☐ entrenched/deeply incised (1 m deep)

IF entrenched (in creek/stream in the wetland), is there a detectable impact to adjacent groundwater? Add a profile measurement and distance perpendicular of impact.

Profile:

Presence of headcut (abrupt change in streambed elevation). Select all that apply:

Headcut 1:

Location relative to wetland:

□ upstream
□ downstream
□ in wetland

Is it causing disconnection to floodplain?

□ Yes
□ Partially
□ No

Streambed condition at headcut:

□hardened surface, easily erodible material
□ other: _____

Streambank condition:

□ NO Armour Layer (Water is flowing over easily erodible material)
□ Sloughing, unvegetated, exposed roots

Sediment deposited downstream:

□ Yes
□ Partially
□ No

Stream measurements: Note: Best to have a clinometer rather than taking rise/run measurements. (*If you are not sure if the stream is accessing its floodplain, take a cross section photo of the stream and floodplain with a meterstick for size reference.* See table in Supplement Materials)

1.Bankfull Width: _____ m

Flood-Prone Width (accessed by 1-2 yr flood, when water is approx. 2X bankfull depth): _____ m (only measure if less than 2x bankfull width)

Entrenchment Ratio (Bankfull Width/Flood-Prone Width): _____

Average slope of stream: _____

Height: _____ m Width:_____ m. Pin GPS location(s).

Presence of headcut (abrupt change in streambed elevation). Select all that apply:

Headcut 2:

Location relative to wetland:

□ upstream
□ downstream
□ in wetland

Is it causing disconnection to floodplain?

□ Yes
□ Partially
□ No

Streambed condition at headcut:

□hardened surface, easily erodible material
□ other: _____

Streambank condition:

□ NO Armour Layer (Water is flowing over easily erodible material)
□ Sloughing, unvegetated, exposed roots

Sediment deposited downstream:

□ Yes
□ Partially
□ No

2.Bankfull Width: _____ m

Flood-Prone Width (accessed by 1-2 yr flood, when water is approx. 2X bankfull depth): _____ m (only measure if less than 2x bankfull width)

Entrenchment Ratio (Bankfull Width/Flood-Prone Width): _____

Average slope of stream: _____

Height: _____ m Width:_____ m. Pin GPS location(s).

Presence of headcut (abrupt change in streambed elevation). Select all that apply:

Headcut 3:

Location relative to wetland:

□ upstream
□ downstream
□ in wetland

Is it causing disconnection to floodplain?

□ Yes
□ Partially
□ No

Streambed condition at headcut:

□hardened surface, easily erodible material
□ other: _____

Streambank condition:

□ NO Armour Layer (Water is flowing over easily erodible material)
□ Sloughing, unvegetated, exposed roots

Sediment deposited downstream:

□ Yes
□ Partially
□ No

3.Bankfull Width: _____ m

Flood-Prone Width (accessed by 1-2 yr flood, when water is approx. 2X bankfull depth): _____ m (only measure if less than 2x bankfull width)

Entrenchment Ratio (Bankfull Width/Flood-Prone Width): _____

Average slope of stream: _____

Height: _____ m Width:_____ m. Pin GPS location(s).

HC4: What percentage of the wetland is currently or imminently affected by disruption to ground or surface water (Consider future threats when answering this question *i.e ponded water behind road, artificial dam/culvert, drainage patterns, channel diversion)*? **Check the items below which apply.**

0 *= >35%* | ***2*** *= 15-35%* | ***4*** *=5-15%* | ***6*** *<5%*	_____

□ Artificial Diversion of Stream □ Ponded Water Behind Road □ Removal of Water □ Engineered Channel Present □ Natural Channel Abandonment □ Blocked Culvert □ N/A	□ Excessive Sediment Input to Channel □ Mid-Channel Bars or Sediment Wedges □ Sediments and Woody Debris Completely Fill >5% Channel Length □ Coarser Dominant Substrate Particles Covered or Embedded in Finer Inorganic Sediments □ Soft dunes resulting in dewatering, multiple channels, and/or misdirected Flow contributing to fresh bank erosion

Overall level of Impact to Wetland

Total Impact Score

Section	Score	Potential Score	Score/Pot.score	% Health Score
Vegetation		**28**		
Soils		**30**		
Water Levels		**15**		
Water Quality		**12**		
Hydrologic Connectivity		**18**		
Total Score		**103**		

Rating Category: <60% = Non-functional (unhealthy), **60-79%** Functional At Risk (healthy but with problems), **80-100%** Proper Functioning Condition (Healthy)-

Legend for site sketch format:

Site Narrative (What are the key causal factors? What happened at site, was something difficult for assessment, etc):

Restoration Potential or not? (list type of restoration, general cost considerations, low/med/high cost and benefit restoration options):

Disturbance type: Is there any other disturbance that wasn't listed?

- □ Road prism
- □ Urban
- □ Natural (i.e wildfire)
- □ Other _____

Completed Assessment for:

- □ Entire Wetland
- □ Part of Wetland

Comment:

Is the wetland currently impacted or imminently threatened?

- □ Currently (**on-going**)
- □ Imminently (**at risk**)
- □ Neither
- □ Other_____

General notes or comments (Final observation i.e. if no intervention actions are taken, will the conditions worsen? Has the wetland adjusted to the observed impacts to the extent that restoration actions would not be beneficial?)

Supplementary Materials

Table 1: Invasive Species Distribution Categories

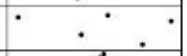
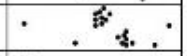
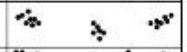
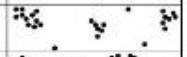
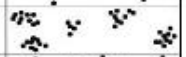
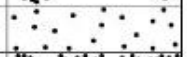
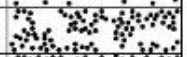
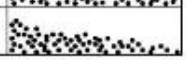
CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several sporadically occurring plants	
7	A few patches	
8	A few patches plus several sporadically occurring plants	
9	Several well spaced patches	
10	Continuous uniform occurrence of well spaced plants	
11	Continuous occurrence of plants with a few gaps in the distribution	
12	Continuous dense occurrence of plants	
13	Continuous occurrence of plants associated with a wetter or drier zone within the polygon.	

Table 2: Disturbance-Increaser Species List

Common Name	Latin Name
Strawberry	*Fragaria* spp.
Cinquefoil	*Potentilla spp.* (excl. Marsh Cinquefoil)
Yarrow	Achillea millefolium
Baltic rush	Juncus balticus
Dandelions	Taraxacum spp.
Sow thistles	Sonchus spp.
Foxtail barley	Hordeum jubatum
Yellow salsify/Western goat's beard	Tragopogon dubius
Clovers	Trifolium spp.

Table 3: Natural Variation in pH and EC by Wetland Class

Wetland Class (BC)	pH	EC
Bog (AB Bog and Poor Fens)	<5.5	Nutrient-poor
Fen (AB Moderate-Rich and Extreme-Rich Fens)	>5.0	Relatively high mineral content
Marsh	Circumneutral. See wetland Edatopic Grids for specific veg associations and translation guide on LMH52 pages 42-43. Range from neutral (pH 6.5 – 7.4) to alkaline (pH > 7.4) on edatopic grids.	Eutrophic to hypertrophic
Swamp	pH on Edatopic Grids ranges from MA, SA, to mid N (sometimes dependent on moisture). Moderately Acidic: 4.5 – 5.5 pH Slightly Acidic: 5.5 – 6.5 pH Neutral: 6.5 – 7.4 pH	Abundant available nutrients
Source: LMH52 https://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh52.htm		

Wetland Class (AB)	pH	EC
Bog	3.0 – 4.2	<100
Poor Fen (BC Bog)	4.0 – 5.5	<100
Moderate-Rich Fen (BC Fen)	5.5 – 7.0	100-250
Extreme-Rich Fen (BC Fen)	7.0 – 8.5	250-2000
Marsh		<500 – 15000
Swamp		<500 – 45000

Sources:
Reclamation Criteria for Wellsites and Associated Facilities for Peatlands
https://open.alberta.ca/dataset/d7bb827e-2212-4a44-ab70-224800afae2a/resource/946827c8-193e-434a-a5a6-6125edcf8e7f/download/reclamationcriteriapeatlands-mar2017.pdf
Alberta Wetland Classification System https://open.alberta.ca/dataset/92fbfbf5-62e1-49c7-aa13-8970a099f97d/resource/1e4372ca-b99c-4990-b4f5-dbac23424e3a/download/2015-alberta-wetland-classification-system-june-01-2015.pdf

Table 4: Severity Categories of Water Level Manipulation

Source: Modified from Alberta Lentic Wetland Health Assessment User Manual, page 15 and FREP Wetland Management Routine Effectiveness Evaluation Technical Supplement, page 75.

None	The water body, or wetland, is not subjected to artificial water level change (e.g., drawdown, addition, stabilization, etc.). This category may include very small amounts of change that cause no detectible fluctuation in water level.
Minor	Hydrological site integrity is near natural. Alteration (including recovery from any past severe alterations) is apparent but reflects minimal impact to plant communities and hydrological function in the altered areas. The water body or wetland is subject to no more than minor artificial water level change or groundwater disruption. The shore area remains vegetated, and withdrawal of water is limited or slow enough that vegetation is able to maintain growth and prevent soil exposure. A relatively narrow band affected by the water level fluctuation may support only annual plants.
Moderate	The water body or wetland is subject to moderate quantities, speed and/or frequency of artificial water level change or groundwater disruption (limit of groundwater entrance to or exit from an area). Where water is removed or groundwater blocked from entering the wetland, it is done in a way that allows pioneer plants to vegetate at least half of the exposed area resulting from drawdown. Where water is added or groundwater blocked from exiting the wetland, some flooding may occur at levels or times not typical to the area/season. Alteration is either in the process of becoming revegetated with appropriate species or is well covered with a mix of less desirable and appropriate species. Wetland may transition from one plant association to another plant association.
Extreme	The water body or wetland is subjected to extreme changes in water level due to volume (extent), speed and/or frequency of artificial water addition or removal or groundwater disruption. Frequent or unnatural levels of flooding occur where water is added, including extensive flooding into riparian and/or upland areas; or no natural annual drawdown is allowed to occur. In extreme artificial drawdown situations, a wide band of exposed area remains unvegetated; a wide band of wetland vegetation is stressed due to limited water indicating that the area is no longer supporting wetland habitat; or upland, undesirable, or invasive species are encroaching into a wide band of the wetland.

Table 5: Terminology

Incision	The downward cutting of a channel into its substrate
Incised Stream	Occurs when downcutting (erosion of the channel bottom) has lowered the channel to a depth where the average 2yr flood cannot escape the channel and access the floodplain. Incised channels are often referred to as degraded channels. Stage II, III, and IV in Schumm's CEM.
Bankfull depth	Bankfull discharge occurs when there is enough flow to fill the entire channel. This typically takes place once every 1-2 years. The water level at this point is called the bankfull stage. This can also be identified as the elevation of the floodplain at the bank edge. Bankfull depth is measured as vertical distance between bankfull stage and the streambed at the thalweg of a riffle.
Bankfull width	Horizontal distance between banks (perpendicular to flow) at bankfull stage. Indicators of the location of bankfull stage include breaks in topography (e.g. vertical bank to floodplain, steep to gentle slope), top of point or central bars, break in sediment particle size, change in bank vegetation from temporary to permanent, upper elevation of fine debris deposits, rocks exposed in the bank, exposed root hairs below an inact soil layer, staining on rocks, and/or lichens or certain riparian vegetation species.
Flood-prone area	Estimated as the vertical distance across the channel that would be covered by water 2 times the bankfull depth (approx. 50-yr recurrence interval flood discharge).
Entrenchment ratio	Vertical containment of a river or stream and the degree to which it is incised or "down-cut" into the valley floor. Measured as flood-prone area width / surface width of bankfull channel.
Entrenched/Incised	Ratio 1 – 1.4. Water rarely escapes the channel, possibly only during extreme flood events.
Moderately Entrenched	Ratio 1.41 – 2.2. The 1 – 5 year high flow events may not access the floodplain, but higher flows (5 – 10 year event) can access a narrow floodplain.
Slightly Entrenched	Ratio > 2.2. Bankfull flows (1-2 year events) regularly spill onto floodplain. Stable to fairly stable channel, unincised.
Headcut	Abrupt change in streambed elevation (step) due to erosion. Often migrates in an upstream direction over time.
Armour Layer	Layer of coarser sediment at the surface of the stream bed than directly below due to stream flow which is only capable of moving finer materials. May indicate a slowing of stream velocity due to impacts.
Downcutting	The process by which a stream or river deepens its channel by eroding the stream bed, often due to increased water flow, changes in sediment load, or human activities such as channelization. This can lead to unstable banks and habitat degradation.
Seeding	The act of planting seeds to promote vegetation growth. In ecological restoration or agriculture, seeding is used to establish plant cover, prevent soil erosion, and improve soil stability.

Cultivation	The preparation of soil for planting by plowing, tilling, or other mechanical means. Cultivation is used in farming to improve soil conditions, control weeds, and enhance water infiltration, but excessive cultivation can lead to soil degradation.
Hummocking	The formation of small mounds or raised areas of soil, often due to frost heaving, water movement, or trampling by animals. In wetlands and pastures, hummocking can indicate poor drainage or soil disturbance.
Pugging	The damage caused to soil by the hooves of livestock, particularly in wet conditions. Pugging results in deep holes or compacted areas, reducing soil aeration, water infiltration, and plant growth.

Sources – Text is modified (and sometimes directly) from:

US EPA. Fundamentals of the Rosgen Stream Classification System. https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=1259

US EPA, 2006. Field Operations Manual for Assessing the Hydrologic Permanence and Ecological Condition of Headwater Streams. https://www.epa.gov/sites/default/files/2015-11/documents/manual_for_assessing_hydrologic_permanence_-_headwater_streams.pdf

Canada,N.R . Forestry glossary I Natural Resources Canada. Website.https://cfs.nrcan.gc.ca/terms#wb-auto-4 [accessed 7 March 2025].

Charlton,Ro,2008. Fundamentals of Fluvial Geomorphology.

Fitch, L, B.W Adams and G. Hale, 2009. Riparian Health Assessment for Streams and Small Rivers- Field Workbook. Second Edition. Lethbridge, Alberta: Cows and Fish Program.

Fitch, Adams and Hale (2009) pages 62 – 70 for photographic examples of streams with different levels of incision, as well as instructions on how to identify incision in the field.

Glossary Of Terms By BC Forest Practises Board. *Forest Practices Board*. Website https://www.bcfpb.ca/blog/news-resources/glossary/ [accessed 7 March 2025].

Table 6: Common Invasive and Noxious Plants in BC

Invasive/Noxious Plant Species	Scientific Name	Wetland Indicator Status
Anchusa (Common Bugloss)	*Anchusa officinalis*	-
Baby's Breath	*Gypsophila paniculata*	-
Black Knapweed	*Centaurea nigra*	-
Blueweed	*Echium vulgare*	-
Bohemian Knotweed	*Fallopia x bohemica*	-
Brazilian Waterweed (syn. Brazilian Elodea)	*Egeria densa*	OBL
Brown Knapweed	*Centaurea jacea*	FACU
Buck's-horn Plantain	*Plantago coronopus*	FACW
Bull Thistle	*Cirsium vulgare*	FACU
Canada Thistle	*Cirsium arvense*	FACU
Caulerpa	*Caulerpa taxifolia*	-
Common Burdock	*Arctium minus*	FACU
Common Tansy	*Tanacetum vulgare*	FACU
Cordgrass	*Spartina spp.*	OBL/FAC
Creeping Buttercup	*Ranunculus repens*	FAC
Dalmatian Toadflax	*Linaria dalmatica*	-
Dandelion	*Taraxacum*	-
Didymo	*Didymosphenia geminata*	OBL
Diffuse Knapweed	*Centaurea diffusa*	-
Dwarf Eelgrass	*Zostera japonica*	FACU
Eurasian Watermilfoil	*Myriophyllum spicatum*	OBL
European Common Reed	*Phragmites australis spp.*	OBL
Fanwort	*Cabomba aquatica*	-
Field Scabious	*Knautia arvensis*	-
Flowering Rush	*Butomus umbellatus*	FACW/OBL
Giant Hogweed	*Heracleum mantegazzianum*	FAC
Giant Knotweed	*Fallopia sachalinensis*	-
Giant Mannagrass/Reed Sweetgrass	*Glyceria maxima*	OBL
Giant Reed	*Arundo donax*	-
Gorse	*Ulex europaeus*	FACU
Hairy Willow Herb	*Epilobium hirsutum*	FACW
Hanging Sedge	*Carex pendula*	-
Himalayan Balsam (syn. Policeman's Helmet)	*Impatiens glandulifera*	FACW
Himalayan Knotweed	*Persicaria wallichii*	FAC
Hoary Alyssum	*Berteroa incana*	-
Hoary Cress	*Cardaria draba*	-

Hound's-tongue	*Cynoglossum officinale*	FACU
Hydrilla	*Hydrilla verticillata*	-
Japanese Knotweed	*Fallopia japonica*	FACU
Japanese Wireweed	*Sargassum muticum*	-
Leafy Spurge	*Euphorbia esula*	-
Marsh Plume Thistle	*Cirsium palustre*	-
Meadow Hawkweed	*Hieracium caespitosum*	-
Meadow Knapweed	*Centaurea debeauxii*	-
Nodding Thistle	*Carduus nutans*	FACU
Orange Hawkweed	*Hieracium aurantiacum*	-
Oxeye Daisy	*Leucanthemum vulgare*	FACU
Parrot's Feather	*Myriophyllum aquaticum*	OBL
Perennial Pepperweed	*Lepidium latifolium*	FAC
Plumeless Thistle	*Carduus acanthoides*	-
Poison Hemlock	*Conium maculatum*	FACW
Policeman's Helmet	*Impatiens glandulifera*	FACW
Puncture Vine	*Tribulus terrestris*	-
Purple Loosestrife	*Lythrum salicaria*	FACW
Reed Canary Grass	*Phalaris arundinacea*	FACU
Rush Skeletonweed	*Chondrilla juncea*	-
Russian Knapweed	*Acroptilon repens*	-
Russian Olive	*Elaeagnus angustifolia*	FAC
Scentless Chamomile	*Matricaria maritima*	-
Scotch Broom	*Cytisus scoparius*	-
Scotch Thistle	*Onopordum acanthium*	-
Spotted Knapweed	*Centaurea biebersteinii*	-
St. John's Wort	*Hypericum perforatum*	FACU
Sulphur Cinquefoil	*Potentilla recta*	-
Swollen Bladderwort	*Utricularia inflata*	OBL
Tansy Ragwort	*Senecio jacobaea*	FACU
Teasel	*Dipsacus fullonum*	FAC
Variable-leaf Milfoil	*Myriophyllum heterophyllum*	-
Wakame	*Undaria pinnatifida*	-
Water Primrose	*Ludwigia hexapetala*	-
Wild Chervil	*Anthriscus sylvestris*	-
Wild Parsnip	*Pastinaca sativa*	-
Yellow Flag Iris	*Iris pseudacorus*	OBL
Yellow Floating Heart	*Nymphoides peltata*	OBL
Yellow Nut Sedge	*Cyperus esculentus*	FACW
Yellow Starthistle	*Centaurea solstitialis*	-
Yellow Toadflax	*Linaria vulgaris*	

Source: Fletcher, N.F., Tripp, D.B., Hansen, P.L., Nordin, L.J., Porter, M., and Morgan, D. 2021. *Protocol for the Wetland Health Management Routine Effectiveness Evaluation*. Forest and Range Evaluation Program, B.C. Ministry of Forests, Lands, Natural Resources Operations and Rural Development, Victoria, B.C.

APPENDIX-D.RIWHA ASSESSMENT FORM REVISED 2026

Road Impact and Wetland Health Assessment (RIWHA)

Surveyors:	**Date/Time:**
Site ID:	**UTM Coordinates:**

Site Description:

Photo Log:

□ If stream is present, inlet (culvert)
□ If stream is present, outlet
□Representative photo(s) of vegetation communities
□ Road
□ Road impacts
□ Impact of other activity/feature (on each side of feature if applicable – **indicate direction**
□ Drone images/videos
□ 360 images

Site Sketch (Include measurements useful for restoration). Follow the legend format seen on the score page.

Area (size of wetland observed):

Which part of the assessment area are you observing or assessing? (Select direction)

☐ Entire wetland polygon N/E/S/W
☐ Partial of wetland polygon N/E/S/W
☐ Floodplain area N/E/S/W

Describe:_____

Other: _____

Observed Activities & Features Leading to Impacts

Observed Activities & Features Leading to Impacts: How close is the road to the wetland?

□ < 30m □ 30-50m □ >50m □ Intersects- □ Actual _____m

Select each activity below which is present within the wetland and may have caused impacts to the wetland:

□ Logging	□ Agriculture	□ Mining	□ Oil & Gas
□ Utilities	□ Recreation	□ Wetland Restoration	□ Other: _____
□ Logging road	□ Forest Service Road	□ Highway	□ N/A

What is the wetland's position relative to the road?

□ Upslope of road	□ Downslope of road	□ Road intersects wetland

If a stream or defined flow path is present, indicate whether any of the following linear impacts occur in or directly adjacent to the wetland.
If no stream or defined flow path is present, leave this section blank.
Circle all that apply and indicate position relative to the road:
Upstream **(U)** or Downstream **(D)** of road or **I** (Intersects) or (**A)** adjacent. You can select more than one

□ Road **U D I A**	□ Borrow Pit **U D I A**	□ Winter Road **U D I A**	□ Cutline **U D I A**
□ Well Pad **U D I A**	□ Pipeline **U D I A**	□ Informal Trails **U D I A**	□ Other: _____ **U D I A**
□ Utility Corridor **U D I A**		□ Constructed Trails **U D I A**	

If no stream or defined flow path is present, indicate whether any of the following linear impacts are present in or directly adjacent to the wetland.
Circle all that apply and indicate position relative to the road:
UP = Upslope **DN** = Downslope **I** = Intersects **A** = Adjacent

□ Road **UP DN I A**	□ Borrow Pit **UP DN I A**	□ Winter Road **UP DN I A**	□ Cutline **UP DN I A**
□ Well Pad **UP DN I A**	□ Pipeline **UP DN I A**	□ Informal Trails **UP DN I A**	□ Other: _____ **UP DN I A**
□ Utility Corridor **UP DN I A**		□ Constructed Trails **UP DN I A**	

Are there known or suspected impacts to vegetation on site? □ yes □ no □uncertain
If yes or uncertain, please answer V1-V9.

Indicate below if any of the following vegetation impacts are observed:

□ Vegetation Clearing	□ Habitat fragmentation	□ Seeding □ Cultivation	□ Drowned or submerged vegetation
□ Uneven or patchy vegetation cover			□ Other: _____

If the road intersects the wetland, what is the area of the road footprint within the wetland? (Measure the length and width of the road prism within the wetland boundary).

Length: _____	Width: _____	Area: _____

Are there indicators of physical impacts to soils in or immediately adjacent to the wetland?
☐ yes ☐ no ☐Uncertain **If yes or uncertain, please answer SI1-SI4.**

Indicate below if any of the following soil impacts are observed:

□ Excavation	□ Stockpiling	□ Addition of Fill	□ Tillage
□ Heavy Machinery Tracks	□ Truck or Off-Road Vehicle Tracks	□ Hummocking and Pugging	□ Land Clearing or Contouring
□ Fire	□ Road Prism		□ Not applicable
□ Other: _____			

Are there known or suspected impacts to the amount or quality of water on site?
☐ yes ☐ no ☐ uncertain . **If yes or uncertain, answer WL, WQ and HC questions**.

Select each item below which is present and likely to have disturbed the amount of water (surface and/or subsurface flows):

□ Obstruction of surface/subsurface flow from road prism	□ Culvert (obstruction/maintenance)	□ Culvert (poor installation)
□ Water Removal (i.e., Pumping)	□ Stream Diversion	□ Dam or Weir □ man-made
□ Stream Incision	□ Inundation	□ Ditching □ water input to wetland □ water removal from wetland
□ Other: _____		□ Not applicable

Comments (i.e if upstream, downslope):

Select each item below which is present and likely to have disturbed the water quality within the wetland:

□ Overland Flow from Anthropogenic Feature (Feature:_____)	□ Contaminant Source or Presence
□ Sediment Input	□ Beaver Activity due to human features (ex: culvert)
□ No impacts on water quality	□ Not applicable
□ Other: _____	
Comments (i.e if upstream, downslope):	

Are the observed impacts to wetland health due to natural processes?

☐ yes ☐ no ☐ uncertain

☐ Wind	☐ Fire	☐ Insects	☐ Diseases
☐ Mass wasting	☐ Floods	☐ Beaver Activity	☐ Not applicable
☐ Other: _____			

Comments (i.e if upstream, downslope):

Vegetation Impacts

Are there clear impacts to vegetation health, quantity, or community within or immediately adjacent to the wetland?
□ yes □ no **(if no, skip VI1 – VI9)**

V1. Has a shift in vegetation occurred to another wetland or upland community from what would be the expected wetland class for the site? Rate the severity and recency of the shift.

0= Severe (No longer a wetland) **/ 1= Moderate** (Some shift from one wetland class to another) **/ 2= None-minimum** (Veg community the same with minimal impact)	_____
0*= 0-5 years* **/** ***1****=6-15 years* **/** ***2****= >15 years*	_____

V2. What percentage of vegetation is exhibiting signs of stress? (*think of how this correlates with the road, is there too much or too little water?)*

0 *= >50% |* ***1*** *= 25-50% |* ***2*** *= 5-25% |* ***3 =*** *<5%* □ *Seasonal Drought*	_____

V3. Total % cover of invasive species **(see in Supplement Guide).**

0 *= >15% |* ***1*** *= 1-15% |* ***2*** *= <1% |* ***3*** *no invasives*	_____

Species	%Cover	Distribution code	Species	%Cover	Distribution code

V4. What is the percent cover of disturbance-caused species within the wetland?

0 *= >50% |* ***1*** *= 25-50% |* ***2*** *= 5-25% |* ***3 =*** *< 5%*	_____

Disturbance-caused species observed: _____

V5. What is the average width of the road where species disturbance is observed? *(Once you have calculated the area of the road prism, calculate the portion of the disturbed area.)*

Area: _____	Comments:

V6. If there is a stream in or connected to the wetland, what percentage of the streambank is covered by deep, stabilizing roots? *(For example, consider how plants like sedges can help hold and stabilize soil. Are shrubs or willows present? These types of vegetation can also help stabilize the bank and support water retention.)*

0 *= <35% |* ***1*** *= 35 - 65% |* ***2 =*** *65 - 85% |* ***3 = >*** *85% |N/A*	_____

Are there woody species present on site or potential for woody species?
□ yes □ no **(if no, skip V6 – V9)**

V7. What percentage of woody vegetation is impacted by browsing and grazing?

0 *= >15%- (excessive) |* ***1*** *= 5-15% (moderate) |* ***2*** *= <5% (minimal) |* ***3 =*** *absent (no impact)*	_____

V8. Are there many dead or dying trees or shrubs, suggesting a recent change in water levels? What percentage of the tree/shrub cover is dead or dying? (Examples: look for decay or decline, or too much or too little water).

0 *=>75% |* ***1*** *=50-75% |* ***2*** *=25 – 50 % |* ***3*** *=<15% |N/A*	_____

V9:Assess how much of the wetland is visible from the road in terms of distance and estimated percentage of the wetland area.*(Assessing how much of the wetland is observable from the roadway is crucial, as increased visibility can lead to heightened impacts on the wetland ecosystem, such as cattle accessing the road and trampling vegetation, increased predation pressure on wildlife due to reduced cover, and higher hunting pressure from human activity.)*

0 *= >100m |* ***1*** *= 50-100m |* ***2 =*** *10-50m |* ***3 =*** *<10m*	_____
0 *= >25% |* ***1*** *= 10-25% |* ***2 =*** *0-10% |* ***3 =*** *0%*	_____

V10: How much of the wetland edge is buried by the road or associated fill? *(This refers to how much of the natural edge is obscured or replaced, which can act as a visual and physical barrier, contributing to habitat fragmentation.)*

0 *= >25% |* ***1*** *= 10-25% |* ***2 =*** *0-10% |* ***3 =*** *0%*	

Soil Impacts

Are there indicators of physical impacts to soils in or immediately adjacent to the wetland?
□ yes □ no **(if no, skip SI1 – SI4)**

SI1. If the road intersects the wetland, estimate the percentage of additional fill/soil extending beyond the width of the road prism. Estimate the areal extent of the soil prism.

***0** = >100%	**2** = >25%	**4** = >5%	**5** = >1%	**6** = 0%*	_____

SI2. % of polygon where fill has been added to or stockpiling has occurred within wetland *(The percentage of the polygon affected should focus on direct impacts, like added soil that creates a non-wetland area or leads to a highly modified wetland or plant community i.e., construction of road, well pad, berm, or building).*

***0** = >35%	**2** = 6-35%	**4** = 1-5%	**6** = <1%*	_____

SI3. % of polygon where wetland soil, bare soil, or exposed peat is present due to human activity (*Human land uses causing bare ground include livestock grazing, recreation, roads, and industrial activities. The evaluator should consider the causes of all bare ground observed and estimate the fraction that is human-caused,e.g., fresh exposure of soil due to excavation, stockpiling of soil, vehicle use within wetland, forestry land prep, compaction).*

***0** = >15%	**2** = 5-15%	**4** = 1-5%	**6** = <1%*	_____

SI4: % of polygon where soil is likely to have been compacted due to human activity *(Estimate the amount of area that has been physically altered by human causes. The purpose of this question is to evaluate physical change to the soil, hydrology, e.g., presence of hummocking and pugging, heavy machinery tracks, cutlines, recreational tracks, could include cattle).*

***0** = >15%	**2** = 5-15%	**4** = 1-5%	**6** = <1%*	_____

S15: **a)** Is there any sign of erosion moving soil to or from the wetland? How severe is the sediment gain/loss? (Consider the amount of exposed soil you observe (e.g., if sand or material from a road is washing down and spreading out). A small amount, such as just a few centimeters, may not affect the vegetation, but if the sediment spreads further, it could impact or shift the plant community).

***0** = severe **>30cm**	**1** =10-30 cm moderate	**2** = 0-10cm slight	**3** = None*	_____

S15: **b)** % polygon with sediment deposits (*i.e sand, mud, pebbles*) on top of vegetation or ground surface? (Look for deposits of sediment on top of the ground surface, leaf litter, or living vegetation.)

***0** = >35%	**1** = 15-35%	**2** =5-15%	**3** <5%*	_____

Hydrologic Impacts

Water Levels: Is the water level in the wetland higher or lower than expected for natural conditions? *(Briefly assess the area upstream and downstream. If only one side is affected, summarize the impact. Is the wetland acting as a dam or causing dewatering downstream? Look for features like ditches or noticeable slope differences.)*
□ yes □ no □ N/A **(if no or not applicable, skip WL1 – WL4)**

WL1**. a)** % of polygon that shows a recent hydrological shift?

***0** = >35%	**1** = 15-35%	**2** =5-15%	**3** <5%*	_____

WL1**: b)** Rate the extent and recency of the shift. *(Based on your knowledge and understanding of these different wetland types, is the hydrology different than expected for the wetland type? Examples can include evidence of abnormal flooding if present (water marks or silt deposits on trunks, moss growth on trunks, silt deposits on ground surface/leaves, flood debris, drowned out trees or shrubs).*

***0** = 0 -5yrs	**5** = 5-20 yrs	**9** = >20 yrs*	_____

WL2: Severity of human caused alteration to current or previous water levels.

***0** = Extreme (non-wetland to wetland)	**1** =Moderate (change of plant community)	**2** = Minor (minimum impact to veg community)	**3** = None*	_____

Elevation measurements:

Upstream (suffix u)

- **Lu =** Average height of land (surface elevation) in wetland *(upstream)*
- **Wu** = Average water level in wetland *(upstream)*
- **LTu =** Top of land surface elevation range *(upstream)*
- **LBu =** Bottom of land surface elevation range *(upstream)*
- **W1u, W2u, etc.** = Additional surface water level measurements *(upstream)*
- **WCu =** Culvert invert elevation or water level at culvert *(upstream)*
- **BLu =** Crest elevation of beaver dam *(upstream)*
- **BWu =** Water level behind beaver dam *(upstream)*
- **PWu-** Perched water

Downstream (suffix d)

- Use the same codes, replacing **u with d** (e.g., Ld, Wd, Wcd, etc.)

Elevation profile: Draw out your elevation profile view here:

Water Quality

Water Quality: Is the water quality of the wetland outside of the reasonable range of natural variation or are there other obvious impacts to water quality on site?
□ yes □ no □ N/A **(if no or not applicable, skip WQ1 – WQ5)**

Water Quality Measurements (on each side of feature if relevant):
Side (circle): N/W/S/E pH: _____ EC: _____ EC units: _____ Temperature: _____
Side (circle): N/W/S/E pH: _____ EC: _____ EC units: _____ Temperature: _____

WQ1: How do the measured pH, EC and/or temperature compare to the expected natural conditions for the wetland class? Answer for whichever side of feature is most impacted.

***0** = pH/EC well within range for a different wetland class | **1** = pH/EC just within range for a different wetland class | **2** = pH/EC at high/low end of range but still within | **3** = pH/EC as expected for natural conditions |*	_____

WQ2: What is the average turbidity of surface water within the wetland? If the water is clear from lack of recent rainfall, look for silt deposits on the ground surface/at the base of any temporary ponded water. *(Note: You may want to look downstream from the road, as roads can increase turbidity through erosion and sediment deposition.)*

***0** = turbid (cloudy or thick with suspended matter) | **1** = moderately turbid (*visibly cloudy or murky*) | **2** = lightly turbid (mostly clear) | **3** = clear or N/A*	_____

WQ3: Does the wetland have any signs of excessive nutrient loading such as algae matts, blooms, or fish kills?

***0** = severe (>60%) | **1** = moderate (25-60%) | **2** = slight (<25%) | **3** = No evidence*	_____

WQ4: % Polygon with evidence of past, present, or imminent contaminant input to the wetland? (*Look for signs of contamination such as visible contaminants from industry/recreation/agriculture/livestock, unusual odor of water, non-organic sheen on water, chemical/contaminant/pollution deposits on ground or vegetation.)*

***0**= >35% (Significant) | **1**=15-35% (Moderate) | **2**=5-15% (Minor) | **3**=<5% (None)*	_____

Hydrologic Connectivity

Are surface and/or subsurface flows to the wetland currently disturbed or is disturbance imminent?
□ yes □ no □ N/A **(if no or not applicable, skip HC1-HC5)**

Water flow description: Check the items below and indicate flow direction (U = upstream, D = downstream). Circle the side the water is entering from (N / W / S / E).

□ Firehose or greater **U D** *Side (circle): N/W/S/E*	□ Trickle **U D** *Side (circle): N/W/S/E*	□ Lentic **U D** *Side (circle): N/W/S/E*	□Garden hose **U D** *Side (circle): N/W/S/E*

HC1: Has there been a disruption to the groundwater/surface water input/export from the wetland?

***0** = Yes	**3** =No*	_____

HC2: Is a stream present that is or soon will be disconnected from contributing surface water to the wetland**?**

***0** = Yes	**3** =No*	_____

HC3: Is there evidence of downcutting? Check the items below which apply. (Refer to Supplement Materials for detailed descriptions)

***0** = Yes	**3**= Moderate **6** =No*	_____

☐ Steep, Unstable Stream Banks
- □ Sloughing
- □ Unvegetated
- □ Exposed Roots Along Stream Bank (eroded roots)

☐ Disconnection of Stream from Wetland and/or Floodplain (Incised/Degraded Channel)

☐ Not entrenched

☐ moderately entrenched/incised

☐ entrenched/deeply incised (1 m deep)

IF entrenched (in creek/stream in the wetland), is there a detectable impact to adjacent groundwater? Add a profile measurement and distance perpendicular of impact.

Profile:

Presence of headcut (abrupt change in streambed elevation). Select all that apply:

Headcut 1:

Location relative to wetland:
- □ upstream
- □ downstream
- □ in wetland

Is it causing disconnection to floodplain?
- □ Yes
- □ Partially
- □ No

Streambed condition at headcut:
- □hardened surface, easily erodible material
- □ other: _____

Streambank condition:
- □ NO Armour Layer (Water is flowing over easily erodible material)
- □ Sloughing, unvegetated, exposed roots

Sediment deposited downstream:
- □ Yes
- □ Partially
- □ No

Stream measurements: Note: Best to have a clinometer rather than taking rise/run measurements. (*If you are not sure if the stream is accessing its floodplain, take a cross section photo of the stream and floodplain with a meterstick for size reference.* See table in Supplement Materials)

1.Bankfull Width: _____ m

Flood-Prone Width (accessed by 1-2 yr flood, when water is approx. 2X bankfull depth): _____ m (only measure if less than 2x bankfull width)

Entrenchment Ratio (Bankfull Width/Flood-Prone Width): _____

Average slope of stream: _____

Height: _____ m Width:_____ m. Pin GPS location(s).

Presence of headcut (abrupt change in streambed elevation). Select all that apply:

Headcut 2:

Location relative to wetland:
- □ upstream
- □ downstream
- □ in wetland

Is it causing disconnection to floodplain?
- □ Yes
- □ Partially

□ No

Streambed condition at headcut:
□hardened surface, easily erodible material
□ other: _____
Streambank condition:
□ NO Armour Layer (Water is flowing over easily erodible material)
□ Sloughing, unvegetated, exposed roots
Sediment deposited downstream:
□ Yes
□ Partially
□ No

2.Bankfull Width: _____ m
Flood-Prone Width (accessed by 1-2 yr flood, when water is approx. 2X bankfull depth): _____ m (only measure if less than 2x bankfull width)
Entrenchment Ratio (Bankfull Width/Flood-Prone Width): _____

Average slope of stream: _____
Height: _____ m Width:_____ m. Pin GPS location(s).

Presence of headcut (abrupt change in streambed elevation). Select all that apply:

Headcut 3:
Location relative to wetland:
□ upstream
□ downstream
□ in wetland
Is it causing disconnection to floodplain?
□ Yes
□ Partially
□ No

Streambed condition at headcut:
□hardened surface, easily erodible material
□ other: _____
Streambank condition:
□ NO Armour Layer (Water is flowing over easily erodible material)
□ Sloughing, unvegetated, exposed roots
Sediment deposited downstream:
□ Yes
□ Partially
□ No

3.Bankfull Width: _____ m
Flood-Prone Width (accessed by 1-2 yr flood, when water is approx. 2X bankfull depth): _____ m (only measure if less than 2x bankfull width)
Entrenchment Ratio (Bankfull Width/Flood-Prone Width): _____

Average slope of stream: _____
Height: _____ m Width:_____ m. Pin GPS location(s).

HC4: What percentage of the wetland is currently or imminently affected by disruption to ground or surface water (Consider future threats when answering this question *i.e ponded water behind road, artificial dam/culvert, drainage patterns, channel diversion)*? **Check the items below which apply.**

0 *= >35%* | ***2*** *= 15-35%* | ***4*** *=5-15%* | ***6*** *<5%*	_____

□ Artificial Diversion of Stream
□ Ponded Water Behind Road
□ Removal of Water
□ Engineered Channel Present
□ Natural Channel Abandonment
□ Blocked Culvert
□ N/A

□ Excessive Sediment Input to Channel
□ Mid-Channel Bars or Sediment Wedges
□ Sediments and Woody Debris Completely Fill >5% Channel Length
□ Coarser Dominant Substrate Particles Covered or Embedded in Finer Inorganic Sediments
□ Soft dunes resulting in dewatering, multiple channels, and/or misdirected Flow contributing to fresh bank erosion

Overall level of Impact to Wetland

Total Impact Score

Section	Score	Potential Score	Score/Pot.score	% Health Score
Vegetation		**28**		
Soils		**30**		
Water Levels		**15**		
Water Quality		**12**		
Hydrologic Connectivity		**18**		
Total Score		**103**		

Rating Category: <60% = Non-functional (unhealthy), **60-79%** Functional At Risk (healthy but with problems), **80-100%** Proper Functioning Condition (Healthy)-

Legend for site sketch format:

Site Narrative (What are the key causal factors? What happened at site, was something difficult for assessment, etc):

Restoration Potential or not? (list type of restoration, general cost considerations, low/med/high cost and benefit restoration options):

Disturbance type: Is there any other disturbance that wasn't listed?

- □ Road prism
- □ Urban
- □ Natural (i.e wildfire)
- □ Other _____

Completed Assessment for:

- □ Entire Wetland
- □ Part of Wetland

Comment:

Is the wetland currently impacted or imminently threatened?

- □ Currently (**on-going**)
- □ Imminently (**at risk**)
- □ Neither
- □ Other_____

General notes or comments (Final observation i.e. if no intervention actions are taken, will the conditions worsen? Has the wetland adjusted to the observed impacts to the extent that restoration actions would not be beneficial?)

Supplementary Materials

Table 1: Invasive Species Distribution Categories

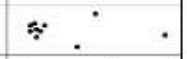
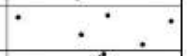
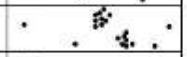
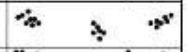
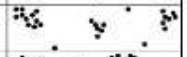
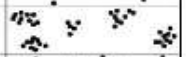
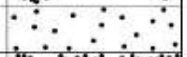
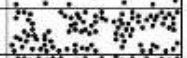
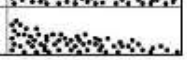
CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several sporadically occurring plants	
7	A few patches	
8	A few patches plus several sporadically occurring plants	
9	Several well spaced patches	
10	Continuous uniform occurrence of well spaced plants	
11	Continuous occurrence of plants with a few gaps in the distribution	
12	Continuous dense occurrence of plants	
13	Continuous occurrence of plants associated with a wetter or drier zone within the polygon.	

Table 2: Disturbance-Increaser Species List

Common Name	Latin Name
Strawberry	*Fragaria* spp.
Cinquefoil	*Potentilla spp.* (excl. Marsh Cinquefoil)
Yarrow	Achillea millefolium
Baltic rush	Juncus balticus
Dandelions	Taraxacum spp.
Sow thistles	Sonchus spp.
Foxtail barley	Hordeum jubatum
Yellow salsify/Western goat's beard	Tragopogon dubius
Clovers	Trifolium spp.

Table 3: Natural Variation in pH and EC by Wetland Class

Wetland Class (BC)	pH	EC
Bog (AB Bog and Poor Fens)	<5.5	Nutrient-poor
Fen (AB Moderate-Rich and Extreme-Rich Fens)	>5.0	Relatively high mineral content
Marsh	Circumneutral. See wetland Edatopic Grids for specific veg associations and translation guide on LMH52 pages 42-43. Range from neutral (pH 6.5 – 7.4) to alkaline (pH > 7.4) on edatopic grids.	Eutrophic to hypertrophic
Swamp	pH on Edatopic Grids ranges from MA, SA, to mid N (sometimes dependent on moisture). Moderately Acidic: 4.5 – 5.5 pH Slightly Acidic: 5.5 – 6.5 pH Neutral: 6.5 – 7.4 pH	Abundant available nutrients
Source: LMH52 https://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh52.htm		

Wetland Class (AB)	pH	EC
Bog	3.0 – 4.2	<100
Poor Fen (BC Bog)	4.0 – 5.5	<100
Moderate-Rich Fen (BC Fen)	5.5 – 7.0	100-250
Extreme-Rich Fen (BC Fen)	7.0 – 8.5	250-2000
Marsh		<500 – 15000
Swamp		<500 – 45000

Sources:
Reclamation Criteria for Wellsites and Associated Facilities for Peatlands
https://open.alberta.ca/dataset/d7bb827e-2212-4a44-ab70-224800afae2a/resource/946827c8-193e-434a-a5a6-6125edcf8e7f/download/reclamationcriteriapeatlands-mar2017.pdf
Alberta Wetland Classification System https://open.alberta.ca/dataset/92fbfbf5-62e1-49c7-aa13-8970a099f97d/resource/1e4372ca-b99c-4990-b4f5-dbac23424e3a/download/2015-alberta-wetland-classification-system-june-01-2015.pdf

Table 4: Severity Categories of Water Level Manipulation

Source: Modified from Alberta Lentic Wetland Health Assessment User Manual, page 15 and FREP Wetland Management Routine Effectiveness Evaluation Technical Supplement, page 75.

None	The water body, or wetland, is not subjected to artificial water level change (e.g., drawdown, addition, stabilization, etc.). This category may include very small amounts of change that cause no detectible fluctuation in water level.
Minor	Hydrological site integrity is near natural. Alteration (including recovery from any past severe alterations) is apparent but reflects minimal impact to plant communities and hydrological function in the altered areas. The water body or wetland is subject to no more than minor artificial water level change or groundwater disruption. The shore area remains vegetated, and withdrawal of water is limited or slow enough that vegetation is able to maintain growth and prevent soil exposure. A relatively narrow band affected by the water level fluctuation may support only annual plants.
Moderate	The water body or wetland is subject to moderate quantities, speed and/or frequency of artificial water level change or groundwater disruption (limit of groundwater entrance to or exit from an area). Where water is removed or groundwater blocked from entering the wetland, it is done in a way that allows pioneer plants to vegetate at least half of the exposed area resulting from drawdown. Where water is added or groundwater blocked from exiting the wetland, some flooding may occur at levels or times not typical to the area/season. Alteration is either in the process of becoming revegetated with appropriate species or is well covered with a mix of less desirable and appropriate species. Wetland may transition from one plant association to another plant association.
Extreme	The water body or wetland is subjected to extreme changes in water level due to volume (extent), speed and/or frequency of artificial water addition or removal or groundwater disruption. Frequent or unnatural levels of flooding occur where water is added, including extensive flooding into riparian and/or upland areas; or no natural annual drawdown is allowed to occur. In extreme artificial drawdown situations, a wide band of exposed area remains unvegetated; a wide band of wetland vegetation is stressed due to limited water indicating that the area is no longer supporting wetland habitat; or upland, undesirable, or invasive species are encroaching into a wide band of the wetland.

Table 5: Terminology

Incision	The downward cutting of a channel into its substrate
Incised Stream	Occurs when downcutting (erosion of the channel bottom) has lowered the channel to a depth where the average 2yr flood cannot escape the channel and access the floodplain. Incised channels are often referred to as degraded channels. Stage II, III, and IV in Schumm's CEM.
Bankfull depth	Bankfull discharge occurs when there is enough flow to fill the entire channel. This typically takes place once every 1-2 years. The water level at this point is called the bankfull stage. This can also be identified as the elevation of the floodplain at the bank edge. Bankfull depth is measured as vertical distance between bankfull stage and the streambed at the thalweg of a riffle.
Bankfull width	Horizontal distance between banks (perpendicular to flow) at bankfull stage. Indicators of the location of bankfull stage include breaks in topography (e.g. vertical bank to floodplain, steep to gentle slope), top of point or central bars, break in sediment particle size, change in bank vegetation from temporary to permanent, upper elevation of fine debris deposits, rocks exposed in the bank, exposed root hairs below an inact soil layer, staining on rocks, and/or lichens or certain riparian vegetation species.
Flood-prone area	Estimated as the vertical distance across the channel that would be covered by water 2 times the bankfull depth (approx. 50-yr recurrence interval flood discharge).
Entrenchment ratio	Vertical containment of a river or stream and the degree to which it is incised or "down-cut" into the valley floor. Measured as flood-prone area width / surface width of bankfull channel.
Entrenched/Incised	Ratio 1 – 1.4. Water rarely escapes the channel, possibly only during extreme flood events.
Moderately Entrenched	Ratio 1.41 – 2.2. The 1 – 5 year high flow events may not access the floodplain, but higher flows (5 – 10 year event) can access a narrow floodplain.
Slightly Entrenched	Ratio > 2.2. Bankfull flows (1-2 year events) regularly spill onto floodplain. Stable to fairly stable channel, unincised.
Headcut	Abrupt change in streambed elevation (step) due to erosion. Often migrates in an upstream direction over time.
Armour Layer	Layer of coarser sediment at the surface of the stream bed than directly below due to stream flow which is only capable of moving finer materials. May indicate a slowing of stream velocity due to impacts.
Downcutting	The process by which a stream or river deepens its channel by eroding the stream bed, often due to increased water flow, changes in sediment load, or human activities such as channelization. This can lead to unstable banks and habitat degradation.
Seeding	The act of planting seeds to promote vegetation growth. In ecological restoration or agriculture, seeding is used to establish plant cover, prevent soil erosion, and improve soil stability.

Cultivation	The preparation of soil for planting by plowing, tilling, or other mechanical means. Cultivation is used in farming to improve soil conditions, control weeds, and enhance water infiltration, but excessive cultivation can lead to soil degradation.
Hummocking	The formation of small mounds or raised areas of soil, often due to frost heaving, water movement, or trampling by animals. In wetlands and pastures, hummocking can indicate poor drainage or soil disturbance.
Pugging	The damage caused to soil by the hooves of livestock, particularly in wet conditions. Pugging results in deep holes or compacted areas, reducing soil aeration, water infiltration, and plant growth.

Sources – Text is modified (and sometimes directly) from:

US EPA. Fundamentals of the Rosgen Stream Classification System. https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=1259

US EPA, 2006. Field Operations Manual for Assessing the Hydrologic Permanence and Ecological Condition of Headwater Streams. https://www.epa.gov/sites/default/files/2015-11/documents/manual_for_assessing_hydrologic_permanence_-_headwater_streams.pdf

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Charlton,Ro,2008. Fundamentals of Fluvial Geomorphology.

Fitch, L, B.W Adams and G. Hale, 2009. Riparian Health Assessment for Streams and Small Rivers- Field Workbook. Second Edition. Lethbridge, Alberta: Cows and Fish Program.

Fitch, Adams and Hale (2009) pages 62 – 70 for photographic examples of streams with different levels of incision, as well as instructions on how to identify incision in the field.

Glossary Of Terms By BC Forest Practises Board. *Forest Practices Board*. Website https://www.bcfpb.ca/blog/news-resources/glossary/ [accessed 7 March 2025].

Table 6: Common Invasive and Noxious Plants in BC

Invasive/Noxious Plant Species	Scientific Name	Wetland Indicator Status
Anchusa (Common Bugloss)	*Anchusa officinalis*	-
Baby's Breath	*Gypsophila paniculata*	-
Black Knapweed	*Centaurea nigra*	-
Blueweed	*Echium vulgare*	-
Bohemian Knotweed	*Fallopia x bohemica*	-
Brazilian Waterweed (syn. Brazilian Elodea)	*Egeria densa*	OBL
Brown Knapweed	*Centaurea jacea*	FACU
Buck's-horn Plantain	*Plantago coronopus*	FACW
Bull Thistle	*Cirsium vulgare*	FACU
Canada Thistle	*Cirsium arvense*	FACU
Caulerpa	*Caulerpa taxifolia*	-
Common Burdock	*Arctium minus*	FACU
Common Tansy	*Tanacetum vulgare*	FACU
Cordgrass	*Spartina spp.*	OBL/FAC
Creeping Buttercup	*Ranunculus repens*	FAC
Dalmatian Toadflax	*Linaria dalmatica*	-
Dandelion	*Taraxacum*	-
Didymo	*Didymosphenia geminata*	OBL
Diffuse Knapweed	*Centaurea diffusa*	-
Dwarf Eelgrass	*Zostera japonica*	FACU
Eurasian Watermilfoil	*Myriophyllum spicatum*	OBL
European Common Reed	*Phragmites australis spp.*	OBL
Fanwort	*Cabomba aquatica*	-
Field Scabious	*Knautia arvensis*	-
Flowering Rush	*Butomus umbellatus*	FACW/OBL
Giant Hogweed	*Heracleum mantegazzianum*	FAC
Giant Knotweed	*Fallopia sachalinensis*	-
Giant Mannagrass/Reed Sweetgrass	*Glyceria maxima*	OBL
Giant Reed	*Arundo donax*	-
Gorse	*Ulex europaeus*	FACU
Hairy Willow Herb	*Epilobium hirsutum*	FACW
Hanging Sedge	*Carex pendula*	-
Himalayan Balsam (syn. Policeman's Helmet)	*Impatiens glandulifera*	FACW
Himalayan Knotweed	*Persicaria wallichii*	FAC
Hoary Alyssum	*Berteroa incana*	-
Hoary Cress	*Cardaria draba*	-
Hound's-tongue	*Cynoglossum officinale*	FACU

Hydrilla	*Hydrilla verticillata*	-
Japanese Knotweed	*Fallopia japonica*	FACU
Japanese Wireweed	*Sargassum muticum*	-
Leafy Spurge	*Euphorbia esula*	-
Marsh Plume Thistle	*Cirsium palustre*	-
Meadow Hawkweed	*Hieracium caespitosum*	-
Meadow Knapweed	*Centaurea debeauxii*	-
Nodding Thistle	*Carduus nutans*	FACU
Orange Hawkweed	*Hieracium aurantiacum*	-
Oxeye Daisy	*Leucanthemum vulgare*	FACU
Parrot's Feather	*Myriophyllum aquaticum*	OBL
Perennial Pepperweed	*Lepidium latifolium*	FAC
Plumeless Thistle	*Carduus acanthoides*	-
Poison Hemlock	*Conium maculatum*	FACW
Policeman's Helmet	*Impatiens glandulifera*	FACW
Puncture Vine	*Tribulus terrestris*	-
Purple Loosestrife	*Lythrum salicaria*	FACW
Reed Canary Grass	*Phalaris arundinacea*	FACU
Rush Skeletonweed	*Chondrilla juncea*	-
Russian Knapweed	*Acroptilon repens*	-
Russian Olive	*Elaeagnus angustifolia*	FAC
Scentless Chamomile	*Matricaria maritima*	-
Scotch Broom	*Cytisus scoparius*	-
Scotch Thistle	*Onopordum acanthium*	-
Spotted Knapweed	*Centaurea biebersteinii*	-
St. John's Wort	*Hypericum perforatum*	FACU
Sulphur Cinquefoil	*Potentilla recta*	-
Swollen Bladderwort	*Utricularia inflata*	OBL
Tansy Ragwort	*Senecio jacobaea*	FACU
Teasel	*Dipsacus fullonum*	FAC
Variable-leaf Milfoil	*Myriophyllum heterophyllum*	-
Wakame	*Undaria pinnatifida*	-
Water Primrose	*Ludwigia hexapetala*	-
Wild Chervil	*Anthriscus sylvestris*	-
Wild Parsnip	*Pastinaca sativa*	-
Yellow Flag Iris	*Iris pseudacorus*	OBL
Yellow Floating Heart	*Nymphoides peltata*	OBL
Yellow Nut Sedge	*Cyperus esculentus*	FACW
Yellow Starthistle	*Centaurea solstitialis*	-
Yellow Toadflax	*Linaria vulgaris*	

Source: Fletcher, N.F., Tripp, D.B., Hansen, P.L., Nordin, L.J., Porter, M., and Morgan, D. 2021. *Protocol for the Wetland Health Management Routine Effectiveness Evaluation*. Forest and Range Evaluation Program, B.C. Ministry of Forests, Lands, Natural Resources Operations and Rural Development, Victoria, B.C.

APPENDIX-E. CNWI CLASSES

Site ID	Date Visited	# of Plots	Wetland Association
NBM_1587 Coordinates: 57°09'48.4"N 125°20'05.1"W	July 14, 2025	3	Wf02 (x2), Ws03 (x1)
NBM_1721 Coordinates: 57°16'50.0"N 125°36'53.6"W	July 15, 2025	1	Wf07
NBM_77777 Coordinates: 57°07'06.5"N 125°18'03.1"W	July 15, 2025	1	Wf01
NBM_2535 Coordinates: 57°05'59.4"N 125°10'42.3"W	July 16, 2025	1	Wm01
NBM_1534 Coordinates: 57°16'02.3"N 125°07'22.9"W	July 17, 2025	3	Wb05, Wf02, Wf11
NBM_2775 Coordinates: 56°52'41.9"N 125°01'44.5"W	July 21, 2025	2	Wm02, Wf02
NBM_55555 Coordinates: 56°54'10.7"N 125°01'34.0"W	July 22, 2025	1	Ww buckbean
NBM_966 Coordinates:	July 22, 2025	1	Wm06

Site ID	Date Visited	# of Plots	Wetland Association
56°54'23.2"N 125°01'38.5"W			
NBM_1811 Coordinates: 56°57'17.0"N 125°03'05.4"W	July 22, 2025	2	Wf02, Wf05
NBM_1007 Coordinates: 56°53'19.7"N 125°06'44.6"W	July 23, 2025	3	Wf02, Ws07, Wf11
NBM_2474 Coordinates: 57°04'54.9"N 125°08'11.2"W	July 24, 2025	4	Wm02 (x3), Ws willow
NBM_2392 Coordinates: 56°53'31.7"N 124°55'25.8"W	July 25, 2025	3	Wf02 (x2), Wb09
NBM_1019 Coordinates: 56°44'46.4"N 125°03'10.9"W	July 26, 2025	5	Ws07 (x2), Wf11 (x2), Wf02
NBM_2420 Coordinates: 56°57'32.5"N 125°02'56.9"W	July 27, 2025	4	Wf01, Wf02 (x2), Ws07
NBM_1027 Coordinates: 56°47'20.3"N 125°01'47.5"W	July 28, 2025	3	Wf02, Wf11, Wf bulrush & hook moss
NBM_1839	July 29, 2025	2	Ws07, Wf11

Site ID	Date Visited	# of Plots	Wetland Association
Coordinates: 57°01'28.8"N 125°12'44.5"W			
NBM_2453 Coordinates: 56°43'31.7"N 125°03'40.2"W	July 30, 2025	2	Ws03 (x2)

Table E1: Canadian National Wetland Inventory (CNWI) wetland associations.

APPENDIX-F. WESP CALIBRATION PROCESS

Appendix 2. How Calibration Wetlands Were Selected

Within each modified ecoprovince (Figure 1), sites were selected to collect calibration data for the scoring models and to determine the likely range of raw values for Function and Benefit scores. Although each of WESP-BC's scoring models has a *theoretical* minimum score of 0 and a maximum of 10, the *actual* range for any given function is usually narrower, even when WESP-BC is applied to a large number of wetlands. The resulting range of the raw scores found among all sites will be quite narrow for some functions (e.g., 3 to 8) whereas for others it will be broader (e.g., 2 to 10). Thus, to facilitate rough comparisons among functions, all raw scores were standardized to a 0 to 10 scale. For each wetland function or other attribute assessed by WESP-BC, this was done by comparing the raw scores with the range of scores determined from all the wetlands that were visited and assessed in each ecoprovince. This comparison process is termed "calibration" or "normalization" and the assessed wetlands are termed "calibration wetlands".

The goal of the calibration wetland selection was to identify wetlands that represent the range of possible types and their condition across an ecoprovince. The intent was not to characterize the condition of wetlands in the study area overall. Rather, the aim was to define the likely range of WESP-BC score variation with as few wetlands as possible. To achieve this goal calibration wetlands were selected based on the following conditions:

- wetlands representative of ecoprovince general climatic envelopes;
- representative across landcover types;
- select wetlands that occur in different landscape disturbance categories;
- sample within a range of hydrological contexts –association with streams, rivers, open water; etc
- representative across different bedrock types;
- identify wetlands of cultural interest, based on guidance from participating indigenous communities;
- restrict site selection to within 500 m of a road to provide ground-based access; and
- select wetlands randomly under this set of conditions.

The spatial data for the selection of calibration data sets was sourced from the Province's BC Data Catalogue (https://catalogue.data.gov.bc.ca/), with three exceptions; 1) land form was acquired from Adaptwest[1]; 2) Land cover, provided by BCWF[2]; and 3) census boundaries and data from Statistics Canada[3]. A set of data processing scripts, implemented using the R statistical package, was used to organize the data for each ecoprovince.

[1] https://adaptwest.databasin.org/pages/adaptwest-landfacets/
[2] McCartney , L. 2020. BC Land Cover. Created by Leon McCartney November 4th, 2020
[3] https://www12.statcan.gc.ca/census-recensement/2021/geo/sip-pis/boundary-limites/index2021-eng.cfm?year=21

All wetlands in an ecoprovince were assigned attributes that reflected local climate, watershed position, surrounding land cover, dominant vegetation form, natural and human disturbance conditions (e.g., fire, agriculture, dense settlement), wetland class (emergent, open water, forested/scrub-shrub), hydroperiod, and wetland position in watershed (headwater, lowland). Each of these categories were considered sampling strata, such that a set of representative wetlands should be evaluated for each strata. In most cases a wetland would be a member of multiple groups reducing the total number of wetlands requiring sampling. Please see Table 1 for complete the list of sampling strata. In some cases specific wetlands were sampled that met sampling criteria and were important cultural sites. Further, sampling was, in some instances, administratively stratified to meet project funding to sample specific areas or to ensure that there was a balance of sampling across First Nation Territories.

The sample draw process selected a target number of total wetlands to sample and the number of wetlands that needed to be surveyed in each of the strata. The goal was to sample 100 wetlands for each ecoprovince, however, the routine would typically identify over that amount, given that some may not be accessible or, based on visual inspection of satellite imagery, not reflective of what type of wetland was being targeted. Within each strata a target number of wetlands would be identified, typically 10 for most units, but 15 for larger groups, such as flow groups see Table 1. Being able to specify the number of wetlands to survey within each strata provided operational flexibility and ensured that, in the case of major strata, sampling was geographically and ecologically dispersed enhancing the randomness of samples. For an ecoprovince sampling would continue till all of the strata had been fully sampled, routinely this would exceed the target of 100 wetlands.

Among several candidates meeting each combination condition, the decision of which one(s) to actually visit and assess was based on areal imagery review to verify the presence of any visible selection criteria and determine physical accessibility as well as achieving a reasonable spatial distribution of sites across the project region. Visiting and assessing a wide variety of calibration wetlands also helped clarify the wording of questions on the data forms and streamline them by determining the most efficient order of questions, i.e., which sequencing allows users to skip the most questions in various contexts.

Table 1. WESP sampling strata, wetlands to sample were divided into Major Strata to ensure ecological and geographic distribution of samples and Minor Strata, those categories important to capture to ensure the full breadth of wetland type was captured.

Field	Description	Comments
Major Strata		
BEC	BEC grouping -1) high, 2) low wet, 3) low dry	Provincial BEC groupings provided by the ecology program
Flow	1) unconnected, 2) connected, 3) adjacent water	Flow characteristic summarized to generate 3 broad flow groups
Minor Requirements		
Lake_Size	1) >5a, 2) 1-5ha, 3) <1ha, 0 no adjacent lake	
Large_Wetland	<1000 ha or >1000 ha	Plains EcoProvinces have some very large wetlands so handled as a special case
Hydrology	stream, river, lake, human-made water body intersect, split by stream, stream start, stream end, vertical flow, bidirectional, throughflow, outflow, inflow	Hydrological context of wetland based on stream modelling. Typically updated by field observations for final hydrological status
Land_Cover	Barren/Urban, Water, Grassland, Conifer, Deciduous, Mixed Forest, Shrubland, Cropland, Snow and Ice	Assigned to wetland based on majority value withing 300% area of each individual wetland - created by Leon McCartney, obtained from Kathleen Moore in 2021
Land_Disturbance	not disturbed, historic fire, recent fire, historic cut blocks, rangeland, current fire, low use roads, current cut blocks, agriculture and rural and recreation, moderate use roads, ROW Power Lines Rail OGC geophysical, high use roads, mine OGC infrastructure, urban	Assigned to wetland based on majority value withing 300% area of each individual wetland - Provincial CEF disturbance and consolidated roads
fire_year	Year of historical fire	Provincial data - combined with Land_Disturbance

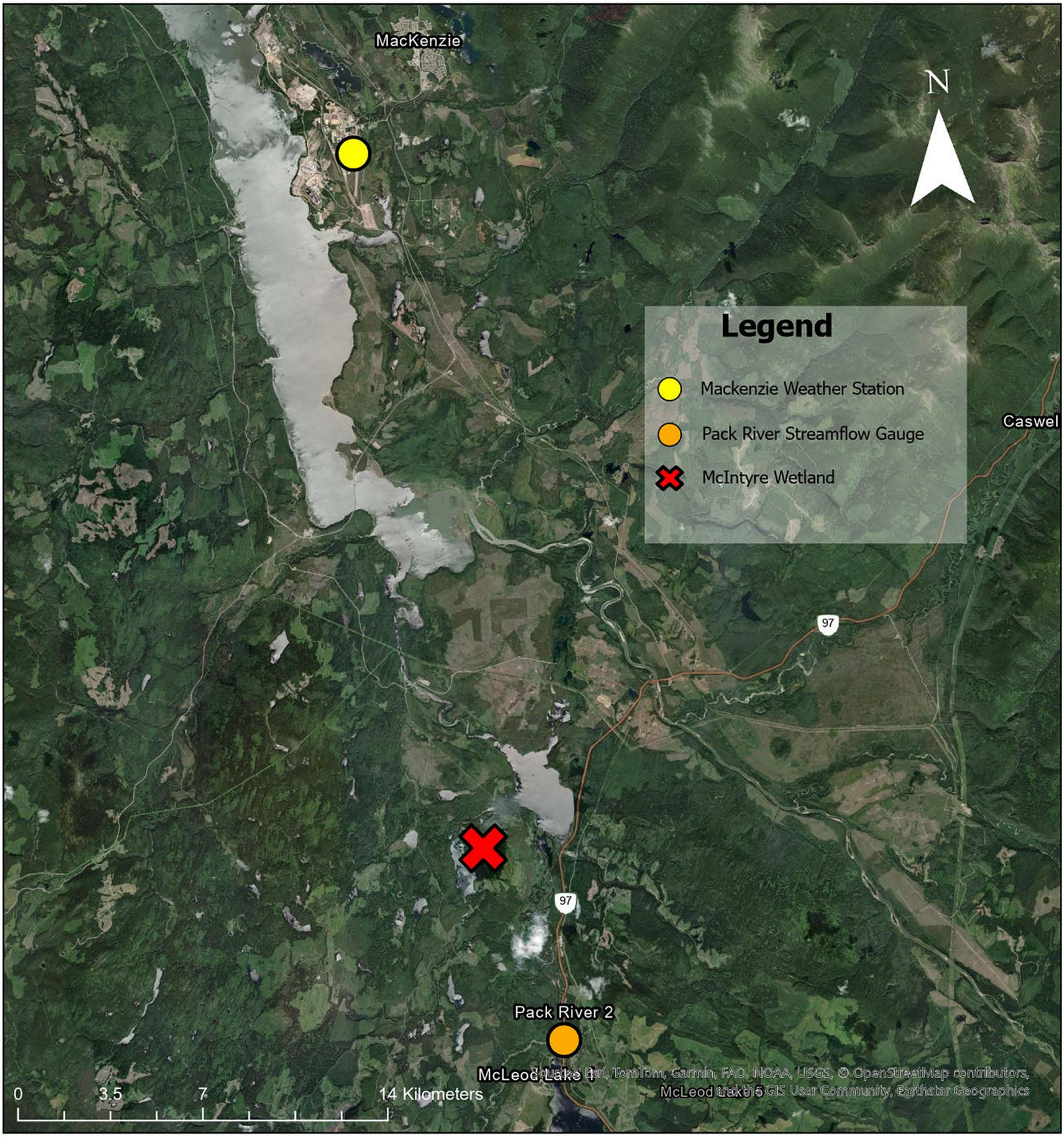
APPENDIX-G.MCINTYRE IMAGERY



Figure 1: Pre-restoration conditions at the project site on July 6, 2024.



Figure 2: Post-restoration conditions at the project site on May 24th, 2025, during fall monitoring.



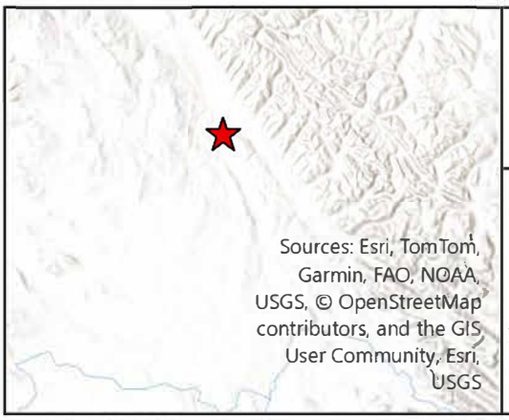


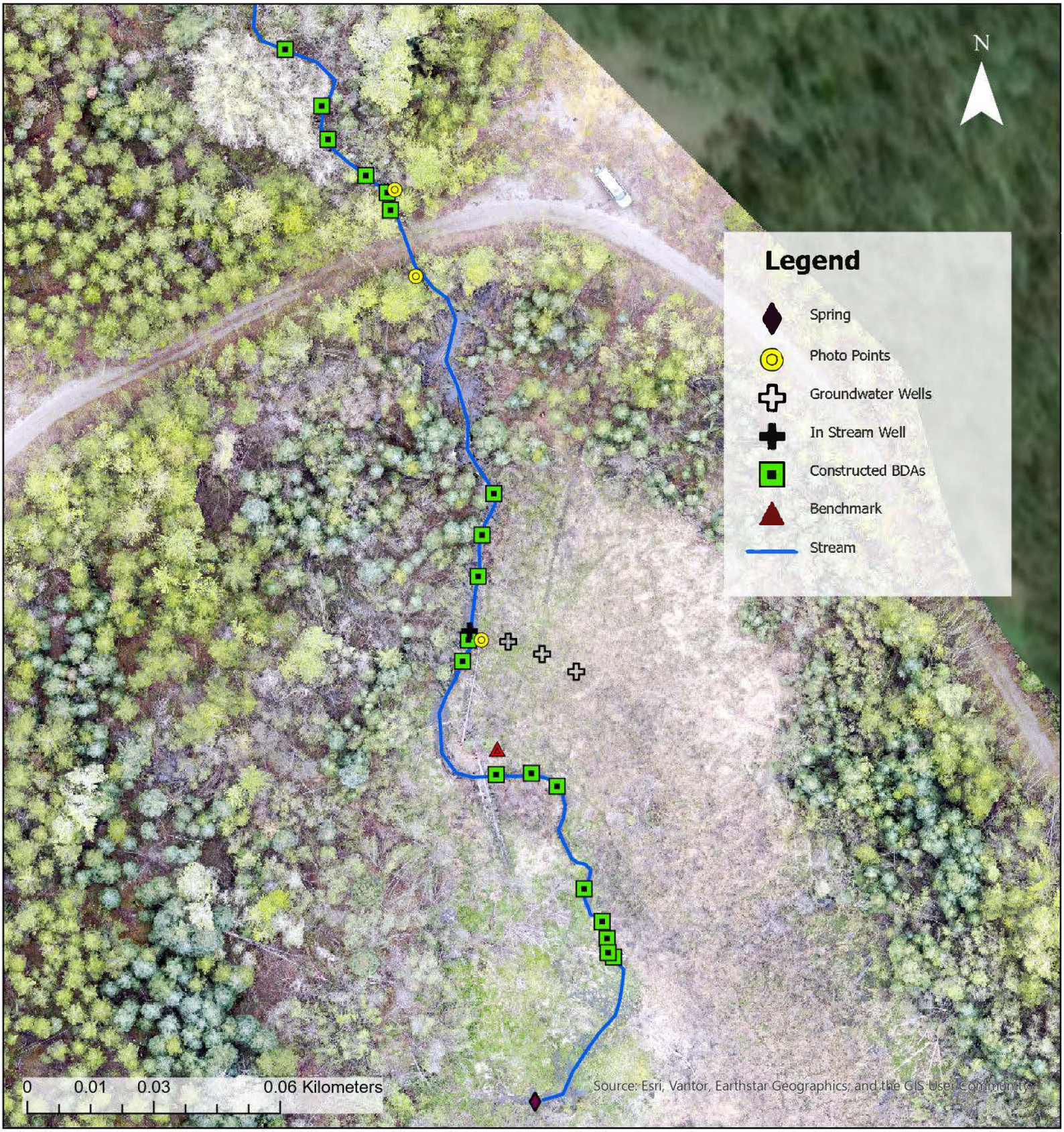
Figure 3.

Coordinate System: NAD83 BC Environment Albers
Created by: British Columbia Wildlife Federation
Created on: October 16th, 2025
Data Source: BC Data Catalogue
Regional District: Fraser-Fort George
Partners: Fish and Wildlife Compensation Program, McLeod Lake Indian Band

MCLEOD LAKE INDIAN BAND

BCWF BC WILDLIFE FEDERATION

FWCP Fish & Wildlife COMPENSATION PROGRAM



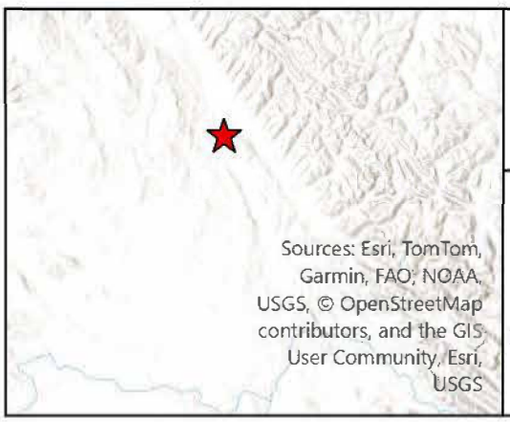


Figure 4.

Coordinate System: NAD83 BC Environment Albers
Created by: British Columbia Wildlife Federation
Created on: October 16th, 2025
Data Source: BC Data Catalogue
Regional District: Fraser-Fort George
Partners: Fish and Wildlife Compensation Program, McLeod Lake Indian Band

McLeod Lake Indian Band

BCWF BC Wildlife Federation

FWCP Fish & Wildlife Compensation Program