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Kootenay Connect: 7CW Columbia Wetlands:

Summary (2023-2026) and Yr 7 Upland Wetlands Restoration Report

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Columbia Wetlands Stewardship Partners

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1. Executive Summary

In the western benchlands of the upper Columbia Valley in BC, CWSP has used a combination of in-person fieldwork, drone photography, and modeling to study the wetlands, lakes, and streams since 2023. These observations have allowed us to better understand the status of these wetlands, threats facing them, and to identify wetlands that we can restore using beaver dam analogues (BDAs).

To assess the status of wetlands and shallow lakes across the landscape, CWSP assessed 371 of the 828 (45%) mapped wetland and lake polygons in the BC Provinces' Freshwater Atlas (FWA). We visited 227 wetland (47%) and 144 lake (41%) FWA polygons via drone or in person between May and September 2023. We used a combination of geographic information system (GIS) resources, in-person observations, and photographic imagery to assess potential sources of water, landscape position, and dominant vegetation types. We then used the drone photograph inventory to broadly classify the vegetation communities based on the "wetness" present in each FWA polygon. The dominant groundcover observed (i.e., open water, wetland vegetation, shrubs, deciduous or coniferous trees, mudflats, or dryland vegetation) was used to determine a 'wetness' index, which followed four categories: Adequately Wet, Mostly Wet but Drying, Drying with wetted areas, and No Signs of Water.

In 2025 we validated the 2023 drone wetness classification by visiting 38 wetlands that had been assessed with drone photographs, and assessed the sites based on wetland vegetation, disturbance, landscape location, and water source. We determined that 24 of 28 wetlands had the same vegetation observations and wetness index ratings. To further improve the correlation between drone and in-person assessment, we corrected differences in how the shrub community was assessed (by drone), and differences in timing of when the sites were examined. These showed that we had an 80% agreement between the drone and in person estimation of the "wetness" of the wetland. This suggests that we can use a drone to examine a larger number of wetlands to assess the effect of climate change and to select wetland sites for potential restoration.

Thus, this method of categorizing wetland vegetation and wetness is effective, but does have limitations, and in-person observations should be incorporated for calibration. Drone imagery collected during field surveys provides a useful overview of the wetland landscape, but interpretation still benefits from ground-based knowledge of the ecosystem.

In 2024, MacHydro Consultants, in collaboration with CWSP, developed a Wetland Restoration Feasibility Index for wetlands on the western benchlands of the Columbia Valley. The index aims to provide a desktop indication of whether an individual wetland can be successfully restored. Our work has shown that an available water supply is the key issue for many small wetlands in the region. The Wetland Restoration Feasibility Index is based on a Wetness Index, an Inflow Index, and a Precipitation – Evapotranspiration Score for 443 wetlands on the western benchlands. The Wetland Restoration Feasibility Index found that many wetlands on the western benchlands have low or moderate restoration feasibility, while far fewer have a high or very high potential to be restored successfully.

In 2025 to provide a validation of the Wetland Restoration Feasibility Index CWSP ground-truthed this Index by visiting 52 wetland sites included in the analysis, and recoding water source, water quality, vegetation, wetland position on the landscape, and signs of drying (if any). From our observations, we believe that the current (2024) Wetland Restoration Feasibility Index is overestimating restoration feasibility in some sites. We found 22 wetlands ranked High or Very High by the Index, which we ranked as Low or Moderate based on field observations, mostly due to a lack of water source. 25 of the wetlands visited had Wetland Restoration Feasibility Index assessments that matched our field assessments; 10 of these were ranked as Low or Moderate, and 15 as High or Very High. Five of the wetlands visited were ranked higher during field assessments than by the Wetland Restoration Feasibility Index. The provincial database for some of the hydrologic data may be outdated. This has led to a revision of the Wetland Restoration Feasibility Index and changes in the databases used to develop the index. This is presented below and in the report titled "*Restoration Index for Bench Wetlands in the Upper Columbia Valley – 2026 Update".*

In 2023, CWSP identified ten wetlands as potential sites for wetland restoration using Beaver Dam Analogues (BDAs). In 2024, we monitored these sites for pre-restoration data, and in September 2024 CWSP built 4 BDAs in 2 wetland sites. In 2025, we continued effectiveness monitoring, identified additional potential restoration sites, and built 21 BDAs and 7 Post Assisted Log Structures (PALs) across four wetland sites. In 2026, we plan to build 56 BDAs and 11 PALs across five wetland sites.

In total in 2024 and 2025 we constructed 25 BDA's and 7 PAL's and restored the habitat in 35.05 ha of upland wetlands. The BDA construction in 2024 restored 12.49 ha of wetland in Beaver Channels and 1.17 ha of wetland in S-Land. The 2025 construction restored 5.47 ha, 3.89 ha, and 1.03 ha of wetland in Northbound, Big Dam and Limbo Sites, respectively. In the Double Dam site, due to dry conditions there was no immediate increase in water within the wetlands, but we anticipate restoration of 10.89 ha of wetland. Both 20224 and 2025 were dry years and yet most sites still retained water after construction. We anticipate that increased water in all these systems in spring will result in more water being retained at all sites, which will be documented in the April surveys.

We monitor 13 upland wetland sites, eleven as restoration sites and two as reference sites. Our primary metric of pre- and post-restoration change is water level. We also map broad scale vegetation communities, open water area, and monitor water quality, breeding birds and detailed vegetation plots. In all breeding bird surveys in all wetland sites, we observed 90 species in 2024 and 2025 of which 25 are Wetland Dependent and six are Wetland Associated. Given the large difference in bird species and numbers between wetlands and between years, we hypothesise that bird use of these small benchland wetlands is quite stochastic, with limited site fidelity. There is also high biodiversity in vegetation in the wetlands. In all vegetation plots in all wetlands, we observed 145 species of plants. Despite it being only one year after the construction of BDAs in 2024, we observed differences in vegetation plots in both wetland sites in 2025. This large plant list shows how diverse these small benchland wetlands can be, with many differences between individual wetlands even if they superficially appear similar.

A major opportunity for conservation groups to mitigate drought and a warming climate is to build BDAs to retain water on the land and to restore degraded wetlands and damaged streams. This has been a major challenge because the regulations associated with BC's Water Sustainability Act are not designed for conservation actions.

2. Status of Benchland Wetlands

In 2023, CWSP began to study the small wetlands present on the western benchlands of the Columbia Valley, focusing our effort between Canal Flats and Spillimacheen. Global concerns are rising regarding the current state of the world's wetlands. Upland wetlands with small catchment areas that are dependent on precipitation or ground water supply are at a higher risk of drought than floodplain wetlands (Winter, 2007; Hupp *et al.,* 2009). These small (on average 3.9 ha in size), non-floodplain wetlands comprise approximately 53% of globally identified wetlands and contribute to important ecosystem services and landscape resilience - including actions such as buffering aquifer dynamics and base stream flow (McLaughlin *et al.,* 2014; Lane *et al.,* 2023). The wetlands on the western upland bench of the Columbia Valley had not, to our knowledge, been well studied prior to this.

We began our assessment by using the Freshwater Atlas of British Columbia (the FWA) to identify wetlands and lakes present on this landscape. The FWA is an open-source dataset created from provincial topographic maps that identifies and maps hydrological features such as watershed boundaries, stream networks, waterbodies, and obstructions (Government of Canada, n.d.). Within the study area, the FWA has mapped 479 wetland and 349 lake polygons, most of which are less than 3 ha in size (Figure 1). Most of the small lakes contain water that is less than 2 meters deep and are therefore considered open water wetlands in the Canadian Wetland Classification System (National Wetlands Working Group, 1997).

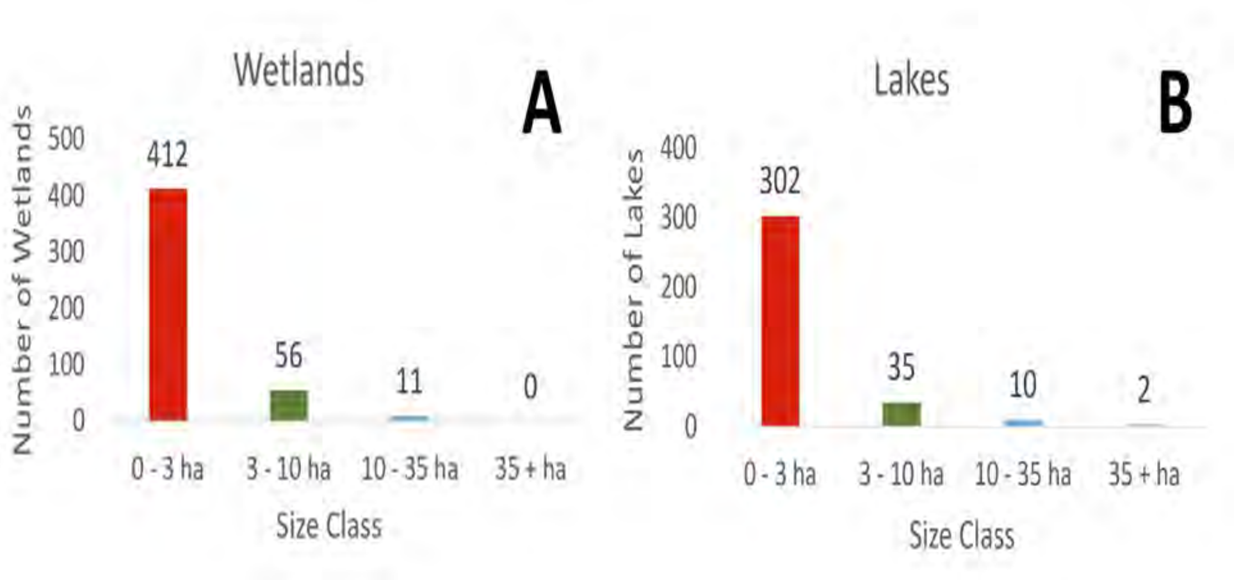

Figure 1. The size of wetlands (A) and lakes (B) mapped by Freshwater Atlas (FWA) that occur on the western upland bench of the Columbia River Valley between Canal Flats and Spillimacheen.

In 2023, CWSP completed a broad-scale inventory and assessment of these wetlands via drone to understand the general health of these wetlands, and to identify potential restoration sites for Beaver Dam Analogues (BDAs) to increase water retention and wetland habitat (this progress is detailed further in Section 3). In 2024, we began to monitor pre-restoration water levels in the selected restoration sites as well as two wetlands where we do not plan to build BDAs, which will provide reference points for water levels in unmodified wetlands to capture natural variation between years.

In 2025, both reference wetlands had lower water levels than in 2024 (Figures 2 and 3). The Westside Junction reference site is characterised by open water and abundant hydrophytic vegetation (e.g., cattails, sedges, and water lilies). The Coltsfoot reference site is dominated by Scrub Birch and sedges, with a stream running through the wetland; despite the presence of degraded, historic beaver dams, there is no open water present. The Westside Junction reference site shows more variation between 2024 and 2025. In 2024, water depth varied between 1.05 m and 0.55 m, and in 2025 between 0.67 m and 0.38 m. The Coltsfoot reference site had less variation, likely due to the lack of open water present, but still showed lower water levels in the stream channel in 2025, with a variation in depth of between 0.36 m and 0.03 m in 2024 and 0.18 m and 0.02 m in 2025. Despite the differences between these wetlands, this similar trend of lower water levels in 2025 indicates that it was a drier year across the whole landscape. In addition, we also noticed streams that were permanent in 2024 or 2023 became ephemeral in 2025, and heard multiple anecdotes about streams, wetlands, and lakes being drier in 2025 than in the living memory of local residents. This highlighted that the impacts of drought and climate change are already being felt in these wetlands, and that understanding and conserving them is important and urgent.

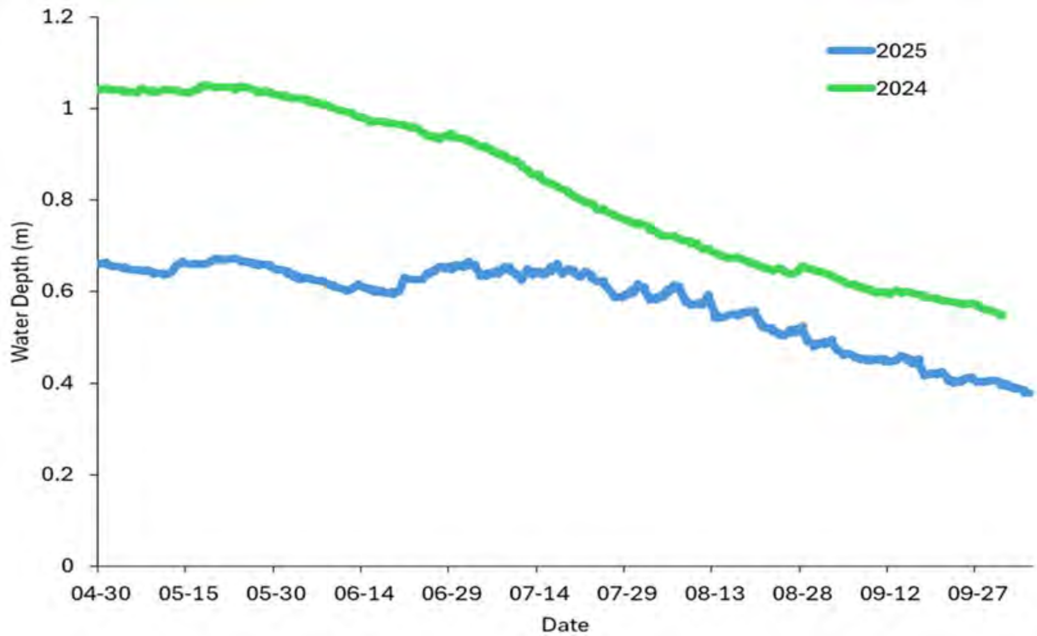

Figure 2. Water levels in 'Westside Junction' reference site in 2024 (green) and 2025 (blue).

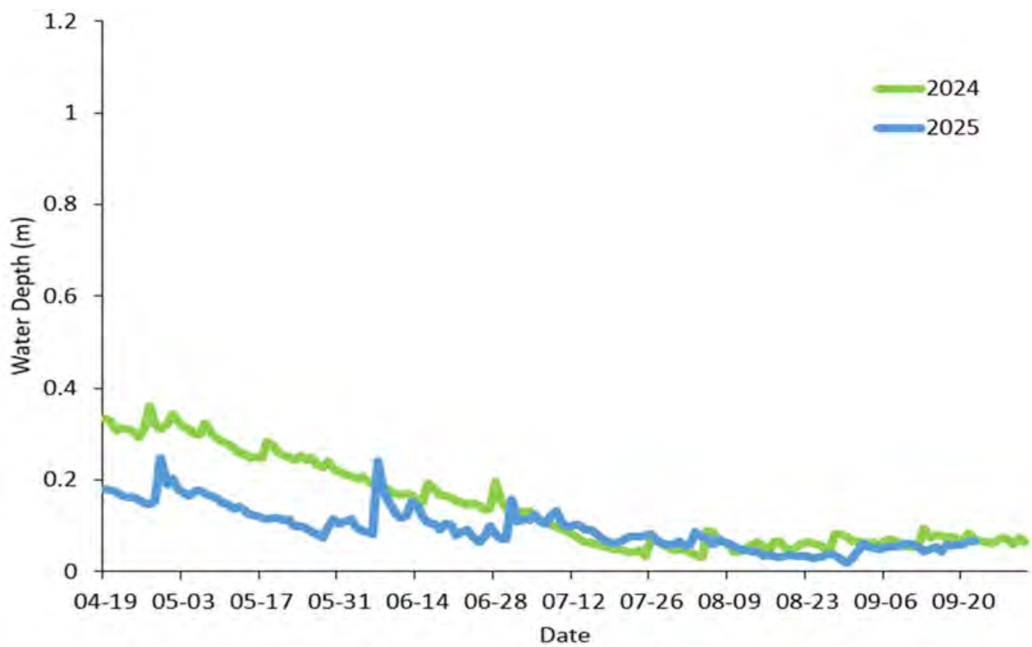

Figure 3. Water levels in 'Coltsfoot' reference site in 2024 (green) and 2025 (blue).

Since 2023, we have used a combination of in-person fieldwork, drone photography, and modeling to study the wetlands, lakes, and streams present on the western benchlands. These observations have allowed us to better understand the status of these wetlands, threats facing them, and to identify wetlands that we can restore using BDAs (detailed further in Section 3). We believe that by combining these methods, our wetland restoration efforts will be more successful, and we can contribute to understanding the impacts of climate change on these and other small wetlands.

2.1 Analysis of wetland vegetation and wetness by drone and in-person

Between May and September 2023, we visited 227 wetland (47%) and 144 lake (41%) FWA polygons via drone or in person to assess their potential for restoration sites and general status; in total we assessed 371 of the 828 (45%) mapped polygons. CWSP used a combination of geographic information system (GIS) resources, in-person observations, and photographic imagery to assess potential sources of water, wildlife values, landscape position, and dominant vegetation types.

We then used the drone photograph inventory to broadly classify the vegetation communities present in each FWA polygon, with the goal of using this as an indication of wetland 'wetness'. The details of this work can be found in CWSP's 2023 report (Holden *et al.*, 2024), but in summary, the dominant groundcover observed (i.e., open water, wetland vegetation, shrubs, deciduous or coniferous trees, mudflats, or dryland vegetation) was used to determine a 'wetness' index, which followed these four categories:

- **Adequately wet** – These wetlands have a dominant and subdominant ground cover type of Open Water or Wetland Vegetation.
- **Mostly wet but drying** - These wetlands have a dominant ground cover type of Open Water or Wetland Vegetation, but a subdominant ground cover type of Shrub, Conifer, Mudflat or Dryland.
- **Drying with wetted areas** - These wetlands have a dominant and subdominant ground cover type of Shrub, Conifer, Mudflat, or Dryland, but did have some Open Water or Wetland Vegetation present.
- **No signs of water -** These wetlands have a dominant and subdominant ground cover type of Shrub, Conifer, Mudflat, Dryland, with no Open Water or Wetland Vegetation present.

As identified in Holden *et al.* (2024), this work needed to be ground truthed via in-person visits to wetlands, to determine if the vegetation analysis and wetness index based on drone surveys was accurate. In 2025 we visited 38 wetlands that had been assessed with drone photographs, and took notes on wetland vegetation, disturbance, landscape location, and water source.

We determined that 28 of these 38 wetlands had the same vegetation observations when assessed with the drone or in-person visits, which is a 74% accuracy rate of the drone-based vegetation analysis. Four of these wetlands with the same vegetation observations between methods had different 'wetness index' ratings, resulting in a 63% accuracy of the wetness index. This occurred because the 2023 wetness index considered shrubs to be an indicator of drying, while subsequent years of study resulted in 2025 field surveys considering shrub presence to not necessarily be an indication of dryness in these wetlands. This indicates that the wetland index categories need to be adjusted.

Other discrepancies are due to variation in visit timing, dense overstories which limit drone assessment, changes in wetland condition between the two survey years, and difficulty distinguishing between vegetation types on drone imagery.

As mentioned, four wetlands had the same vegetation observations as both the drone and in-person, but different wetness indices. The 2023 analysis considered shrubs to be a sign of drying, as this is the case in many wetland systems (e.g. Capon, 2003; Klein *et al.*, 2005; Kotowski *et al.*, 2013) However, after spending more time studying the wetlands in this area, we have observed that many wetlands are naturally Scrub Birch or Willow species dominated (Figure 4), and that this is not necessarily an indication of drying, with many of these wetlands having saturated ground and herbaceous wetland vegetation as understory. Therefore, if we adjust the wetness index categories for drone classifications so wetlands with Shrub as the dominant ground cover, when accompanied by wetland vegetation, are considered Adequately Wet then the drone classification for these four sites align with the in-field classification.

Figure 4. On the left, shrub-dominated areas of a wetland (A); on the right, the same shrub-dominated habitat from the ground (B). After working on the western bench of the Columbia Valley, we believe that this is a common wetland type in this region and is

Two wetlands were classified differently between assessment methods due to differences in the timing of site visits. In one case, the wetland is a fen where standing water is not visible in drone imagery because dense wetland vegetation forms floating mats over the water surface. As a result, the presence of water can only be confirmed through on-the-ground observations within the wetland. Furthermore, the drone photos were taken in May, before wetland vegetation had sprouted and greened up (Figure 5A), and so the area looked like a dry mudflat; the in-person field visit took place in August, when the vegetation was lush and green (Figure 5B). The second site had open water when drone photos were taken in May 2023, but in August 2025 the open water areas were mudflat, and there was no saturated ground within the wetland. This highlights that time of year and year of survey are important factors to consider for both drone and on the ground surveying. Overall, 2025 was a much drier year than 2023 (see Section 3 for more details) and so more wetlands had ephemeral water.

Figure 5. Above, drone photo of fen wetland from May 2023 (A), looking like a dry mudflat; below, the same wetland in August 2024, with wetland vegetation growing well (B). While there is no open water in the wetland, the ground is saturated and in some places the fen vegetation is growing in floating mats over water.

Four wetlands that were assessed differently between drone and in-person visits had simply changed between 2023 and 2025. In one of these wetlands, beavers naturally moved into the area and began building dams, thus increasing water levels within the wetland; and altering it from 'No Signs of Water' in 2023 to 'Mostly Wet, But Drying' in 2025. The other three wetlands with observed changes were drier in 2025 during in-person visits than in 2023 when drone photos were taken; likely due to this being a drier year in most cases.

One of these wetlands is within a clear cut, and thus it is likely that this wetland will not persist due to the impacts of poor logging practices, as it will continue to dry (Figure 6). The high vulnerability of these systems can lead to rapid consequences due to changes on the landscape, and available information can be out of date within two years. This presents challenges for restoration planning, as the available data are often not recent enough to accurately reflect current wetland conditions. If available data on wetlands are old, in-person or drone visits are needed to determine if wetlands still possess the reported characteristics. This also highlights the importance of collecting baseline data, such as drone inventories and broad scale surveying, to be able to detect changes as climate change intensifies.

Figure 6. Above, small wetland in the middle of cut block in summer 2023, with visible open water (A); below, the same small wetland in summer 2025, with no open water present (B).

Three of these wetlands misclassified by drone inventory were conifer-dominated swamps, specifically classified in the BC Wetland Classes as Spruce – Horsetail (Ws07) (Figure 7). It is impossible for the drone to 'see' into these wetlands due to the presence of large conifers, so it is only by visiting them in-person that the presence of a stream and wetland vegetation understory can be determined. Therefore, these wetlands cannot be identified using a drone.

Figure 7. On the left, drone photo of wetland with conifers as the dominant vegetation (A); on the right, the same wetland, with a visible understory of wetland vegetation (Horsetails and Labrador Tea) (B).

Finally, one misclassified wetland was determined to be dominated by wetland vegetation from drone photos (Figure 8A), but in-person visits determined that it was dominated by dryland herbaceous vegetation, with wetland vegetation as sub-dominant (Figure 8B). This is because it can be hard to identify herbaceous vegetation from drone photos when adjacent to wetland margins, and this wetland has open water and then an abrupt transition into dryland herbaceous vegetation.

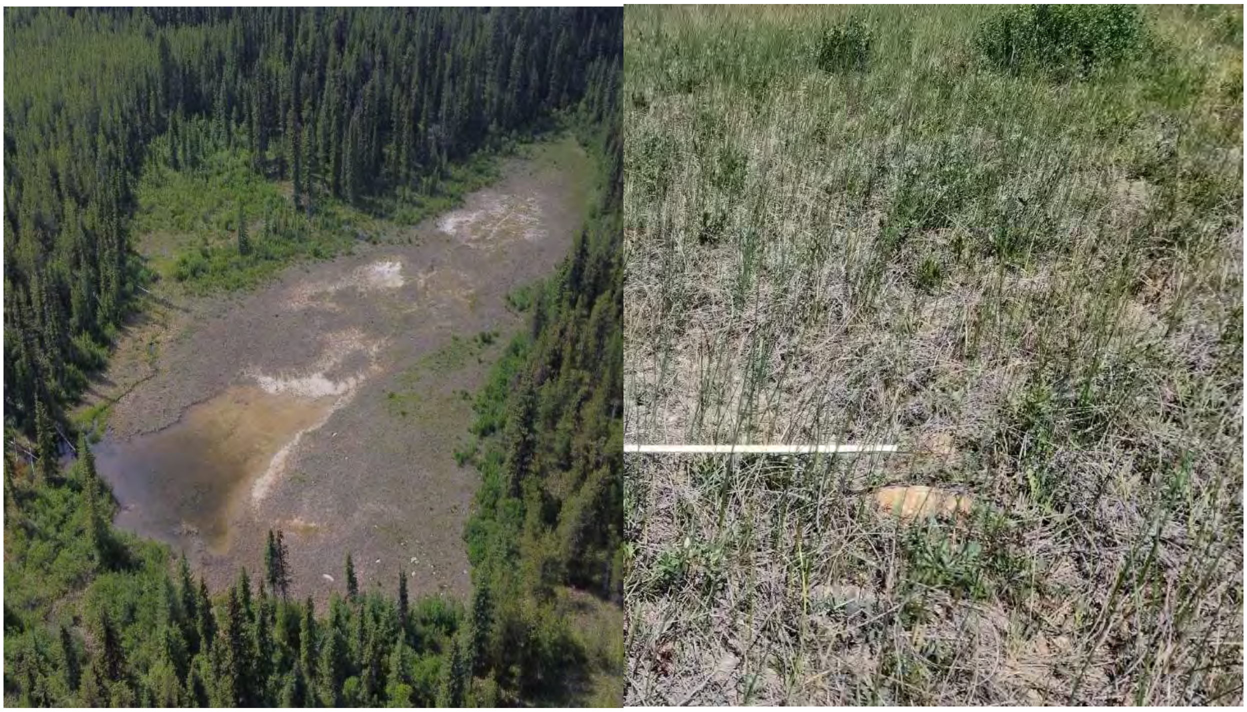

Figure 8. On the left, drone photo of this wetland, with hard-to-identify vegetation around open water (A); on the right, a close-up photo of this wetland, with a mix of upland herbaceous plants, small shrubs, and horsetail (B).

When amending our drone analysis to consider these factors (i.e. reclassifying shrub wetlands, removing the wetlands that changed between visits), the drone photo-based analysis was 80% in agreement with in-person field-based analysis. Four wetlands were incorrectly categorised by drone analysis in ways that cannot be fixed (i.e., wetlands with conifer over-story), where drone photos do not capture the nature of the wetland. Thus, the drone survey and remote vegetation analysis method of categorising wetland vegetation and wetness is effective, but does have limitations. In-person observations should be incorporated for calibration when planning restoration sites. Drone imagery collected during field surveys (Figure 9) provides a useful overview of the wetland landscape, but interpretation still benefits from ground-based knowledge of the ecosystem. Having an understanding of the ecosystem in question is important to allow for better interpretation of results, which often requires on-the-ground fieldwork and observations.

In our case, it took several years of wetland visits and assessments to gain a better understanding of the shrub-dominated wetlands in this landscape, and with that understanding we were able to improve the drone-based analysis. There is great variety in these shrub-dominated wetlands, which makes them hard to classify, and their function and health varies depending on the individual wetland. Many of these shrub-dominated wetlands have extensive wetland vegetation understory, permanently saturated ground, and some of them have extensive organic matter buildup that classifies them as fens. Some of these shrub-dominated wetlands do seem to be drying, with an understory composed of dryland species rather than wetland-associated ones, and with drying organic hummocks throughout the wetland. However, the presence of shrubs alone is not an indication of drying; we aim to continue to study these types of wetlands to be able to better describe and understand them.

In 2026, we plan to visit more wetlands on the upland western bench to further refine this analysis, improve our assessment of wetland condition, and better calibrate drone observations for this type of wetland assessment. We hope that this will be useful to other practitioners, as a drone-based analysis can be more cost effective and quicker for large areas compared to in-person visits.

Figure 9. Launching a drone to survey and take photographs of benchland wetlands.

2.2 Wetland Restoration Potential Index

In 2024, MacHydro Consultants, in collaboration with CWSP, developed a Wetland Restoration Feasibility Index for wetlands on the western benchlands of the Columbia Valley. This index aims to give an indication of the feasibility of restoring an individual wetland, mostly based on available water, as much of our work shows that this is a key issue for many small wetlands in the region. The Wetland Restoration Feasibility Index is based on a Wetness Index, an Inflow Index, and a Precipitation – Evapotranspiration Score. Further details can be found about this in the Year 6 Report: Hydrologic Feasibility of Bench Wetland Restoration in the Upper Columbia Valley (Millions *et al.*, 2024).

The Wetland Restoration Feasibility Index found that many wetlands on the western bench have low or moderate restoration feasibility, while far less have high or very high restoration feasibility (Figure 10).

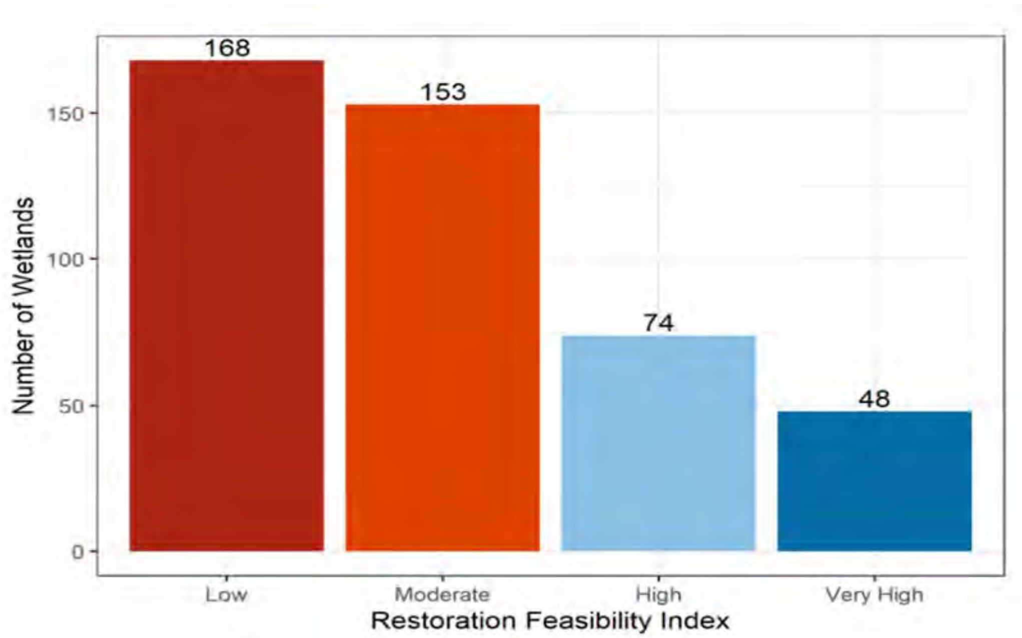

Figure 10. Distribution of Wetland Restoration Feasibility Index values for the bench wetlands.

In 2025, we ground-truthed this model to see if the predicted Restoration Feasibility Index score (Low, Moderate, High, or Very High) matched in-field observations. We visited 52 wetland polygons in July and August 2025, and recorded water source, water quality, vegetation, wetland position on the landscape, and signs of drying (if any). The refinement of the model is reported in the Year 7 report: *Restoration Index for Bench Wetlands in the Upper Columbia Valley – 2026 Update.*

While CWSP is focused on BDA-based wetland restoration, both the Restoration Feasibility Index score and our in-field observations considered other forms of wetland restoration. The Restoration Feasibility Index is primarily based on available water, as that is a key determinant of wetland restoration success; without water, particularly in places such as the East Kootenays where water is often a limiting factor, wetland restoration will struggle to succeed. In-field observations considered the potential for restoration using BDAs, but also other methods such as riparian or wetland vegetation planting, opening up blocked channels, fencing to prevent cattle access, improvement of water flow into wetland areas, measures to retain water within wetland areas, removal of invasive species etc.

From our observations, we think that the current Wetland Restoration Feasibility Index overestimates restoration feasibility in some sites. For example, we visited 22 wetlands ranked High or Very High by the Index, which we ranked as Low or Moderate based on field observations, mostly due to a lack of water source. For example, Figure 11 shows a wetland that was ranked as High by the Wetland Restoration Feasibility Index, and was shown by the FWA to have a stream flowing into and out of it; as can be seen in this photo, there is no stream or any other water in this wetland, and the vegetation present is dryland grass species, not wetland vegetation.

Figure 11. 'Wetland' area identified on the FWA and visited as part of ground truthing the Wetland Restoration Feasibility Index; ranked as 'High' feasibility for restoration and mapped as having a stream running through it. However, in the field we found no indication of a stream or other water source and no wetland vegetation was present, suggesting this area does not function as wetland, and we ranked it as 'Low' restoration feasibility.

However, 25 of the wetlands visited had Wetland Restoration Feasibility Index assessments that matched our field assessments; 10 of these were ranked as Low or Moderate, and 15 as High or Very High (Figure 12). Five of the wetlands visited were ranked higher during field assessments than by the Wetland Restoration Feasibility Index.

Figure 12. Wetland has the same ranking of High Restoration potential from both the Wetland Restoration Feasibility Index and field assessment.

This process demonstrates how essential ground-truthing a model is, especially when that model is based on old or incomplete datasets. While the FWA is a valuable resource, and in this area the only large-scale dataset available for wetlands, lakes, and streams, we have found that it generally overestimates the presence of water bodies and particularly overestimates the presence and size of streams. This may be due to the effects of climate change and drought in this area, where streams that were present during the creation of the FWA are now dry.

We plan to visit more wetlands to further ground-truth and modify this Wetland Restoration Feasibility Index, and then to make this available to other researchers, conservationists, and wetland practitioners as a tool that can be used as an initial guide for where wetland restoration projects might be successful. While nothing can replace field knowledge and understanding of a system, we believe it will be helpful for other practitioners to be able to use this tool as a broad scale filter for potential wetland restoration projects.

3. Restoration Site Monitoring and Beaver Dam Restorations Using Beaver Dam Analogues (BDAs)

In 2023, CWSP identified ten wetlands as potential sites for wetland restoration using Beaver Dam Analogues (BDAs). In 2024, we began to monitor these sites for pre-restoration data, and in September 2024 CWSP built four BDAs in two wetland sites. In 2025, we continued effectiveness monitoring, identified additional potential restoration sites, and built 21 BDAs and 7 Post Assisted Log Structures (PALs) across four wetland sites. In 2026, we plan to build 56 BDAs and 11 PALs across five wetland sites.

The 2024 constructions restored 12.49 ha of wetland in Beaver Channels and 1.17 ha of wetland in S-Land. They also resulted in an increase of 980 m^2 of open water in Beaver Channels and 3483 m^2 in S-Land. The 2025 constructions restored 5.47 ha, 3.89 ha, and 1.03 ha of wetland in the Northbound, Big Dam and Limbo sites, respectively. They increased open water in Northbound by 620 m^2, in Big Dam by 1035 m^2, and in Limbo by 1684 m^2.

In total we have restored 24.05 ha of upland wetlands. We also anticipate that increased water in all these systems in spring will result in more water being retained at all sites, which will be documented during planned April surveys, particularly at the Double Dam site which was dry during construction. The planned 2026 constructions will improve wetland habitat in a total of 26.89 ha.

We are now monitoring 13 sites, eleven as restoration sites and two as reference sites (Figure 13). In all sites we monitored water levels as our primary metric of pre- and post-restoration change. We also identified and mapped broad scale vegetation communities, pre- and post-restoration flooding extent, and monitored water quality at least three times per season (in April/May, July/August, and October). In 2025 we monitored all constructed BDAs and PALs once a month and going forward will be monitoring all constructed structures at least three times per field season (in April/May, July/August, and October). In 11 sites, we are more intensively monitoring breeding birds and vegetation, with yearly breeding bird surveys in May and June, and yearly surveys of 10 vegetation plots in August, as well as using trail cameras to document large mammals using these wetlands.

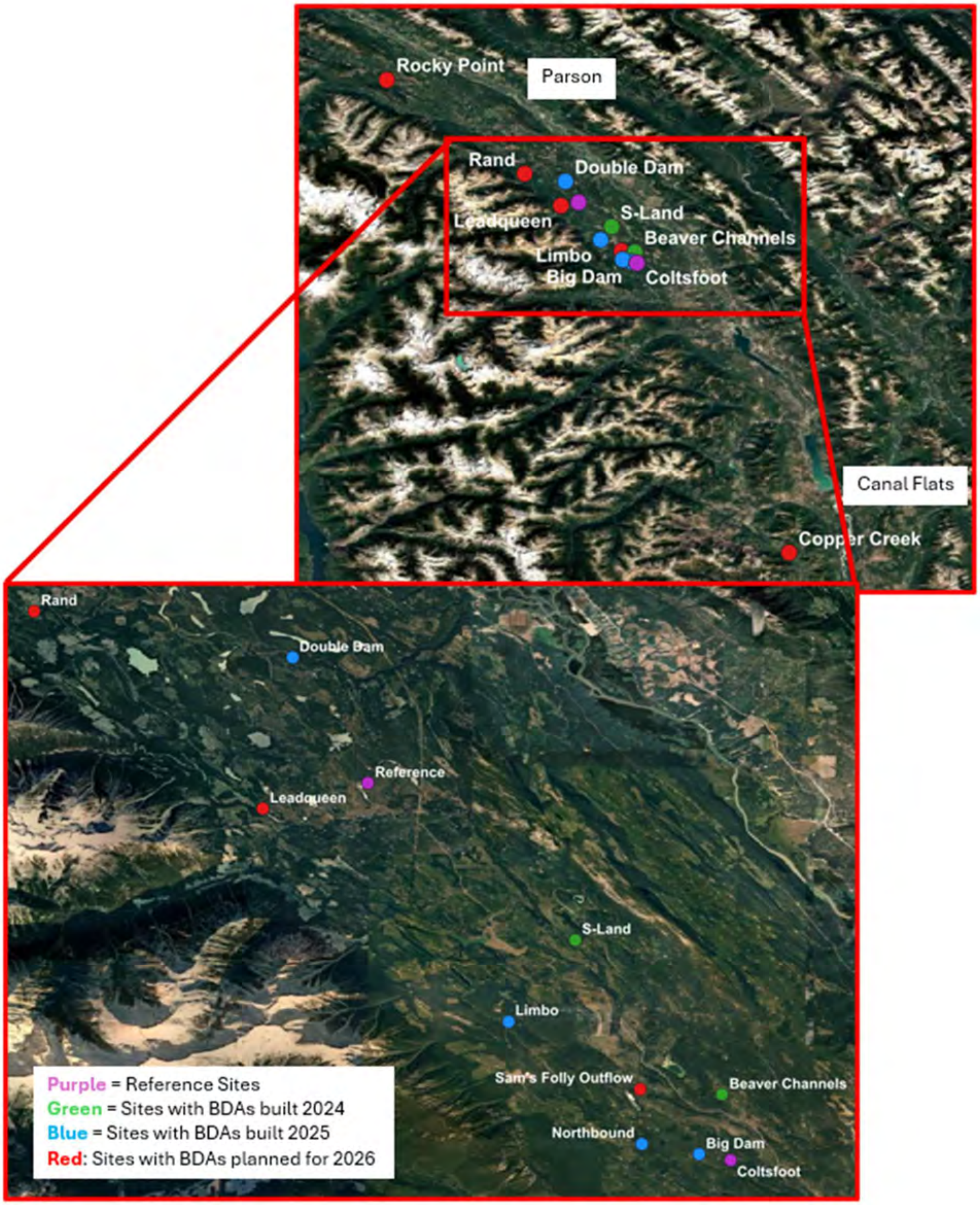

Figure 13. Map of the 11 sites CWSP has restored in 2024 and 2025 or plans to restore in 2026, and the two reference sites.

Our Year 6 report (Leven *et al.*, 2025) discusses the actual BDA building in more detail than this report does, but in general we are guided by the Wheaton *et al.*, (2019) Low-Tech Process- Based Restoration of Riverscapes: Design Manual and the data we have collected from these wetland sites.

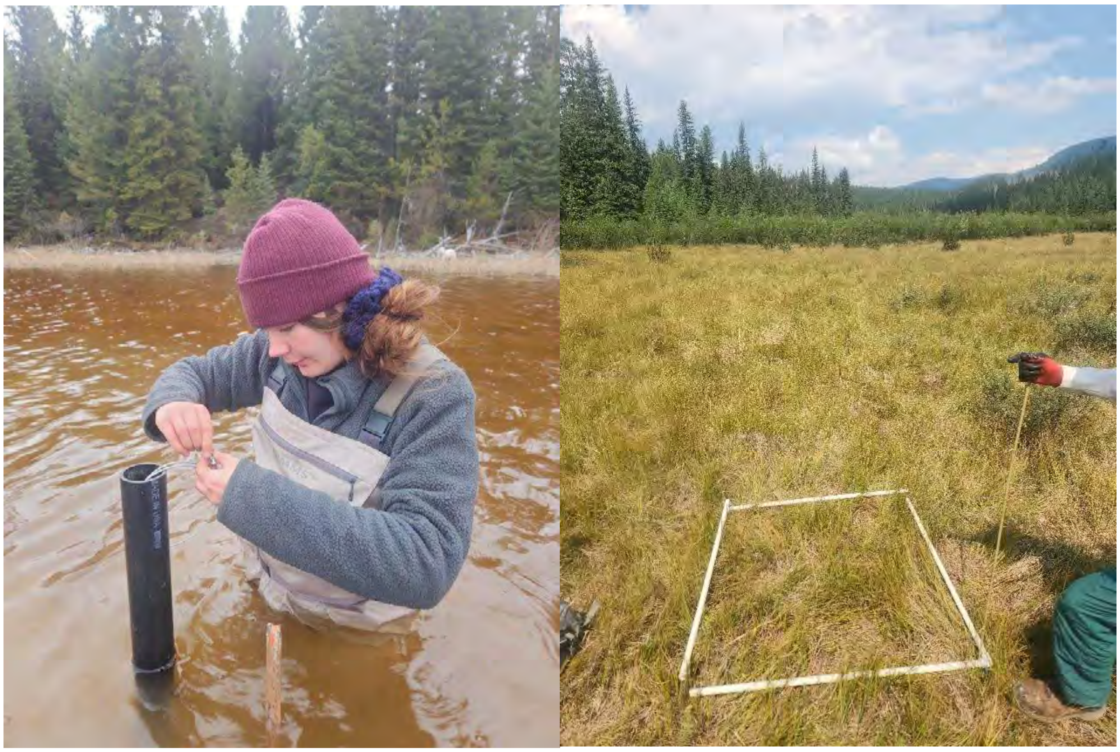

Figure 14. Left: Installing water level logger in restoration wetland site 'Beaver Channels'; Right: photo of us using a quadrat for vegetation monitoring within the site.

3.1 S-Land – Built in 2024

In S-Land, we built two BDAs in September 2024 (Figures 15 and 16) and monitored the post-construction impact of these BDAs through 2025. While in 2024 the stream flowing through this site was permanent, in 2025 it was ephemeral, with flow stopping sometime in late August and resuming in early October.

Figure 15. Photographs of the two Beaver Dam Analogues (BDAs) constructed in this wetland in September 2024. Left: Downstream BDA. Right: Upstream BDA.

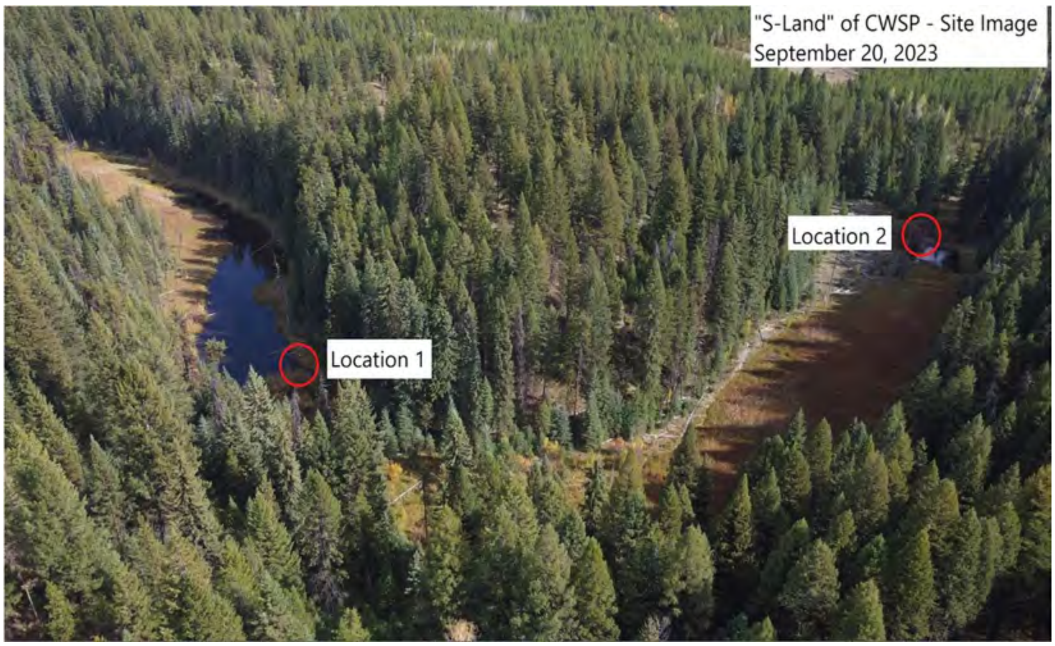

Figure 16. Drone photograph showing S-Land wetland, with BDA locations indicated.

3.1.1 Water Monitoring

We installed a HOBO-U20 Water Level Logger upstream of both BDAs and collected water level data from 2024 (pre-restoration) and 2025 (post-restoration). In 2024, this logger was installed from April 15th to October 1st, and in 2025 from April 30th to October 6th.

The drier conditions in 2025 can be observed at both of our installed water level loggers in the S-Land wetland, with clear decreases in water level above both BDAs in August (Figures 17 and 18). However, both wetland areas upstream of installed BDAs retained more water, despite drier conditions, than was recorded pre-restoration. From April to the beginning of August 2025, the downstream BDA retained approximately 0.3 m more water than pre-restoration conditions recorded in 2024 (Figure 17). In April and June, the Upstream BDA retained only slightly more water than pre-restoration; however, from mid-June to mid-August, the wetland area retained significantly more water in 2025 (0.7 m) than in 2024 (0.5 m) (Figure 18) Thus, both of these BDAs succeeded in our goal of retaining more water in this wetland post-restoration.

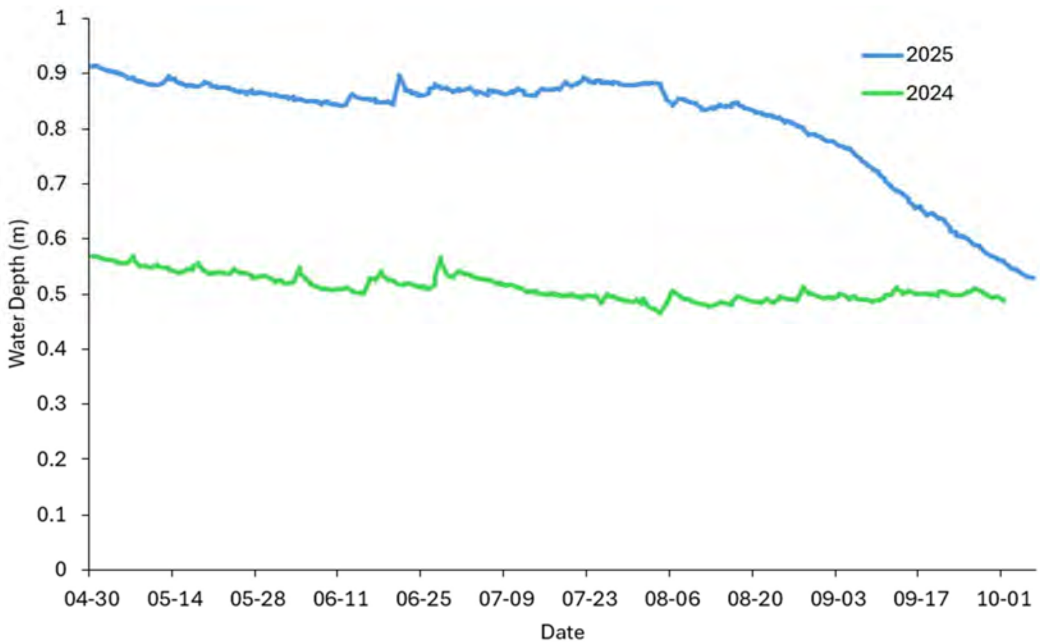

Figure 17. Water levels in 2024 (green) and 2025 (blue) above downstream BDA in S-Land..

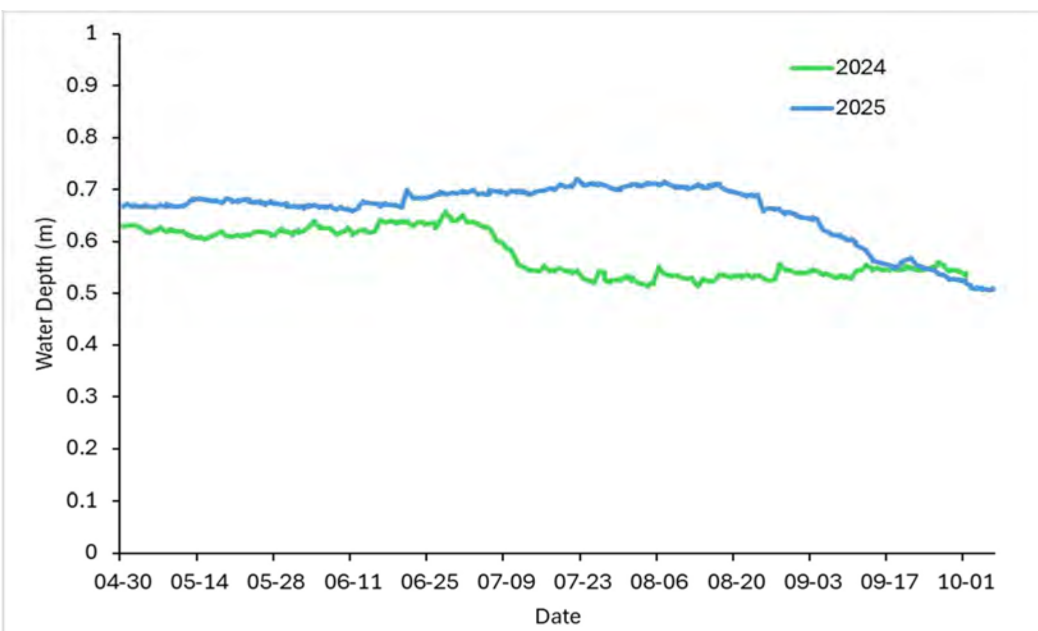

Figure 18. Water levels in 2024 (green) and 2025) above upstream BDA in S-Land.

While water levels above both BDAs declined in August, we suspect that had these BDAs not been present, the areas would have been even drier and water would not have persisted as long. Considering the lower water levels recorded in Westside Junction and Coltsfoot wetlands during 2025 (Figures 2 and 3), it appears that even in the face of overall dry conditions, these BDAs are retaining water and maintaining wetland habitat (Figure 19). We also observed that more streams became ephemeral in 2025 than in 2024. The stream flowing into the S-Land wetland was one of those streams; our September visit to site noted that the stream channel above the wetland no longer had a strongly flowing stream in it, and instead there were pools of standing water and areas where the streambed was completely dry.

Figure 19. Flooded area in the lower section of the S-Land wetland observed during monitoring in May 2025.

The installed water level loggers also recorded water temperature every four hours. Water temperatures varied in ponds above both BDAs in 2024 and 2025. Generally, they both had low temperatures and ranged from 6°C in April to 14°C in July (Figures 20 and 21). Water temperatures in 2025 showed less variation, with the water warming earlier and remaining warmer longer, but not reaching the same maximum temperatures. In 2024, the maximum temperature at both loggers was nearly 16°C, whereas in 2025 it did not go above 14°C at both locations, despite the warmer and drier summer.

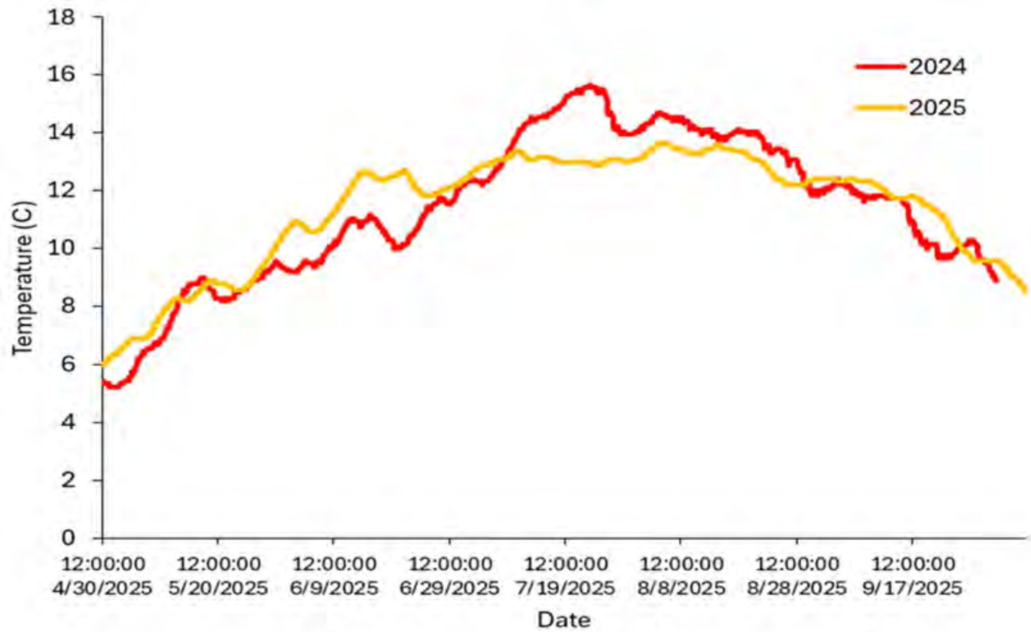

Figure 20. Water temperature recorded from April to October 2024 and 2025 in S-Land wetland above Downstream BDA.

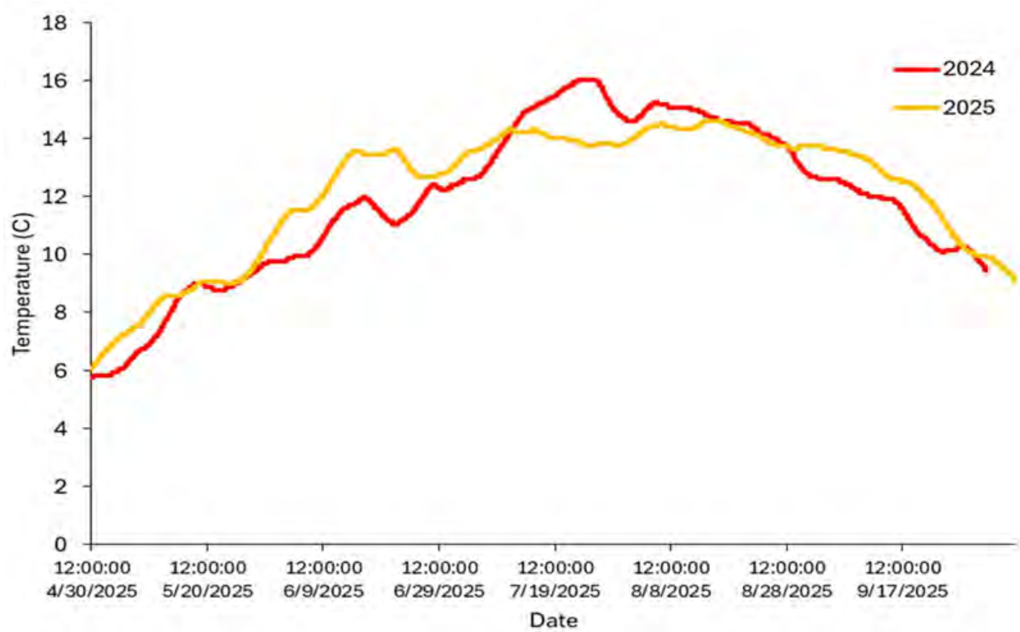

Figure 21. Water temperature recorded from April to October 2024 and 2025 in S-Land wetland above Upstream BDA.

3.1.2 Flooded Area Mapping (Open water extent)

We mapped open water flooded areas in Summer 2023 (pre-restoration) and Fall 2025 (post-restoration) to exhibit the extent of flooding achieved by the installed BDAs (Figure 22). The pre-restoration estimate of flooded areas within this wetland was ~ 2700 m^2. After the installation of BDA structures, the new estimate of flooded area was ~ 10,291 m^2; however, the flooded extent varies throughout the year due to water inputs. We plan to map flooded areas again in spring 2026, at what we assume will be the maximum flood extent. The flood water also extends into the vegetated portions of the wetlands and we will be documenting the vegetative response in 2026.

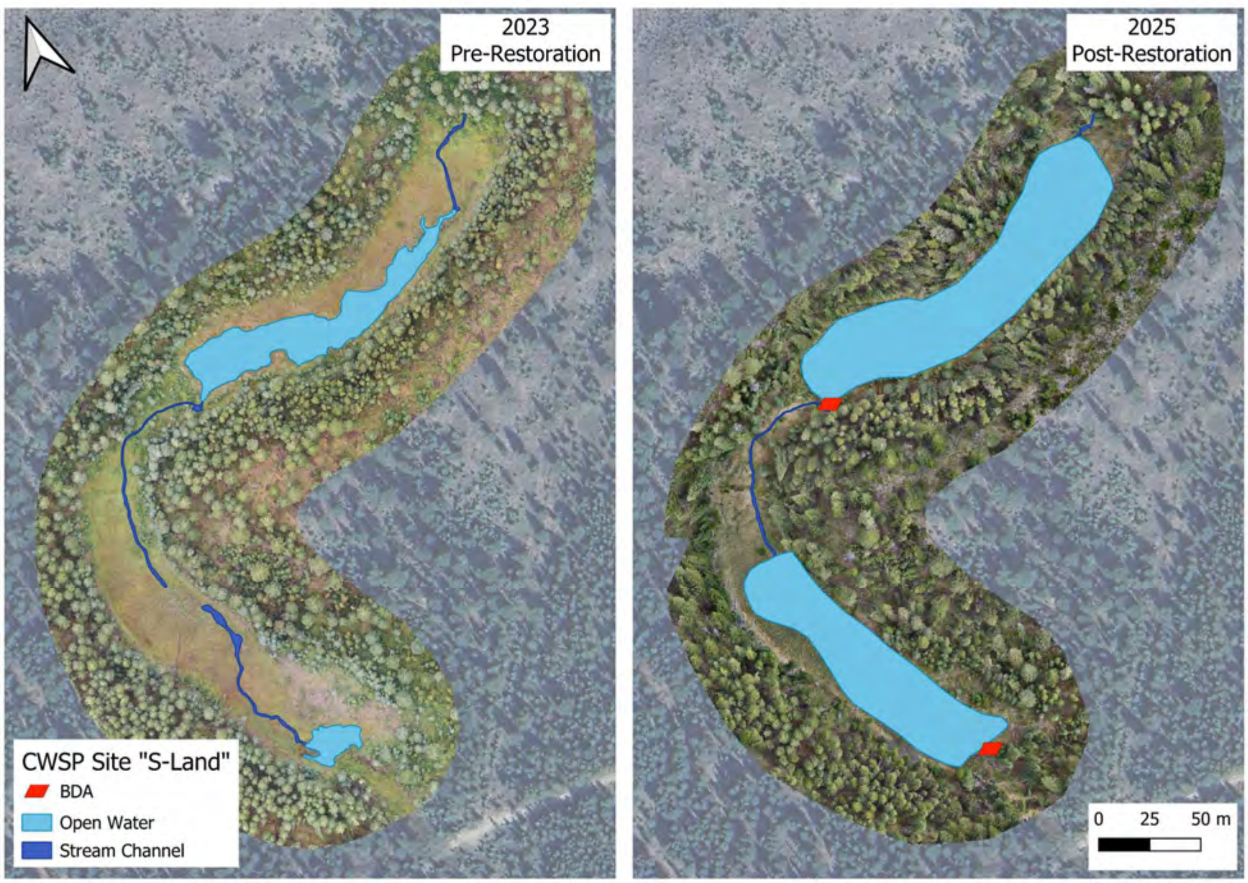

Figure 22. Areas of open water/flooding in S-Land were mapped in the field using GIS applications (Avenza, ArcGIS Field Maps).

3.1.3 Structure Monitoring

We monitored both BDAs once a month between March and October in 2025. We assessed the structure, measured water depth just above each BDA, and collected water quality measurements. The BDAs remained in good condition throughout all of 2025 and did not require any repairs. Monthly monitoring may not be required in systems where water volume and stream flow are as low as observed at this site and at other sites in the area. An example of the data collected during our inspections is included below (Table 1).

Table 1. BDA observations from April 28, 2025.

Downstream BDA		**Upstream BDA**	
Water Depth Upstream of BDA:	0.45 m	Water Depth Upstream of BDA:	0.26 m
Water Depth Downstream of BDA:	0.31 m	Water Depth Downstream of BDA:	0.11 m
Water Depth Over BDA:	0.05 m	Water Depth Over BDA:	-
Notes: The BDA is in good condition with no visible leaks or structural concerns. The upstream pool depth was measured at 0.45m deep and water clarity was very high, with no turbidity observed. The clay on top of the BDA remains solid and intact. We observed a Brook Trout (*Salvelinus fontinalis)* swimming from the downstream to the upstream side of the BDA, successfully navigating over the BDA. The elevation drop from the BDA crest to the downstream water surface is approximately 0.10m.		**Notes:** The BDA is in good condition, with water visibly flowing through the mud layer beneath the overlying branches, with a consistent and steady flow. The drop from the top of the BDA to the downstream water surface is approximately 0.38m. While water is moving through the structure, the BDA is still effectively holding water upstream. Additionally, flow was observed flowing over the remnant natural dam adjacent to the BDA, with an average water depth of 0.08m across a span of approximately 3.2m.	
			

3.2 Beaver Channels – Built in 2024

In Beaver Channels we built two BDAs in September 2024 (Figure 23 shows both locations; Figures 24 and 25 show the individual BDAs). The creek at this site is ephemeral, typically drying up by May, so the observed increase in wetland area during 2025 was also ephemeral.

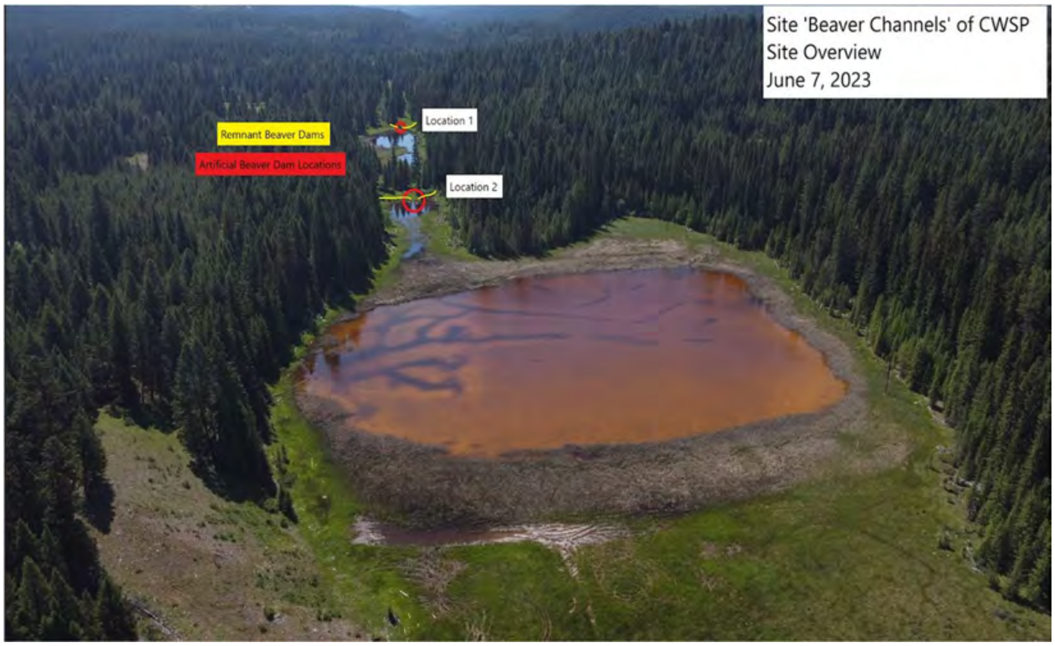

Figure 23. Drone photo of 'Beaver Channels' wetland, showing locations of the two BDAs built in 2024.

Figure 24. Downstream BDA was constructed at Beaver Channels in September 2024, showing water held behind the dam in May 2025. This area directly behind the BDA was not flooded in May 2024.

Figure 25. Upstream BDA was constructed at Beaver Channels in September 2024, showing water being held by BDA in May 2025. This area directly behind the BDA was not flooded in May 2024.

3.2.1 Water Monitoring

In wetland areas above both BDAs, the water levels declined through the monitoring period both pre- and post-restoration, which is due to this system being ephemeral (Figures 26 and 27). In the wetland area above the downstream constructed BDA, water levels were lower in 2025 than 2024 (Figure 26). Levels both began and ended the monitoring period lower, thus this decreased water in 2025 is likely due to lower water inputs during the winter (i.e., precipitation) and not an effect of our activities.

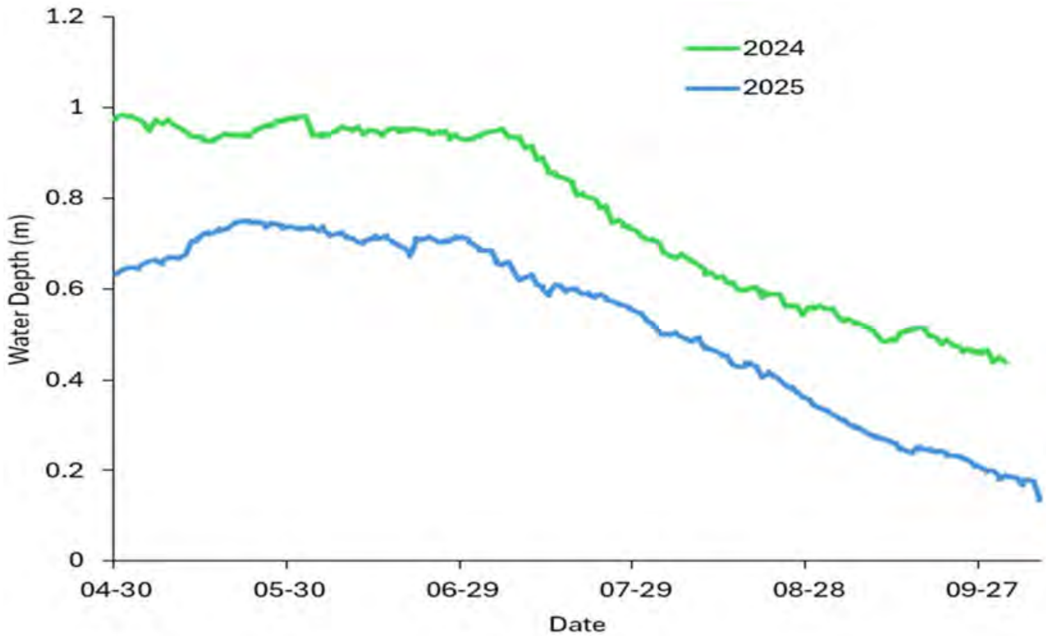

Figure 26. Water levels recorded from April to October 2024 and 2025 in the Beaver Channels wetland above the Downstream BDA.

In the wetland area above the upstream constructed BDA, water levels in 2025 began lower than in 2024; however, by mid-July the post-restoration (2025) water levels were higher. These higher water levels persisted until the end of the monitoring period in early October, when water levels between the two years were very similar (Figure 27).

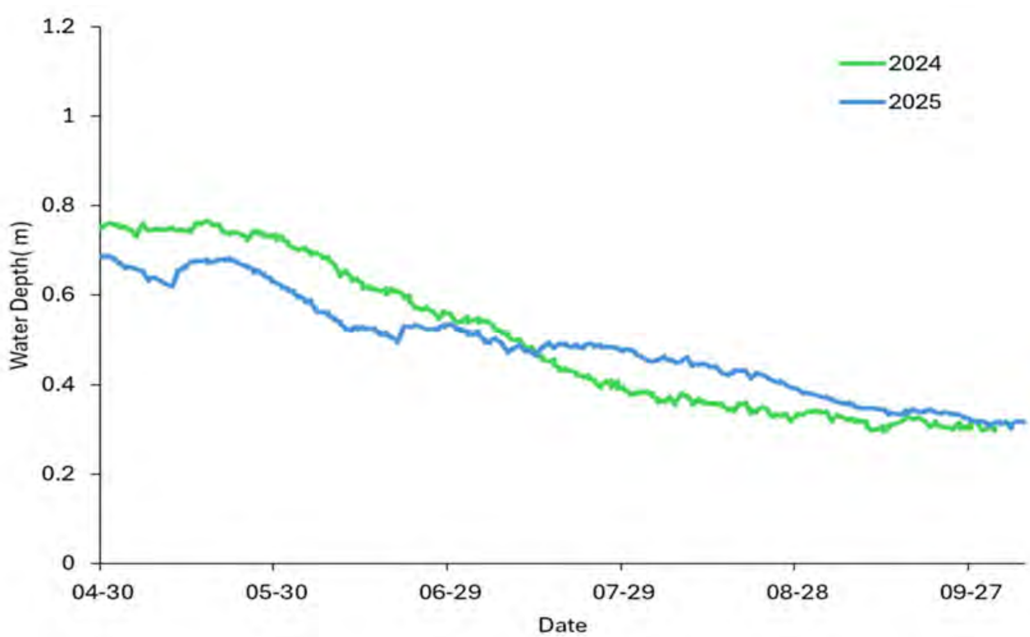

Figure 27. Water levels recorded from April to October 2024 and 2025 in the Beaver Channels wetland above the Upstream BDA.

As can be seen from the Westside Junction and Coltsfoot wetland water levels (Figure 2 and 3), 2025 was drier than 2024. This is likely because multiple relatively dry years in the East Kootenays have led to reduced water in this and other watersheds. For example, on April 1st, 2025, the East Kootenay snowpack was assessed at 78% of normal; on May 1st, 2025 at 62% of normal; and by June 1st to only be at 24% of normal (Ministry of Water, Land and Resource Stewardship, 2025), indicating less snow overall and in particular early melting, which impacts water availability for wetlands throughout the summer. Anecdotally, talking to locals who know the area well, streams and springs that people remembered being consistently wet ran dry this year.

While ephemeral creek outflow from wetland areas in Beaver Channels was noted in 2023, 2024, and 2025, there is no defined creek channel which suggests the small trickle from these wetlands is minimal and does not persist very long. The lack of visible inflow to the upstream wetland area, high conductivity in both wetlands, and the persistence of open water that existed prior to BDA construction suggest that groundwater springs are the main source of water for both of these wetlands. The differences in hydrographs between the two wetland areas may be due to differences in spring depth and spring water supply and may suggest a lack of connectivity between the two wetland areas. Monitoring of both these wetland areas will continue next year, and more data may allow firmer conclusions to be drawn.

Water levels above both BDAs began lower than in 2024 and declined throughout the summer, which is the same pattern shown in the Reference Wetland, providing evidence that 2025 was a drier year than 2024. Similar to 2023 and 2024, there was an ephemeral outflow from the downstream wetland. Despite the hydrographs not showing an increase in water depth to the BDA construction, an expansion of open water flooded area was observed during the monthly dam inspections (Figures 28-31) (Section 2.1.3). The constructed BDAs held water and increased ephemeral wetland habitat in 2025 which persisted through June. Despite these BDAs not supplying a significant increase in water depth, they did increase persistence and area of ephemeral wetland habitat which is deemed successful given the low water availability within this system.

This increase in ephemeral wetland habitat provides an increase of water on the landscape for use by wildlife (and, incidentally, domestic cattle, many signs of which have been observed in this site). It also allows wetland species such as Wood Duck and Wild Mint to have more suitable habitat available for them during the breeding/growing season; these were both species observed in 2025 in the newly ephemerally flooded areas that were not in those areas in

2024 when they had been dry. Thus, the constructed BDAs are helping to increase wetland habitat, though only for some portions of the year.

Despite this, given the limited positive effects of BDAs in this wetland due to lack of aboveground water source and overall low water levels, if we were considering wetland restoration sites with the knowledge we know have, we would not choose to build BDAs in this wetland. This site was one of the first we picked, with limited knowledge of the wetlands in this system, and so we did the best we could with the information we had at the time. After further years of work in this area, however, we don’t think this is the best wetland system to build BDAs in and would not build in similar wetlands again.

Figure 28. Pond above the downstream BDA at CWSP Site Beaver Channels. Drone image taken pre-restoration, in June 2023.

Figure 29. Pond above the downstream BDA at CWSP Site Beaver Channels. Drone image taken post-restoration, in May 2025.

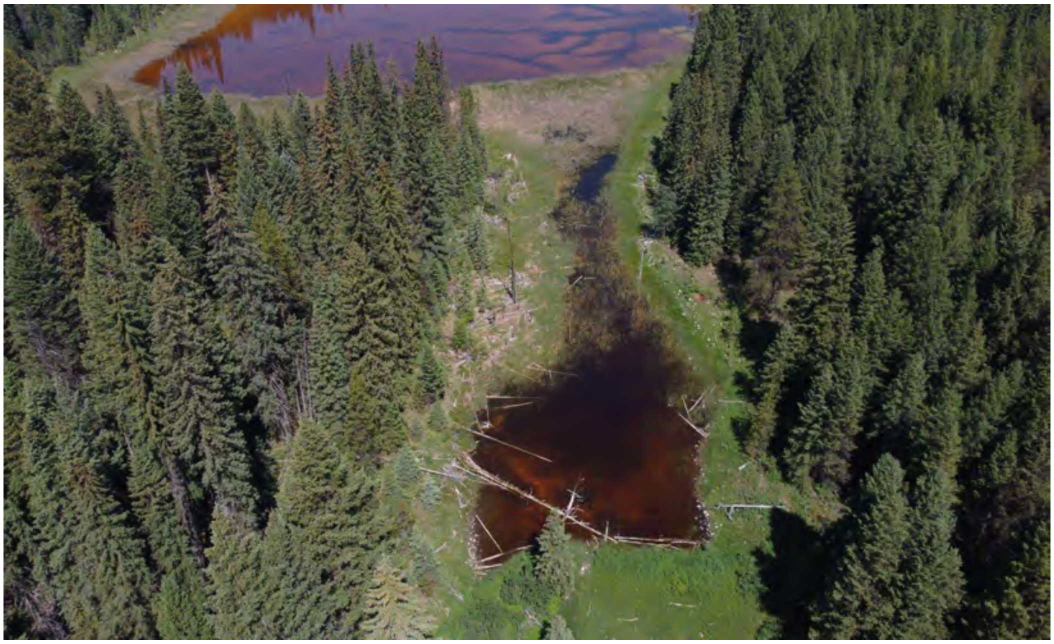

Figure 30. Pond above the upstream BDA at CWSP Site Beaver Channels. Drone image taken pre-restoration, in June 2023.

Figure 31. Pond above the upstream BDA at CWSP Site Beaver Channels. Drone image taken post-restoration, in May 2025.

The installed water level loggers also recorded water temperature every four hours. Temperatures above the downstream BDA (16.81 °C in 2024; 19.18 °C in 2025) were slightly cooler in both years than those above the upstream BDA (22.05 °C in 2024; 21.66 °C in 2025). Temperature measurements are displayed in Figures 32 and 33. This temperature difference between open water areas may be related to their substrates and amount of submerged aquatic vegetation. The downstream wetland area has darkly colored rich organic sediment which supports lots of submerged aquatic vegetation that provides cover in the wetland. The upstream wetland area has very pale, inorganic sediments and lacks submerged aquatic vegetation. Compared to other wetlands monitored by CWSP, these water temperatures are quite warm (e.g. at the Double Dam site, the maximum temperature in 2025 was 16°C); we hypothesise this is due to the lack of stream inflow to the Beaver Channels wetland areas, as stream water temperatures tend to be cooler.

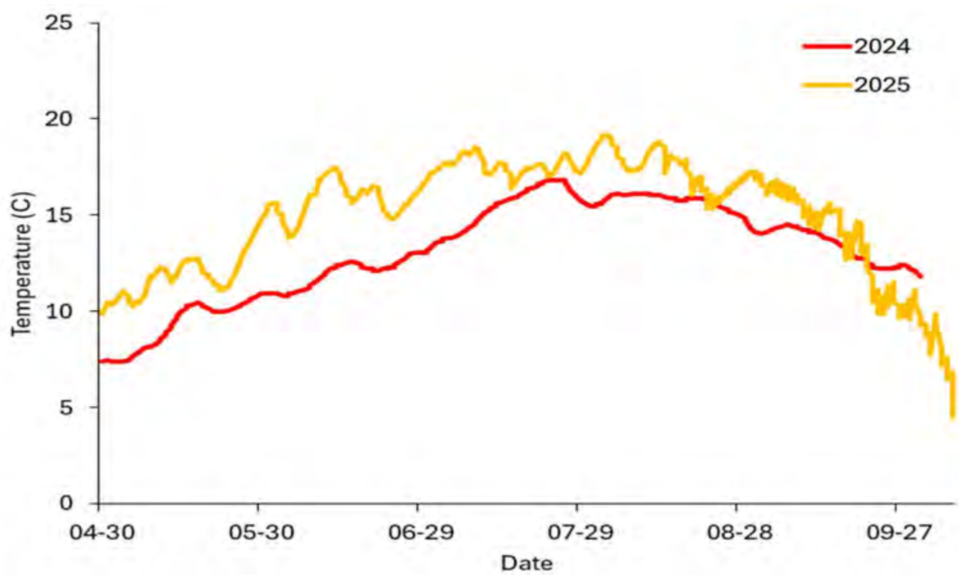

Figure 32. Water temperature recorded from April to October 2024 and 2025 in the Beaver Channels wetland above the Downstream BDA.

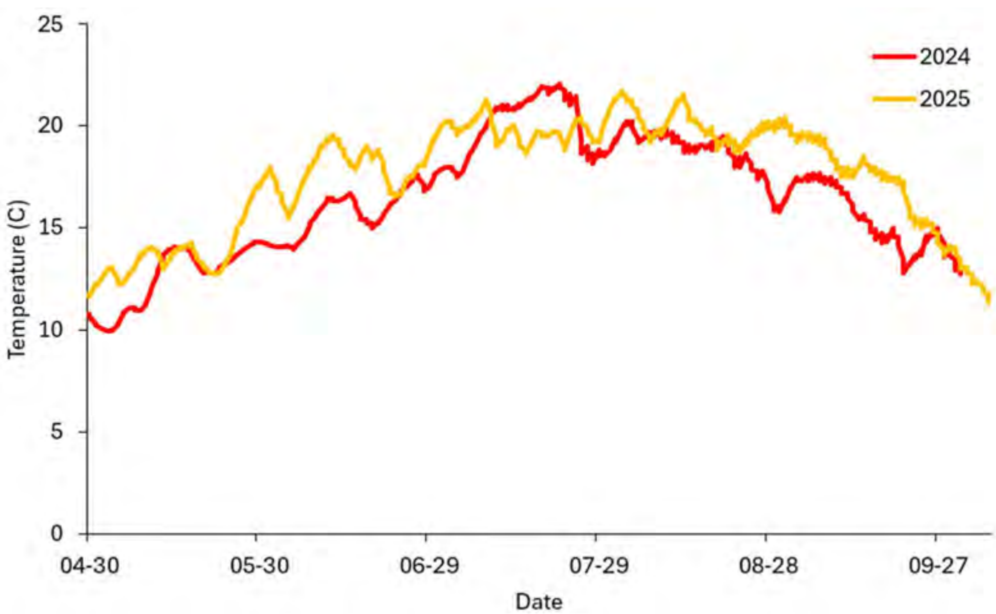

Figure 33. Water temperature recorded from April to October 2024 and 2025 in the Beaver Channels wetland above the Upstream BDA.

3.2.2 Drone Imagery and Flooded Area Mapping

Flooded areas in Beaver Channels were mapped in Summer 2023 (pre-restoration) to exhibit the extent of flooding at this site pre-restoration. Mapping was not completed at this site in 2025, thus there are no results to report this year. We will complete this flooded area mapping in spring 2026.

3.2.3 Structure Monitoring

We monitored both BDAs once a month between March and October in 2025. We assessed the structure, measured water depth just above each BDA, and collected water quality measurements. The BDAs remained in good condition throughout all of 2025 and did not require any repairs. Monthly monitoring is probably not necessary in systems where water volume and stream flow is as low as in this site, and our other sites in this area. An example of the data collected during our inspections is included below (Table 2).

Table 2. BDA observations from May 15, 2025.

Downstream BDA		**Upstream BDA**	
Water Depth Upstream of BDA:	0.27 m	Water Depth Upstream of BDA:	0.16 m
Water Depth Downstream of BDA:	0.00 m	Water Depth Downstream of BDA:	0.00 m
Water Depth Over BDA:	0.00 m	Water Depth Over BDA:	0.00 m
Notes: The deepest point in the upstream pool behind the BDA was measured at 0.27m. Lateral flooding is more extensive compared to last time we visited the site in April when no flooding behind the BDA was observed. Water retention is improved and has resulted in a presumably ephemeral expansion of wetland habitat. The BDA appears to be in good repair and is effectively retaining water! Previously existing open water area upstream of this newly flooded area is well flooded, with sedges being inundated.		**Notes:** The BDA is functioning well and retaining water, with a measured depth of 0.16m in the main upstream pool. The BDA appears to be in good repair with no signs of leakage or instability. Increased lateral flooding was noted here as well, with water extending further to the sides. Previously existing open water area upstream of this newly flooded area is well flooded, with sedges (*Carex sp.)* and bulrush (*Schenoplectus sp.)* being inundated.	

3.3 Double Dam – Built in 2025

CWSP built six BDAs and two PALs and repaired two present but damaged natural beaver dams in the site Double Dam in September 2025 (Table 3, Figure 34 and 35). We built all of these structures on September 10th, 2025. The stream supplying Double Dam went dry in approximately mid-August 2025 (discussed further in Section 3.3.1), so all work completed in this wetland occurred 'in the dry', as there was no water remaining in the wetland in the locations where we built structures. In constructing these dams, we plan to increase open water flooded area by 4500 m^2 and improve wetland habitat across 10.89 ha. However, as this wetland was dry, the constructed BDAs did not fill before the end of the season, and so we will be surveying this wetland in spring 2026 to determine how much flooding occurred.

Table 3. Dimensions and construction details of Beaver Dam Analogues and Post-Assisted Log Structures at the Double Dam restoration site built in September 2025.

Structure	Width	Height	Depth	Type
DDA01	19.5 m	0.40 m	1.6 m	Patching with sediment and branches
DDA02	1.50 m	0.42 m	0.9 m	BDA - Full
DDA03	1.30 m	0.50 m	0.40 m	BDA - Full
DDA04	1.30 m	0.45 m	0.50 m	BDA - Full
DDA05	2.40 m	0.60 m	1.50 m	BDA - Full
	1.5 m	0.20 m	0.6 m	Patching with sediment and branches
DDA06	0.70 m	1.0 m	0.60 m	PAL
DDA07	1.40 m	0.40 m	1.00 m	BDA – Full
DDA08	1.30 m	0.30 m	0.70 m	BDA - Full
DDA09	0.75 m	0.45 m	0.65 m	PAL

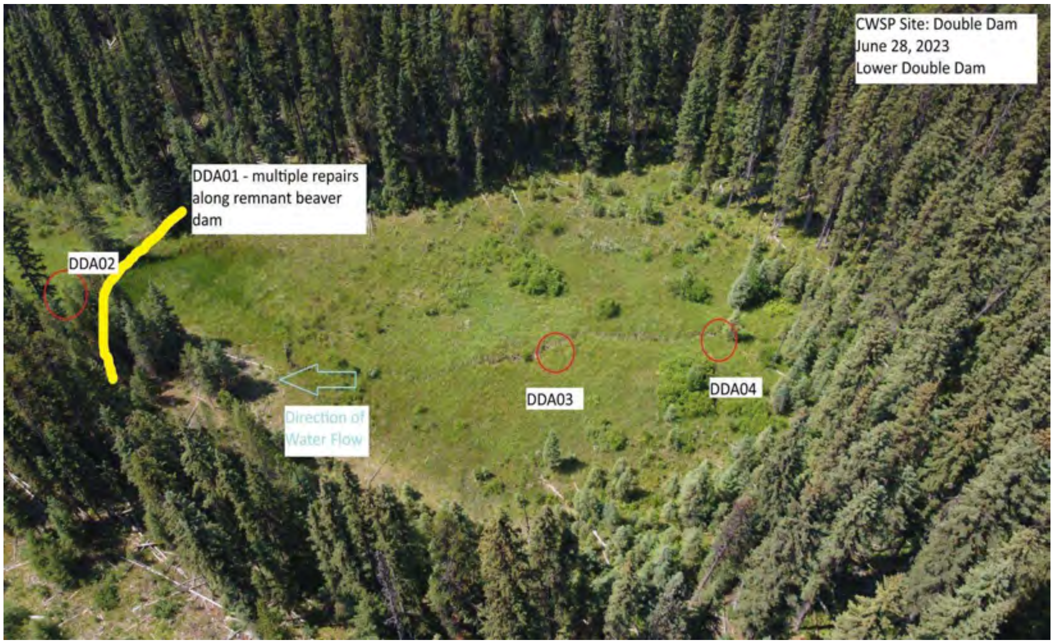

Figure 34. Drone photograph showing the locations of the proposed structures within CWSP Site "Double Dam".

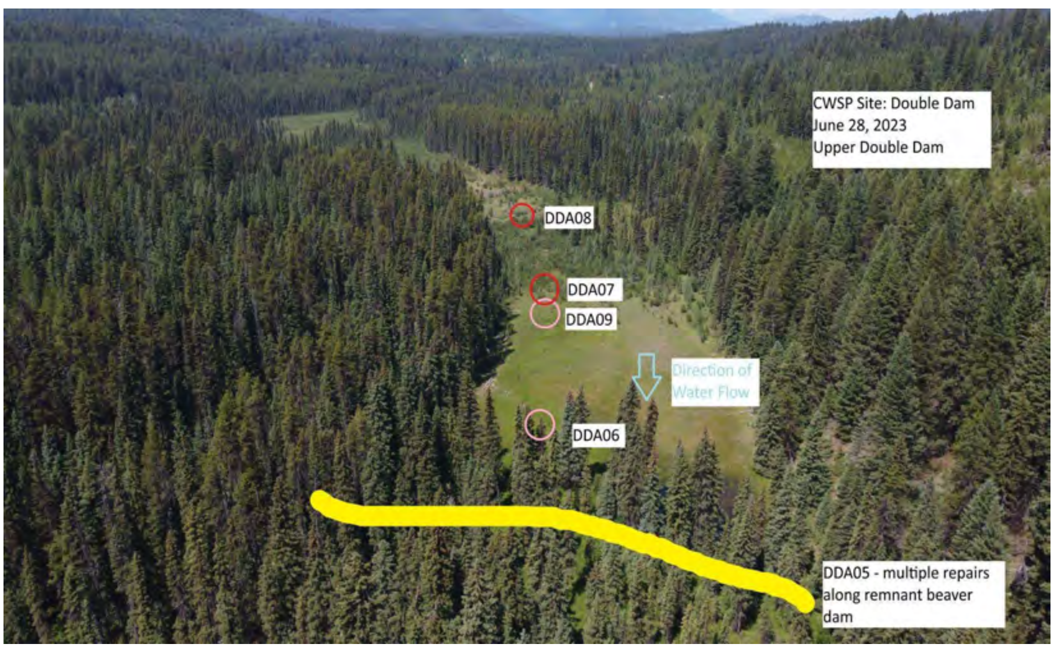

Figure 35. Drone photograph showing the locations of the proposed structures within CWSP Site "Double Dam".

This work was conducted by hand, with a team of staff and volunteers from CWSP, Cirque Consulting, and Living Lakes Canada (Figures 36 to 39). One of the advantages of BDAs as a restoration technique is it is low-tech and does not require machinery, so site disturbance is reduced.

Figure 36. Beaver Dam Analogue was constructed by hand during restoration work at the Double Dam site, September 2025.

Figure 37. A crew member shortening the posts on one of the Beaver Dam Analogues in September 2025.

Figure 38. Post Assisted Log Structure was constructed by hand during restoration work at the Double Dam site, September 2025.

Figure 39. A staff member working during the initial stages of BDA construction at Double Dam restoration site, September 2025.

3.3.1 Water Monitoring

As we are working in small streams and wetlands, there are concerns that while building BDAs, downstream flow may be interrupted. Thus, we installed a water level logger downstream of the construction site to monitor the stream flow before, during, and after construction (Figure 40). Prior to and during construction there was no water in the stream, and water depth did not become detectable until October 3rd, 2025, though during an October 6th site visit we noted that while there was standing water within the streambed, the stream was not flowing.

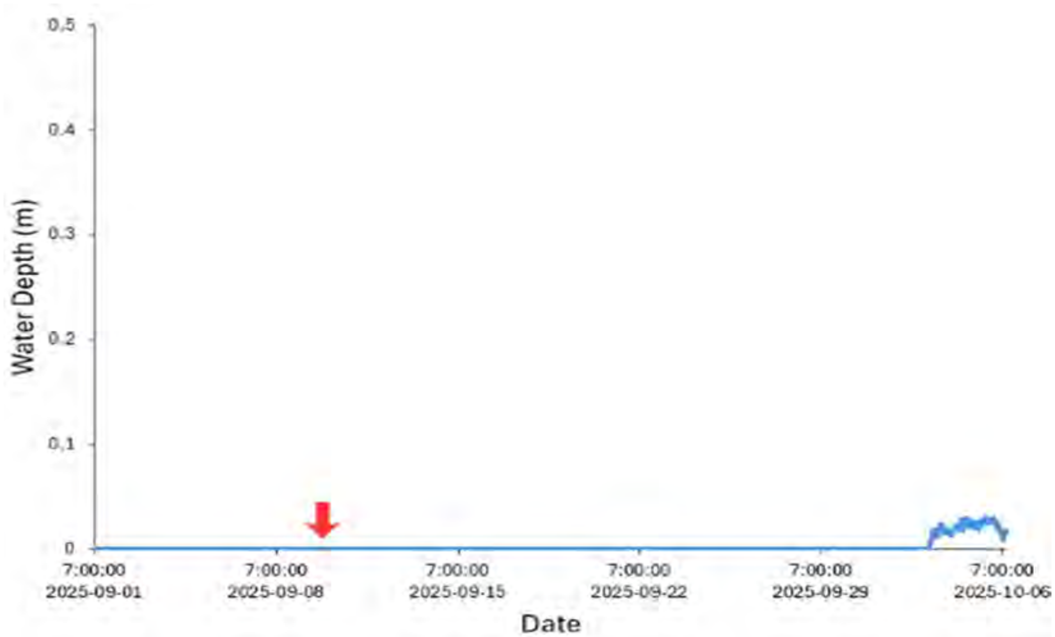

Figure 40. Water depth data from the water level logger (HOBO U-20) installed ~ 50 m downstream of the project site at Double Dam. The red arrow indicates when construction began on September 10th, 2025.

We also installed two HOBO-U20 Water Level Loggers in this site to monitor pre-construction water depths (Figure 41). The first was located approximately 2 m upstream of DDA-01, while the second was installed in the already existing open water pool upstream of the remnant beaver dam, DDA-05. Both loggers were installed on May 1st, 2025 and remained installed until October 6th, 2025, so they both recorded during and post-construction water depths as well. Both loggers will be re-installed for the remaining years of the project to continue to monitor water depth.

Between May 1st and September 3rd (when the water level dropped to 0 m) the average water depth was 0.18 m (Figure 41). The water levels were very ‘flashy’, showing several very quick increases and then slower decreases, which were likely to be due to snow melt or rainfall, both of which result in a short-term increase in water inflow. This area was dry (water depth = 0.0 m) between September 3rd and October 2nd and experienced a rapid increase to over 0.20 m deep on October 3rd. This water remained in the wetland until the water level logger was collected four days later. Due to the lack of stream flow, it was not possible to immediately see the effects of water impoundment behind DDA-01; this logger will be re-installed in April 2026 to record next season's water levels.

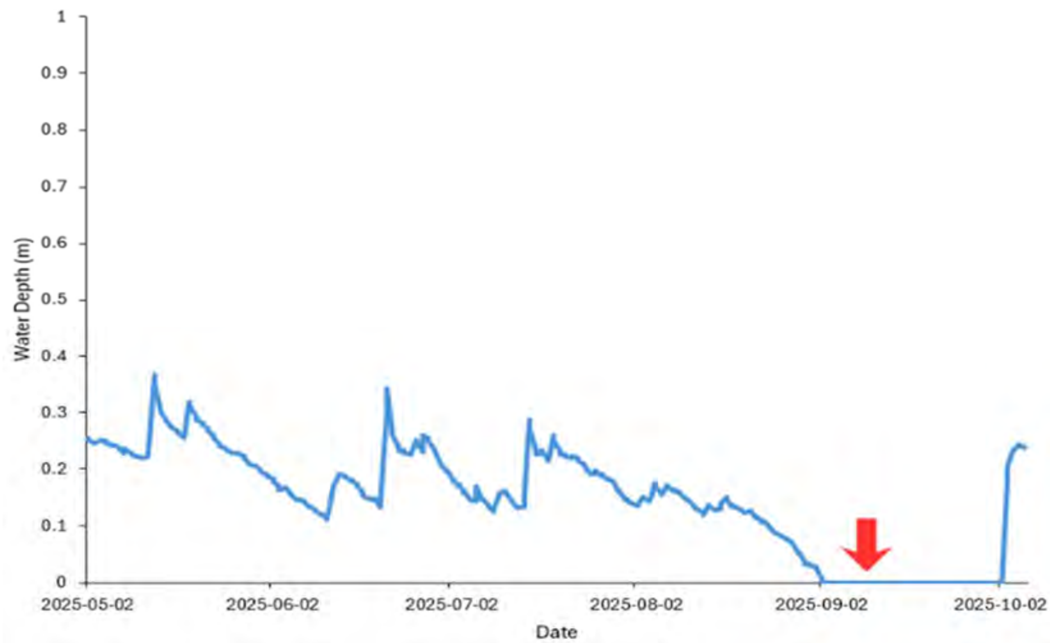

Figure 41. Water depth data from the water level logger (HOBO U-20) installed ~ 2 m upstream of DDA-01 in Double Dam. The red arrow indicates when construction began on September 10th, 2025.

At the second logger upstream of DDA-05, between May 1st and September 4th (when the water level dropped to 0 m) the average water depth was 0.19 m, with a maximum depth of 0.272 m on May 13th (Figure 42). Compared to water levels upstream of DDA-01 (Figure 41), the upper pond was less 'flashy'; increases in water depth were observed at the same time but resulted in much smaller increases in depth. This is likely because this logger is installed in an area of open water, which causes water to disperse more slowly and across a greater area (as opposed to the in-stream location of the downstream HOBO). There was no water recorded at the location of the HOBO between September 3rd and October 6th (logger collection date), and the open water area was visibly dry (Figure 43). Due to the lack of stream flow, it was not possible to immediately see the effects of water impoundment behind DDA-05; this logger will be installed in April 2026 to record next season's water levels.

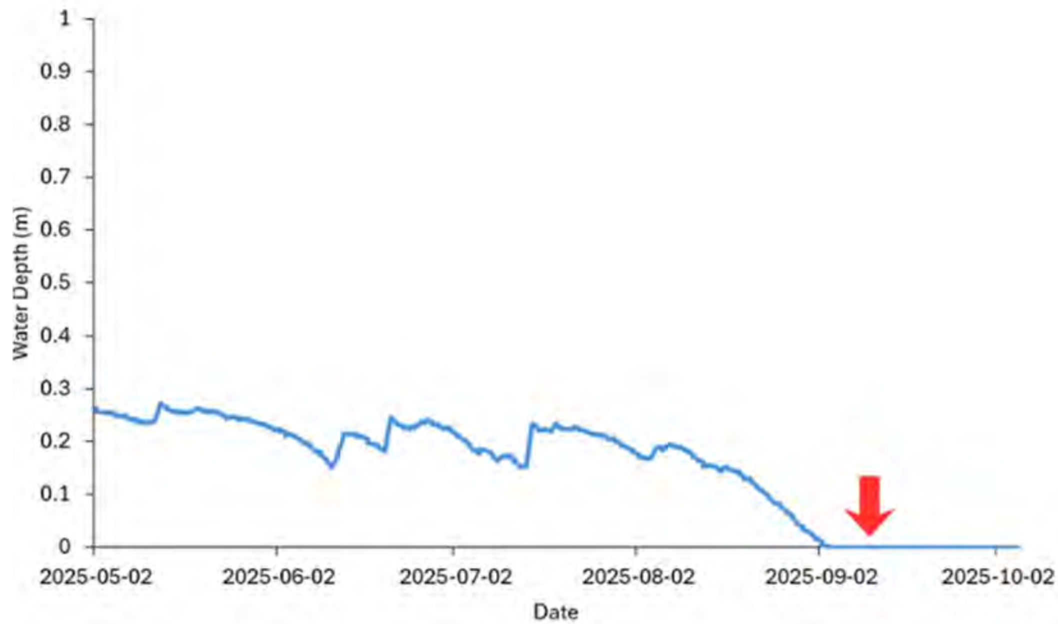

Figure 42. Water depth data from the water level logger (HOBO U-20) installed ~ 2 m upstream of DDA-05 in Double Dam.The red arrow indicates when construction began on September 10th, 2025.

Figure 43. Dry open water pool above remnant beaver dam and DDA-05 in Double Dam wetland.

The installed water level loggers also recorded temperature every four hours. The logger installed upstream of DDA-01 recorded a maximum temperature of 12°C on multiple days between August 3rd and 13th, while the minimum recorded temperature was 4.42°C recorded on May 2nd (Figure 44). The logger installed upstream of DDA-05 recorded a maximum temperature of 14°C recorded on August 4th and 5th and a minimum recorded temperature of 7.38°C on May 2nd (Figure 45). Water temperatures recorded in this location were on average higher than at the logger above DDA-01, as this logger was in an open water pool while the other was in the stream channel with flowing water.

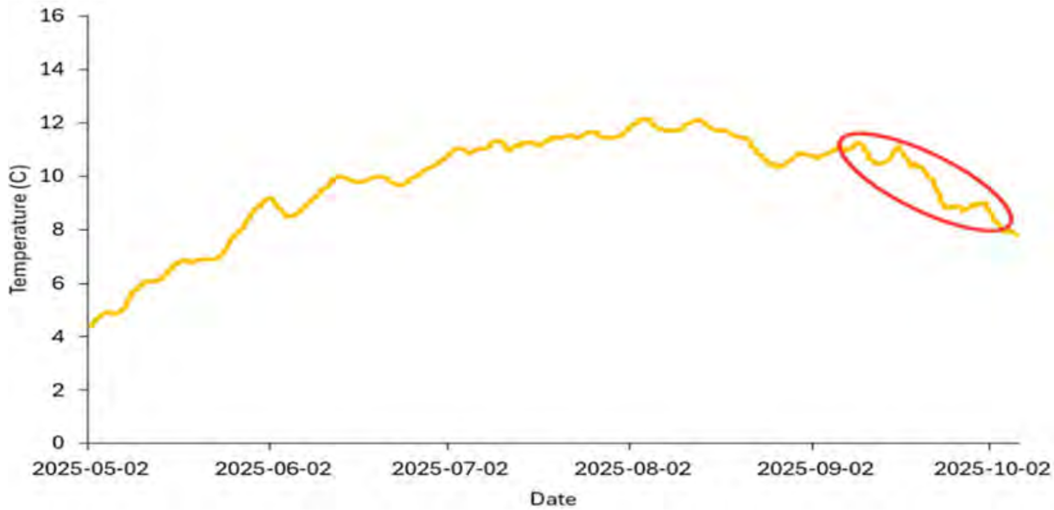

Figure 44. Temperature data from the water level logger (HOBO U-20) installed upstream of DDA-01 in Double Dam wetland. This logger was installed from May 1st to October 6th, 2025, to monitor stream temperatures pre- and post-construction. The red circle indicates the period when water levels were 0 m and so the temperature recorded is air temperature and not water temperature.

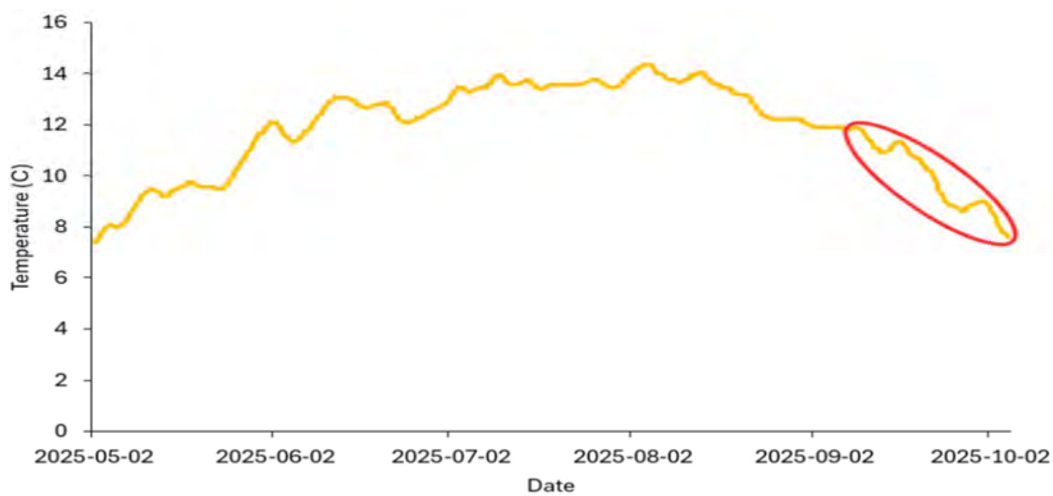

Figure 45. Temperature data from the water level logger (HOBO U-20) installed in open water pool upstream of DDA-05 in Double Dam. This logger was installed from May 1st to October 6th, 2025, to monitor stream temperatures pre- and post-construction. The red circle indicates the period when water levels were 0 m and so the temperature recorded is air temperature and not water temperature.

3.3.3 Flooded Area Mapping

We mapped pre-restoration flooded areas in Summer 2023 so that a comparison of open water flood extent achieved by the installed BDA and PAL structures could be evaluated. Due to the stream being dry during construction, and only slightly re-wetted by the end of the field season, these measurements were not repeated in 2025 as there were no immediate results of flooding at this site. We will therefore complete this in spring 2026, when we anticipate that flooding will have occurred.

3.4 Northbound – Built in 2025

CWSP built three BDAs and one PAL on September 11th, 2025, in the Northbound wetland site (Table 4, Figure 46). Northbound and Big Dam are located along the same stream, with Big Dam being downstream of Northbound. Thus, fewer structures were constructed in each individual wetland because the two sites were considered collectively. In constructing these dams, we increased water depth by 0.2 m above NOB01 and 0.3 m above NOB02, increased flooded area by 620 m^2, and improved wetland habitat across 5.49 ha.

Table 4. Dimensions and construction details of Beaver Dam Analogues and Post-Assisted Log Structures at the Northbound restoration site built in September 2025.

Structure	Width	Height	Depth	Type
NOB01	0.65 m	0.60 m	1.90 m	BDA - Full
NOB02	0.48 m	0.36 m	1.60 m	BDA - Full
NOB03	0.40 m	0.16 m	1.00 m	BDA - Full
NOB04	1.00 m	0.90 m	1.60 m	PAL

Figure 46. Drone photograph showing the locations of the proposed structures within CWSP Site "Northbound".

The stream flowing through this wetland remained flowing throughout 2025, and the wetland itself retained open water areas and saturated ground. Therefore, construction in this wetland happened ‘in the wet’ and required mitigation for turbidity increases, danger to fish, and danger to amphibians resulting from construction. We isolated each construction area using wire mesh installed within the stream to prevent fish and other wildlife from entering the work area (Figure 47). A temporary coffer dam was installed downstream to mitigate turbidity increases caused by sediment disturbance during in-stream work. Water quality was monitored upstream and downstream throughout the construction period, and the isolated section was electrofished to remove fish prior to construction.

Figure 47. Staff and volunteers constructing a Beaver Dam Analogue at the Northbound wetland restoration site in September 2025. A temporary mesh barrier is visible, functioning both as a turbidity curtain and to isolate the construction area.

As the stream was still flowing, we also constructed our BDAs slowly while monitoring stream flow and allowed the area behind the dams to fill slowly before building more dams (Figure 48 and 49). As with the Double Dam site, we also wanted to monitor downstream flow; as Big Dam is downstream of Northbound, we installed a water level logger downstream of that second wetland to monitor both wetlands; these data are discussed in section 3.5.

Figure 48. Crew uses a 'post pounder' to secure posts into the ground in Northbound wetland during BDA construction in September 2025.

Figure 49. Crews monitor the BDA's performance as water pools behind it, ensuring proper function before increasing its height or installing additional structures in Northbound wetland. September 2025.

3.4.1 Water Monitoring

In 2025 and 2024, CWSP installed two HOBO-U20 Water Level Loggers approximately 2m upstream of NOB-01 and NOB-02, to monitor pre-construction water depths. In 2025, these loggers were installed from May 3rd to October 6th, so they also recorded post-construction water depths. In 2024, these loggers were installed in the same locations from April 22nd to October 2nd.

These loggers will be re-installed for the remaining years of the project to continue to monitor water depth.

The open water area upstream of the remnant dam at NOB-01 was deeper in 2025 than in 2024, which differs from other trends observed in wetlands that CWSP monitors. The water level increase after construction is evident, with an increase of approximately 0.2 m, similar to peak water depth observed during freshet (Figure 50).

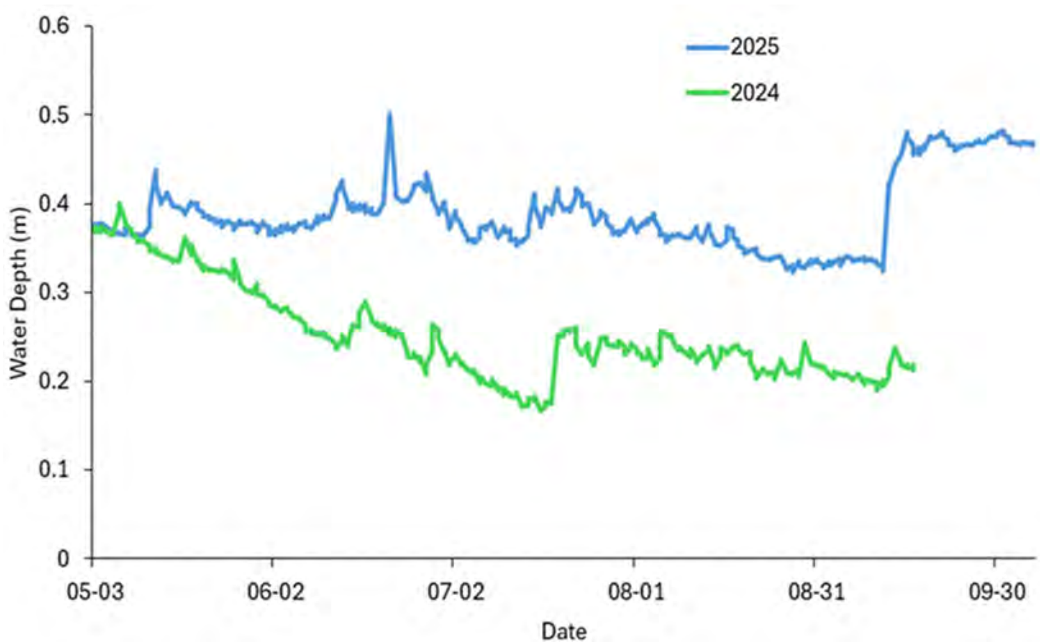

Figure 50. Water depth data from the water level logger (HOBO U-20) installed ~ 2 m upstream of NOB-01. This water level logger was installed from May 1st to October 6th, 2025, to monitor water depth pre- and post-construction in Northbound wetland.

Similarly to all other wetlands monitored by CWSP in this area, the water levels above NOB-02 were lower in 2025 than in 2024 - we hypothesise that this is due to less precipitation in this area. Like NOB-01, the water level increase after construction in this area of the wetland can be easily observed (Figure 51). The water level at the installed HOBO increases by approximately 0.3 m, which exceeds the water levels observed during freshet.

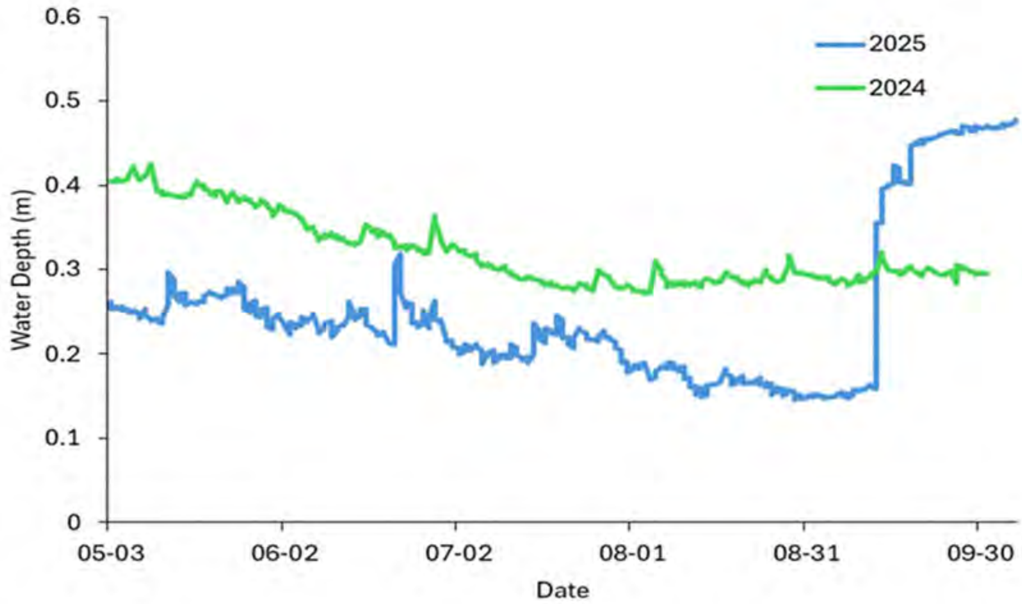

Figure 51. Water depth data from the water level logger (HOBO U-20) installed ~ 2 m upstream of NOB-02. This water level logger was installed from May 1st to October 6th, 2025, to monitor water depth pre- and post-construction in Northbound wetland.

The HOBO-U20 Water Level Loggers installed at this site (approximately 2 m upstream of NOB-01 and NOB-02) also record water temperature in the wetland. Upstream of NOB-01, average water temperature is similar in both years, recorded as 13.01°C in 2024 and 13.21°C in 2025 (Figure 52). Maximum and minimum temperatures varied between years, with 2024 experiencing a colder minimum of 4.83 °C and a warmer maximum of 18.01 °C, compared to 2025, which had a minimum of 7.28 °C and a maximum of 16.71 °C (Figure 52). This means that the range of temperatures in 2024 was greater at 13.21°C while in 2025 the temperature range was only 9.43°C. These differences are due to weather and temperature conditions unrelated to our work.

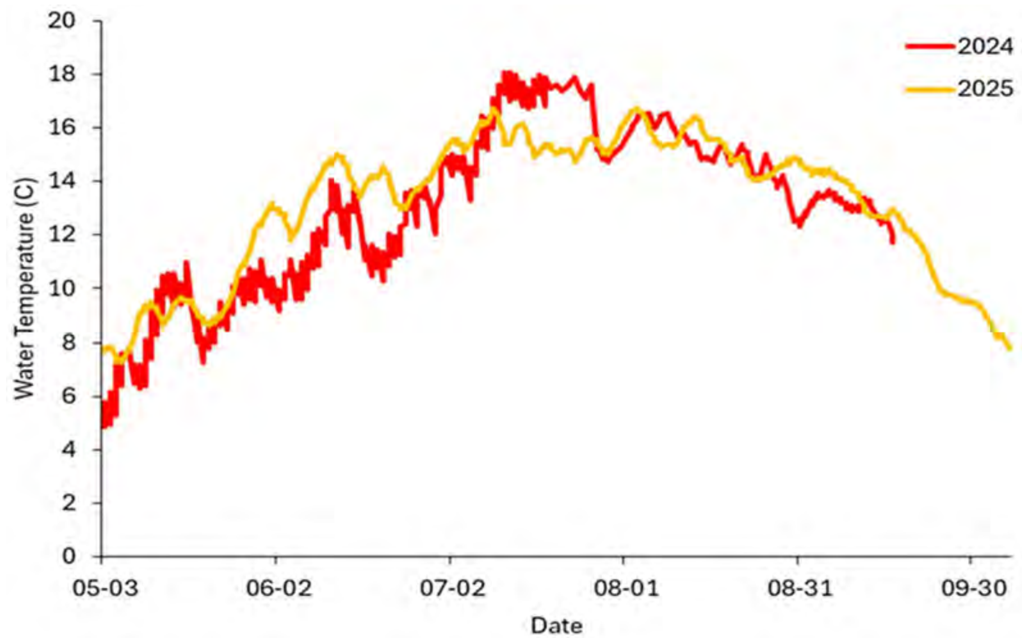

Figure 52. Temperature data in Northbound from the water level logger (HOBO U-20) installed ~ 2 m upstream of NOB-01.

Upstream of NOB-02, in 2024 the average temperature was 13.00°C, the maximum 18.90°C, and the minimum 5.35°C (Figure 53). In 2025, the average temperature was 13.91°C, the maximum 19.00°C, and the minimum 6.67°C. Thus, the average temperature is again similar between the two years, but the temperature range between the two years was more similar, being 13.55°C in 2024 and 12.32°C in 2025.

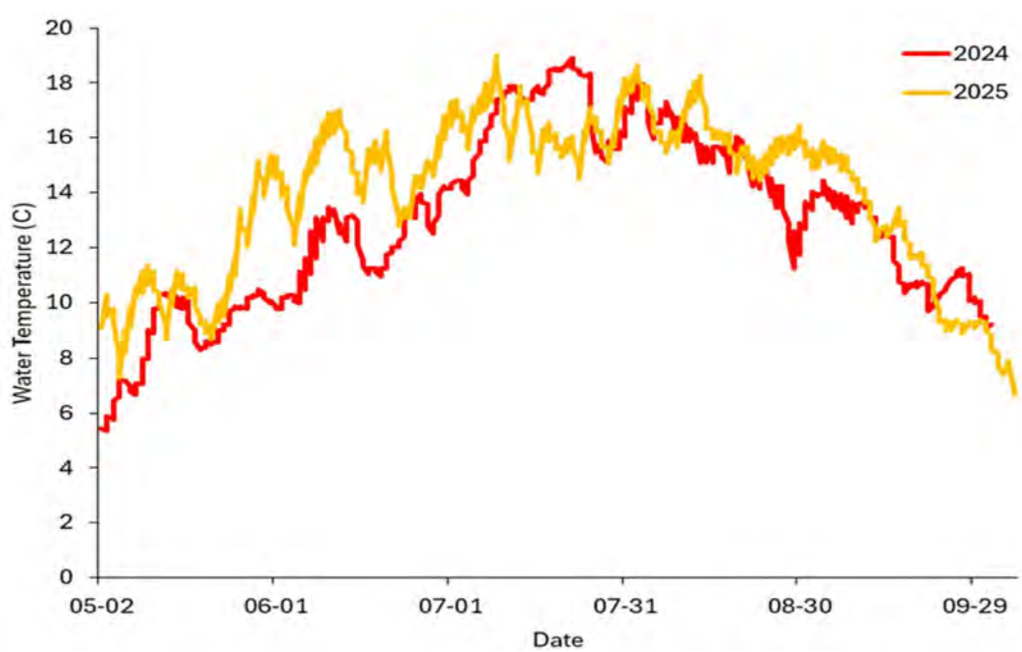

Figure 53. Temperature data in Northbound wetland from the water level logger (HOBO U-20) installed ~ 2 m upstream of NOB-02.

3.4.2 Flooded Area Mapping

We mapped flooded areas in both Summer 2023 (pre-restoration) and Fall 2025 (post-restoration) at the Northbound site to determine the extent of open water flooding due to the installed BDA and PAL structures (Figure 54). There are other flooded areas within this wetland (e.g., northern arm), but this analysis is only focused on areas upstream of constructed BDAs. The pre-restoration estimate of flooded areas near proposed BDA structures was ~ 290 m^2. After the installation of BDA and PAL structures, the new estimate of flooded area is 620 m^2. We anticipate that more flooding will be observed during high water, so flooded area mapping will be repeated in Spring of 2026, and will include all areas of open water in this wetland.

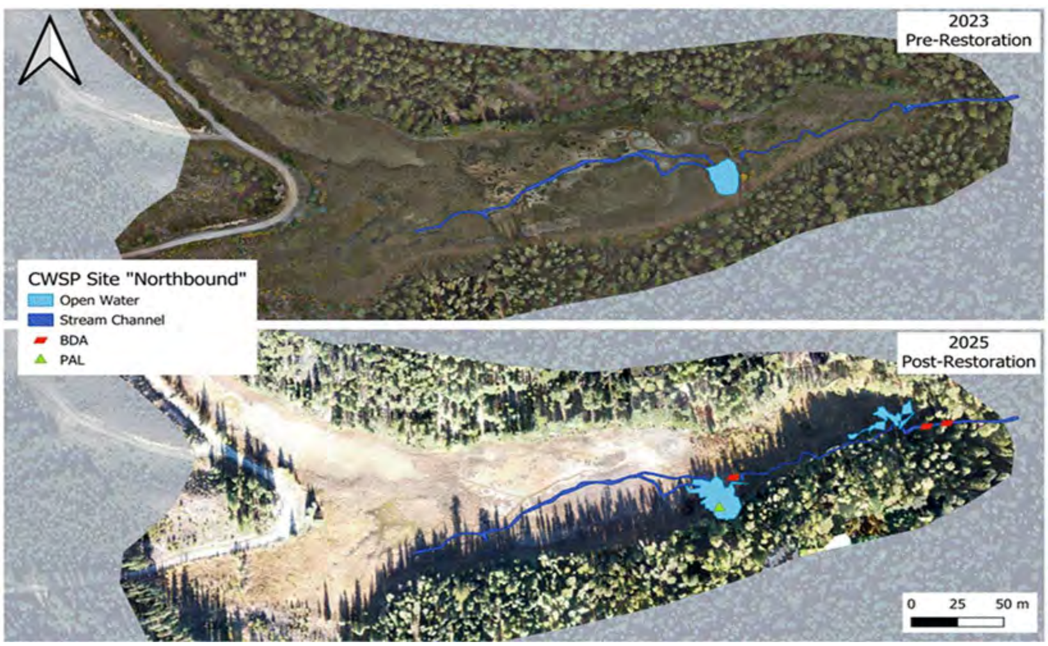

Figure 54. Areas of open water/flooding were mapped in the field using GIS applications (Avenza, ArcGIS Field Maps). Only flooded areas immediately upstream of a BDA are shown.

3.5 Big Dam – Built in 2025

CWSP built four BDAs and one PAL on September 12th, 2025, in the Big Dam wetland site (Table 5, Figure 55). Big Dam is downstream of Northbound, so we treated these two wetland sites as part of the same riverscape, building BDAs in both sites as part of the same whole system approach. In constructing these dams, we increased water depth by 0.26 m above BGD01, increased open water area by 1035 m^2, and improved wetland habitat across 4 ha.

Table 5. Dimensions and construction details of Beaver Dam Analogues and Post-Assisted Log Structures at the Big Dam restoration site built in September 2025.

Structure	Width	Height	Depth	Type
BGD01	2.00 m	0.45 m	0.70 m	BDA - Full
BGD02	3.80 m	0.40 m	0.75 m	BDA - Full
BGD03	0.55 m	0.25 m	0.70 m	BDA - Full
BGD04	1.15 m	0.40 m	0.50 m	BDA - Full
BGD05	1.30 m	0.60 m	1.10 m	PAL

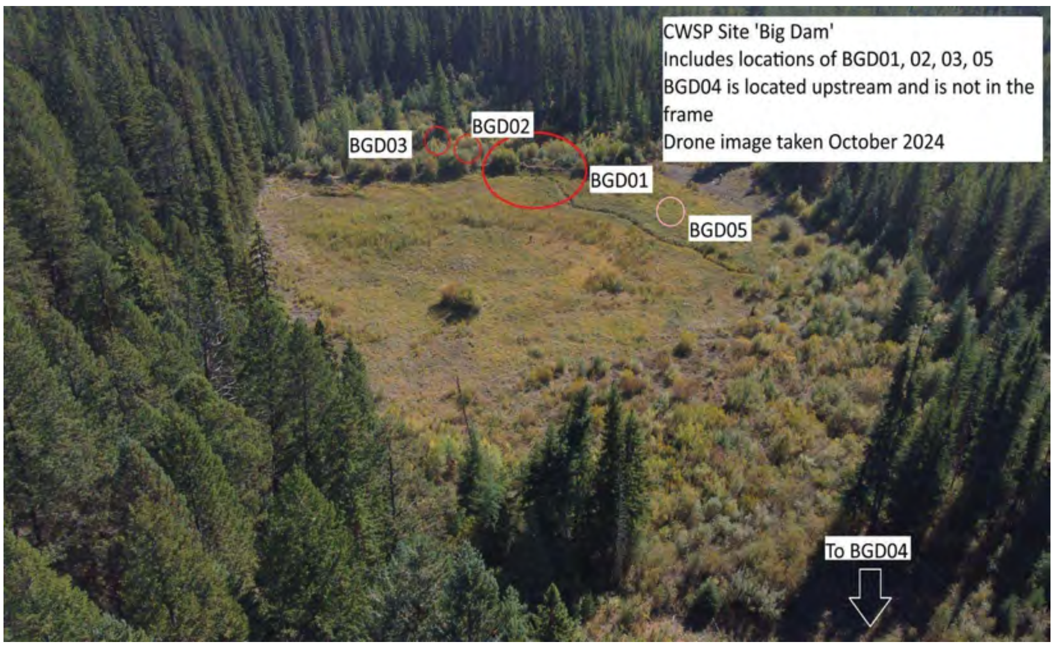

Figure 55. Drone photograph showing the locations of the proposed structures within CWSP Site "Big Dam".

This stream remained flowing through both sites, and so we took the same precautions as detailed in Section 3.4 Northbound during construction. At one point during construction, we observed stream flow visibly decreasing, and so halted construction and removed the top section of the BDA upstream to allow the stream to recover. With these precautions, the stream remained flowing and the stream channel remained wetted throughout.

The water level logger installed downstream of the site monitored stream water depths pre-, during, and post-construction. Pre-construction, the logger recorded an average water depth of 0.35m. During construction, an average water depth of 0.25 m was recorded. This is a decrease of 0.10 m in depth, which is an approximately 29% decrease, which we did not consider a significant reduction in flow. In the week post-construction, the average water depth was 0.32 m, a decrease of 0.03 m from the pre-construction average. Water levels decreased on September 17th and remained lower, on average, than pre-construction measurements. We do not think that this was due to our activities and is likely a natural late season decrease in water availability (Figure 56).

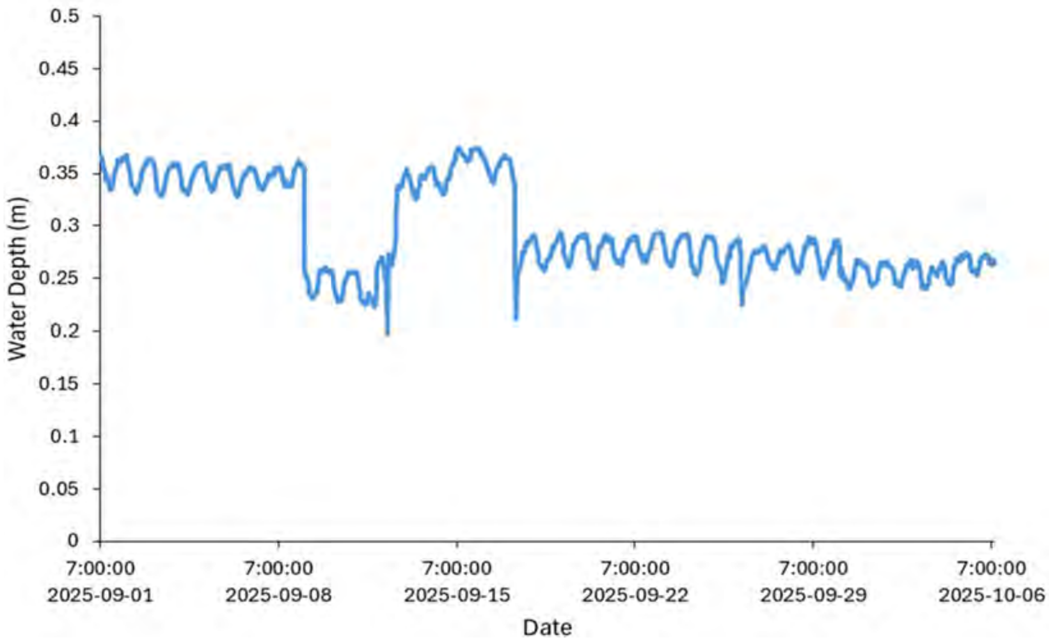

Figure 56. Water depth data from the water level logger (HOBO U-20) installed ~ 50 m downstream of the 'Big Dam' restoration site. This position is therefore downstream of both 'Northbound' and 'Big Dam'. This water level logger was installed from September 1st to October 6th, 2025, to monitor downstream flows before, during, and after BDA construction.

As with our other sites, BDA and PAL construction was completed by hand, with employees and volunteers from CWSP, Cirque Ecological, and Living Lakes Canada.

Figure 57. A completed Beaver Dam Analogue that was constructed at Big Dam in September 2025.

Figure 58. Crews construct a BDA in the background of Big Dam wetland while a team member conducts a visual amphibian survey in the foreground.

3.5.1 Water Monitoring

As CWSP did not identify this as a potential restoration site until the fall of 2024, we did not monitor water levels in the Big Dam wetland until 2025. We installed a HOBO-U20 Water Level Logger approximately 2 m upstream of BGD-01 on April 30th, 2025, to monitor pre-construction water depths (Figure 59). As this logger remained installed until October 6th, 2025, it also recorded post-construction water depths. This logger will be re-installed for the remaining years of the project to continue to monitor water depth.

Between April 30th and September 7th (i.e. pre-construction) the average water depth was 0.19 m (Figure 19). Between September 13th and October 7th (i.e. post-construction) the average water depth was 0.39 m, with a maximum depth of 0.45 m. This is an increase of approximately 0.26 m in the area immediately upstream of the remnant beaver dam. Due to the low flow of this stream, the water levels slowly increased after construction. Deeper water depths were not reached until October when more flow had returned to the system.

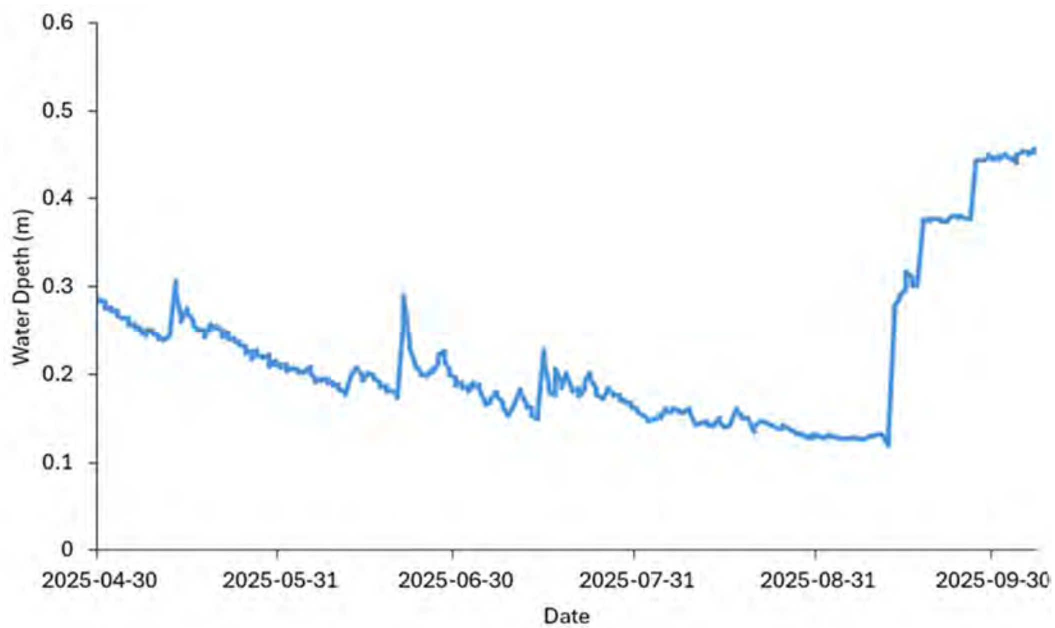

Figure 59. Water depth data from the water level logger (HOBO U-20) installed ~ 2 m upstream of BGD-01. This water level logger was installed from April 30th to October 6th, 2025, to monitor water depth pre- and post-construction in Big Dam.

The HOBO-U20 Water Level Loggers installed at this site (approximately 2 m upstream of BGD-01) also records water temperature (Figure 60). As expected, water temperature increased over the summer months reaching a maximum temperature of 14.80°C on August 2nd, 2025. The minimum recorded temperature was 4.00°C and was recorded on May 5th.

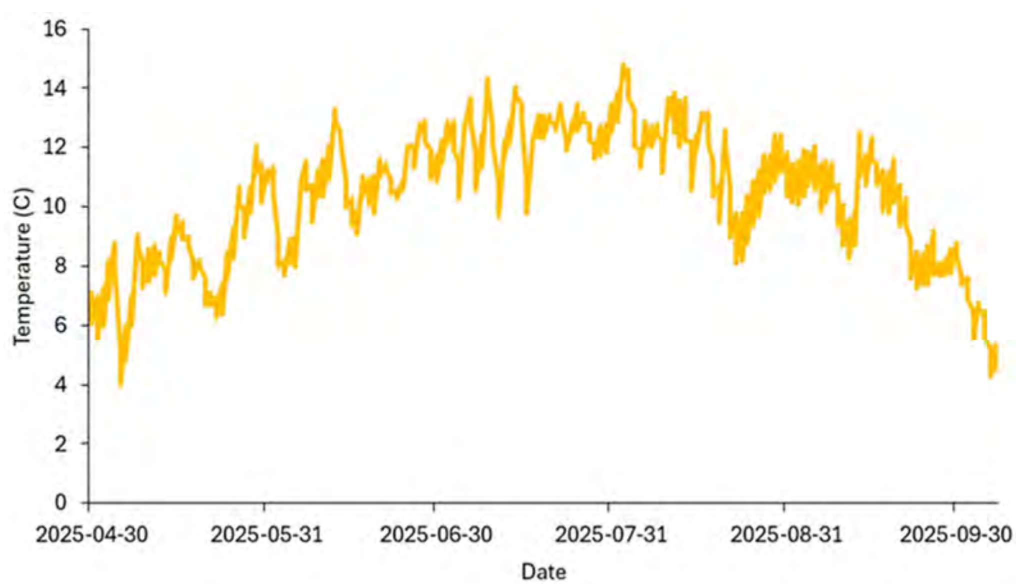

Figure 60. Temperature data from the water level logger (HOBO U-20) installed ~ 2 m upstream of BGD-01 in Big Dam wetland.

3.5.2 Drone Imagery and Flooded Area Mapping

From drone imagery we estimated the 2024 open water flooded area to be 380 m^2. The post-restoration flooded area mapping shows that the current flooded area has increased to 1415 m^2 (Figure 61). We anticipate that there will be more flooding in spring 2026, when water levels are at peak volume.

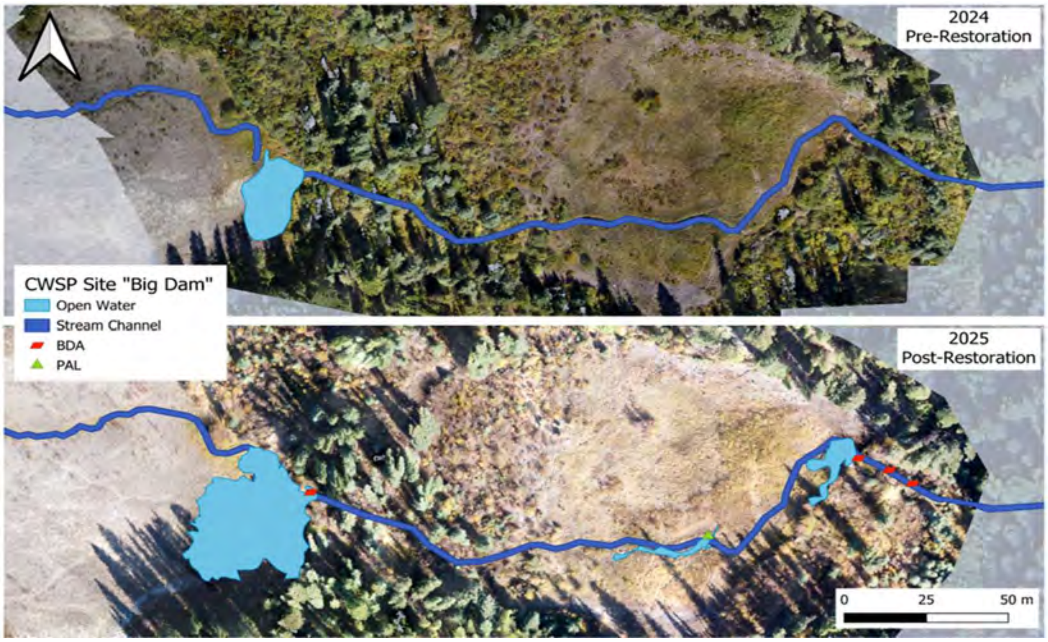

Figure 61. Areas of open water/flooding in Big Dam wetland were mapped in the field or based on drone imagery.

3.6 Limbo – Built in 2025

CWSP built seven BDAs and three PALs on September 8th and 9th 2025 in the Limbo wetland site (Table 6, Figures 62 to 64). In constructing these dams, we increased water depth by 0.24 m above LIM01, increased open water flooded area by 1684 m^2, and improved wetland habitat across 1.03 ha. Limbo was the wetland with the largest stream that we built BDAs within in 2025, and therefore water levels and flooded areas in this wetland responded faster than they did in any of our other sites (Figure 64).

Table 6: Dimensions and construction details of Beaver Dam Analogues and Post-Assisted Log Structures at the Limbo restoration site built in September 2025.

Structure	Width	Height	Depth	Type
LIM01	2.54 m	0.46 m	0.9 m	BDA - Full
LIM02	3.55 m	0.27 m	0.85 m	BDA - Full
LIM03	0.75 m	0.45 m	1.5 m	BDA - Full
LIM04	2.1 m	0.3 m	0.7 m	BDA - Full
LIM05	1.8 m	0.7 m	1.35 m	PAL
LIM06	1.65 m	0.75 m	1.3 m	PAL
LIM07	2.45 m	0.5 m	1.3 m	BDA - Full
LIM08	2.6 m	0.3 m	1.0 m	BDA - Full
LIM09	1.1 m	1.1 m	0.75 m	PAL
LIM10	2.75 m	0.21 m	0.62 m	BDA - Full

Figure 62: Drone photograph showing the locations of the proposed structures within CWSP Site "Limbo".

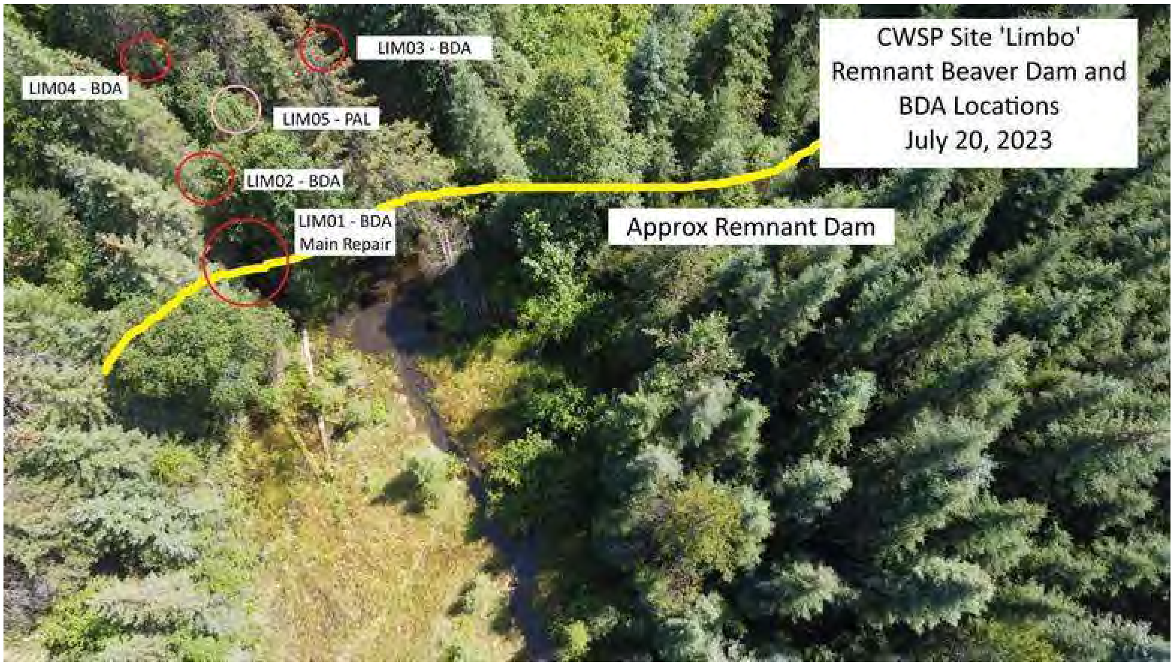

Figure 63: Drone photograph showing the locations of the proposed structures within CWSP Site "Limbo".

Figure 64: Post-construction drone image in Limbo showing PAL LIM-06, BDA LIM-10, PAL LIM-09, and BDA LIM-07, and associated flooding.

The stream flowing through this wetland remained flowing throughout 2025, and the wetland itself retained open water areas and saturated ground. Therefore, construction in this wetland happened 'in the wet' and required mitigation for turbidity increases, danger to fish, and danger to amphibians resulting from construction. We isolated each construction area using wire mesh installed within the stream to prevent fish and other wildlife from entering the work area (Figure 65). A temporary coffer dam was installed downstream to mitigate turbidity increases caused by sediment disturbance during in-stream work. Water quality was monitored upstream and downstream throughout the construction period, and the isolated section was electrofished to remove fish prior to construction.

Figure 65: In-stream isolation (fine-mesh window screening secured with rebar posts and rocks) set up around LIM-08 on September 8th, 2025. This image was taken after fish salvage was finished and crews began to install vertical wooden posts in Limbo wetland.

Figure 66: Electrofishing to ensure no fish remain in the isolated work site in Limbo wetland. All electrofishing was conducted by qualified personnel.

As the stream flowing through this wetland was larger than those in any of our other sites, water backed up rapidly behind the BDAs during construction and stream flow remained strong and consistent throughout construction. Construction was completed by hand, as with other BDAs (Figures 67 and 68).

Figure 67: Pounding posts into the Limbo stream for BDA structure; PAL post-construction.

Figure 68: Structure LIM-10 immediately post-construction and six weeks later on October 29th, 2025 in Limbo Wetland..

3.6.1 Water Monitoring

As we are working in small streams and wetlands, there are concerns that while building BDAs, downstream flow may be interrupted. Thus, we installed a water level logger downstream of the construction site to monitor the stream flow before, during, and after construction (Figure 69). The average water depth recorded by the downstream HOBO logger the week before construction (September 1st – September 7th) was 0.27 m. The largest reduction in water depth during construction on September 8th and 9th was 0.02m, indicating that construction had a negligible effect on this stream, as did water depth returning to pre-construction average after construction.

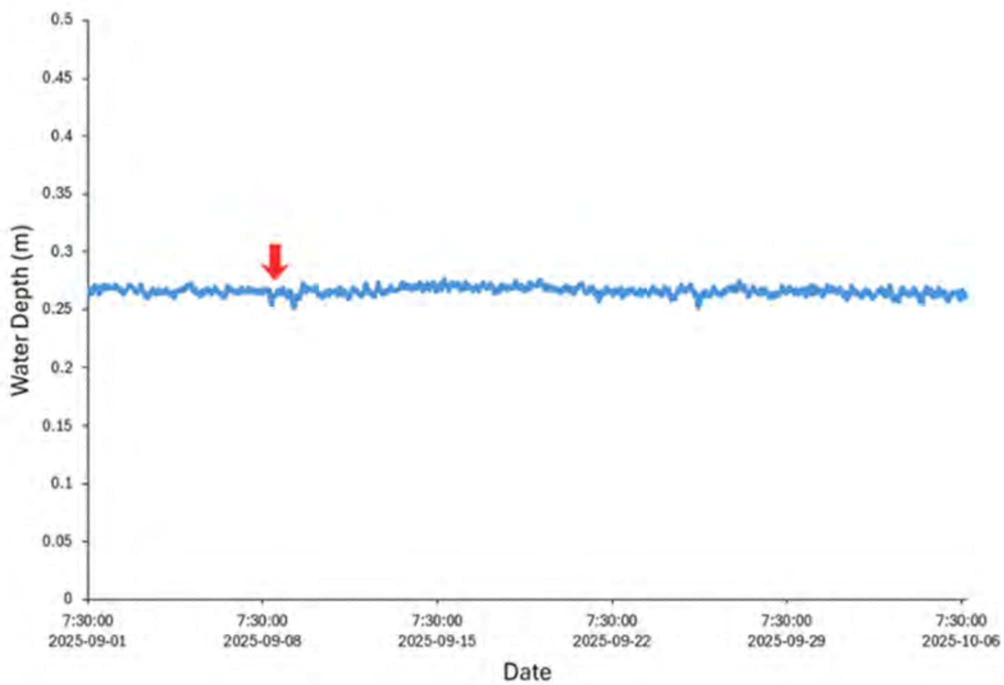

Figure 69: Water depth data from the water level logger (HOBO U-20) installed ~ 50 m downstream of the project site in Limbo wetland. This water level logger was installed from September 1st to October 7th, 2025, to monitor downstream flows before, during, and after BDA construction. The red arrow indicates when construction began on September 8th, 2025.

A HOBO-U20 Water Level Logger was installed approximately 2m upstream of LIM-01 on April 30th, 2025, to monitor pre-construction water depths. As this logger remained installed until October 7th, 2025, it also recorded post-construction water depths. This logger will be re-installed for the remaining years of the project to continue to monitor water depth.

Between April 30th and September 7th (i.e. pre-construction) the average water depth was 0.51 m. Variation was small, with the maximum depth recorded being 0.54 m and the minimum 0.48 m. Between September 10th and October 7th (i.e. post-construction) the average water depth was 0.749 m, showing an increase in water depth of 0.24 m. Variation in water depth in this period was also low, varying between 0.76 m and 0.73 m (Figure 70).

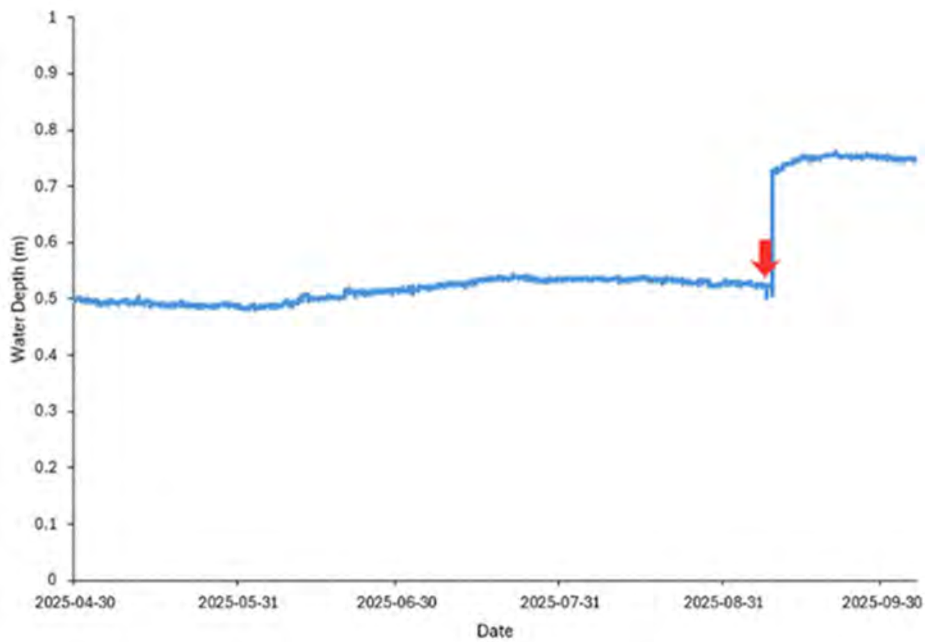

Figure 70: Water depth data from the water level logger (HOBO U-20) installed ~ 2 m upstream of LIM-01 in Limbo Wetland. This water level logger was installed from April 30th to October 7th, 2025, to monitor water depth pre- and post-construction. The red arrow indicates when construction began on September 8th, 2025.

3.6.2 Drone Imagery and Flooded Area Mapping

We mapped open water flooded areas in Summer 2023 (pre-restoration) and Fall 2025 (post-restoration) to visualise the increase in flooding post-construction (Figure 71). The pre-restoration estimate of open water areas within this wetland was ~ 58 m^2. After the installation of BDA and PAL structures, the new estimate of open water area is 1,742 m^2. Water also extended out into the vegetated areas providing water to the hydrophytic vegetation. We predict that more open water will be observed during high water, so flooded area mapping will be repeated in Spring of 2026.

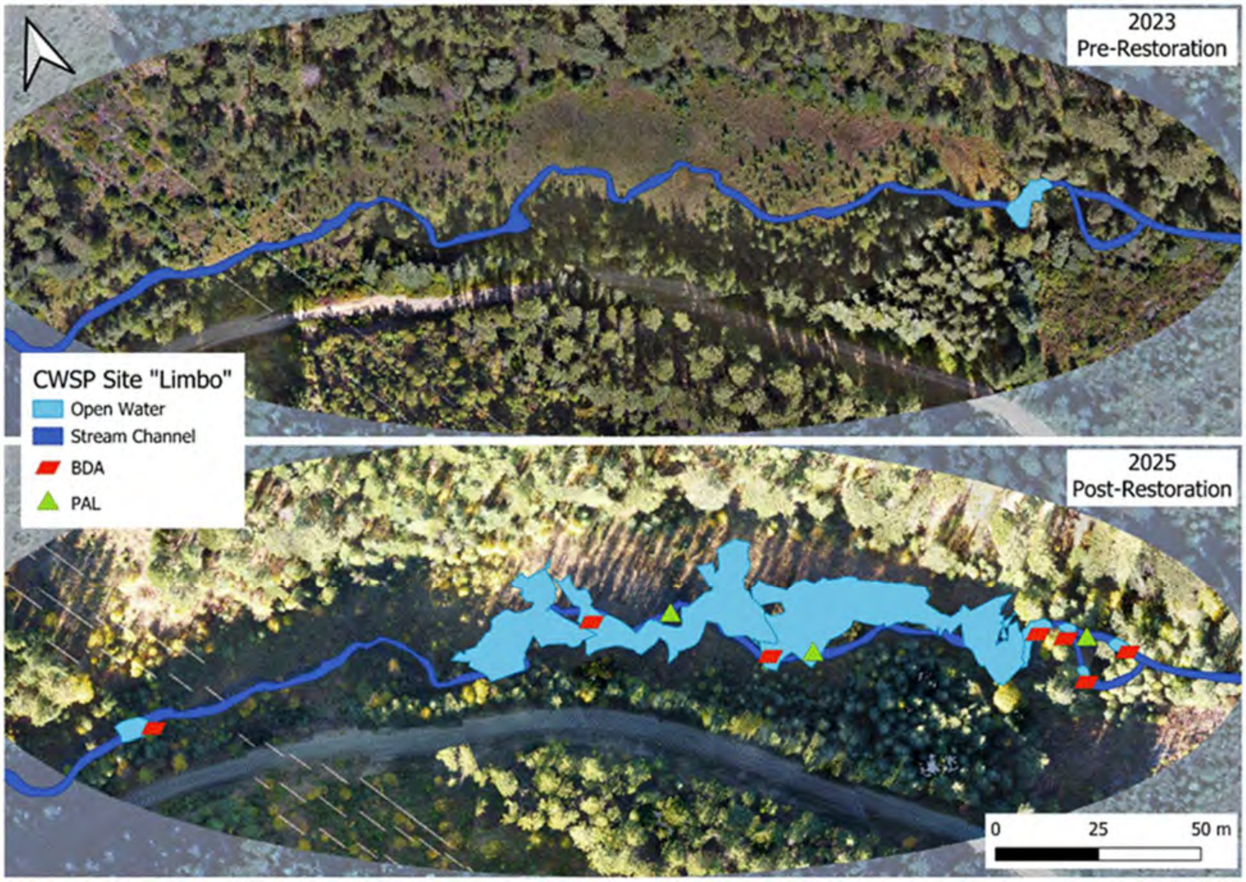

Figure 71: Areas of open water/flooding in Limbo Wetland were mapped in the field using GIS applications (Avenza, ArcGIS Field Maps).

As this wetland had a strong water source at the time of construction and little pen water area prior to construction, the increase in wetland flooding was more visible in this wetland than in our other restoration wetlands and can be seen from drone photos (Figure 72 and 73).

Figure 72: Drone image highlighting flooding achieved upstream of LIM-10 in Limbo Wetland.

Figure 73: Drone image highlighting flooding achieved around LIM-07 in Limbo Wetland.

3.7 Plans for 2026

CWSP assessed many wetland sites for restoration potential using BDAs and we have selected five wetlands for restoration in fall 2026 (pending permit approval). Three of these wetlands are sites that have been monitored in previous years by CWSP, while two of these sites were identified in 2025 and thus pre-restoration monitoring will begin in summer 2026. These two new sites are also in the expanded regions of CWSP's study area along the western upland bench, with one site west of Parson (further north than previous efforts) and one site west of Canal Flats (further south than previous efforts). These sites have been named Rand Creek, Sam's Folly Outflow, Leadqueen, Copper, and Rocky Point, and their locations are indicated on Figure 74. In total we plan to build 56 BDAs and 11 PALs within these five sites. The number and locations of the proposed structures (56 BDAs and 11 PALs within all five sites) at these sites are indicated on Figures 75 to 79. These wetland restoration projects are projected to restore 26.89 ha of wetland habitat.

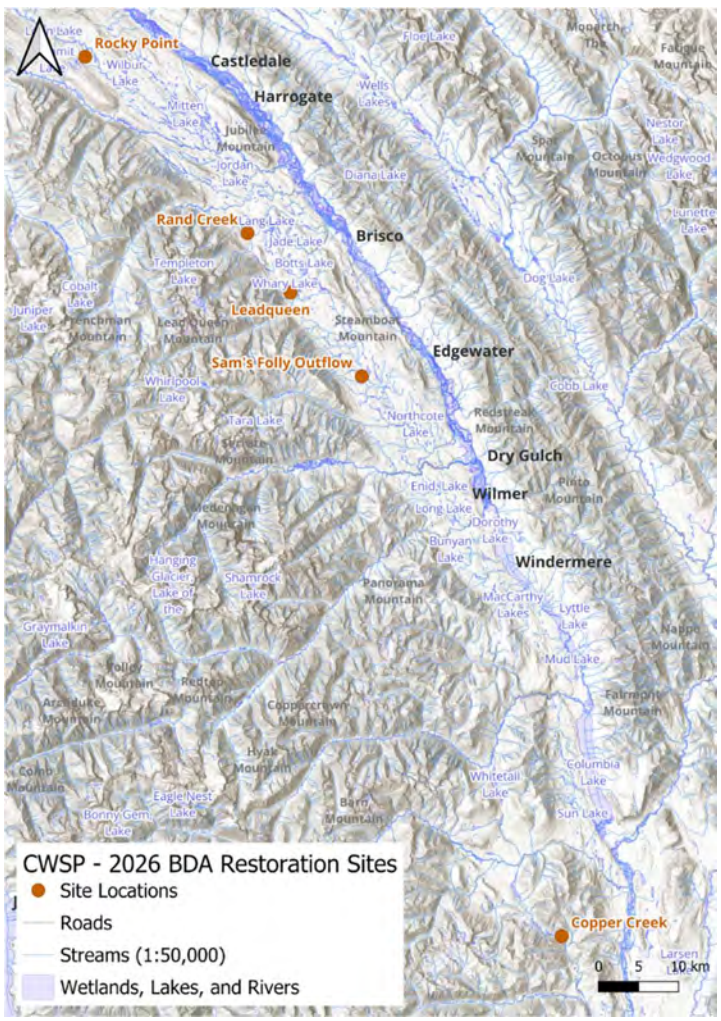

Figure 74: Map of CWSP's restoration sites that will be completed in fall 2026.

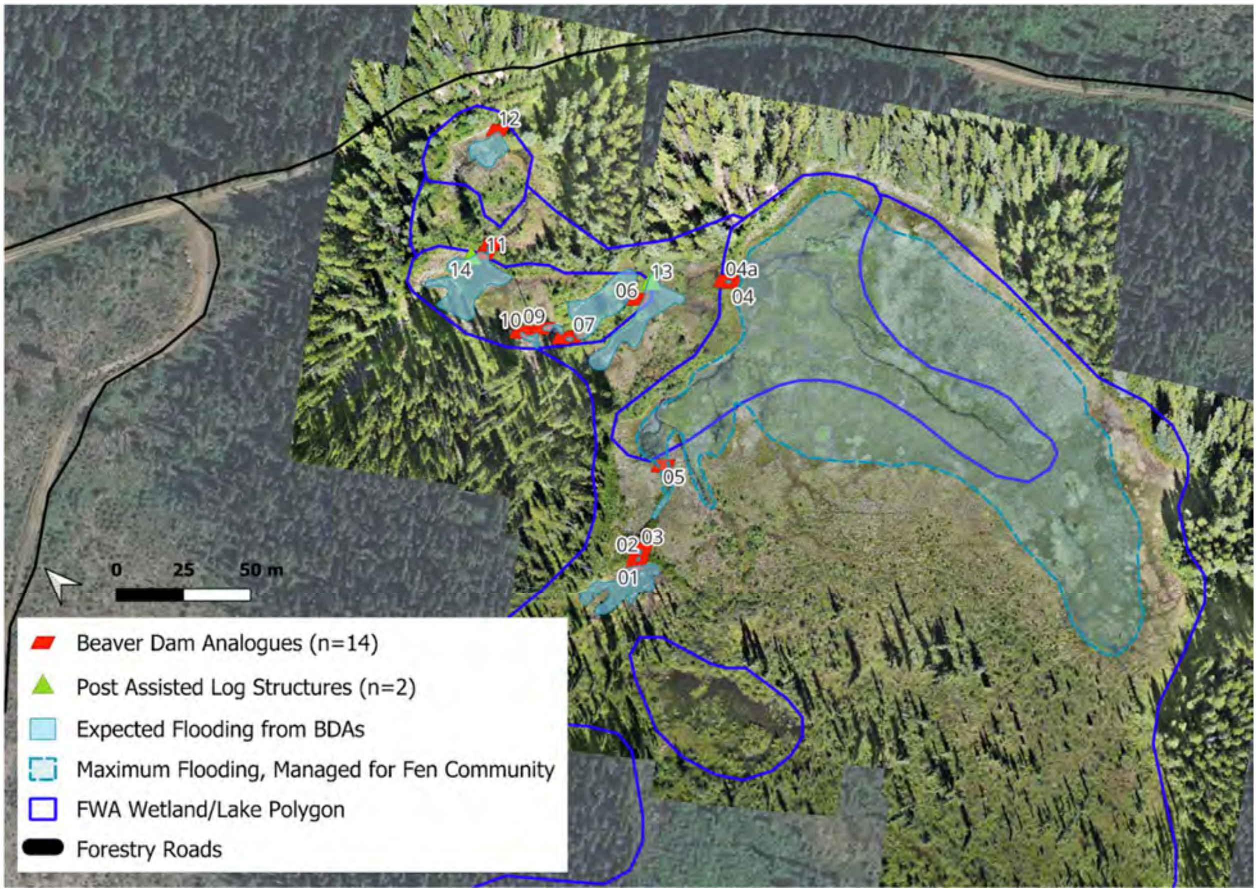

Figure 75: Restoration design for CWSP Site 'Rocky Point' near Parson, BC. There is a fen community within this site that shows signs of drying. This restoration site will be adaptively managed to provide the most water to the fen community without over-flooding it. This restoration site also aims to add depth to existing areas of open water where there is visible evidence of draw-down.

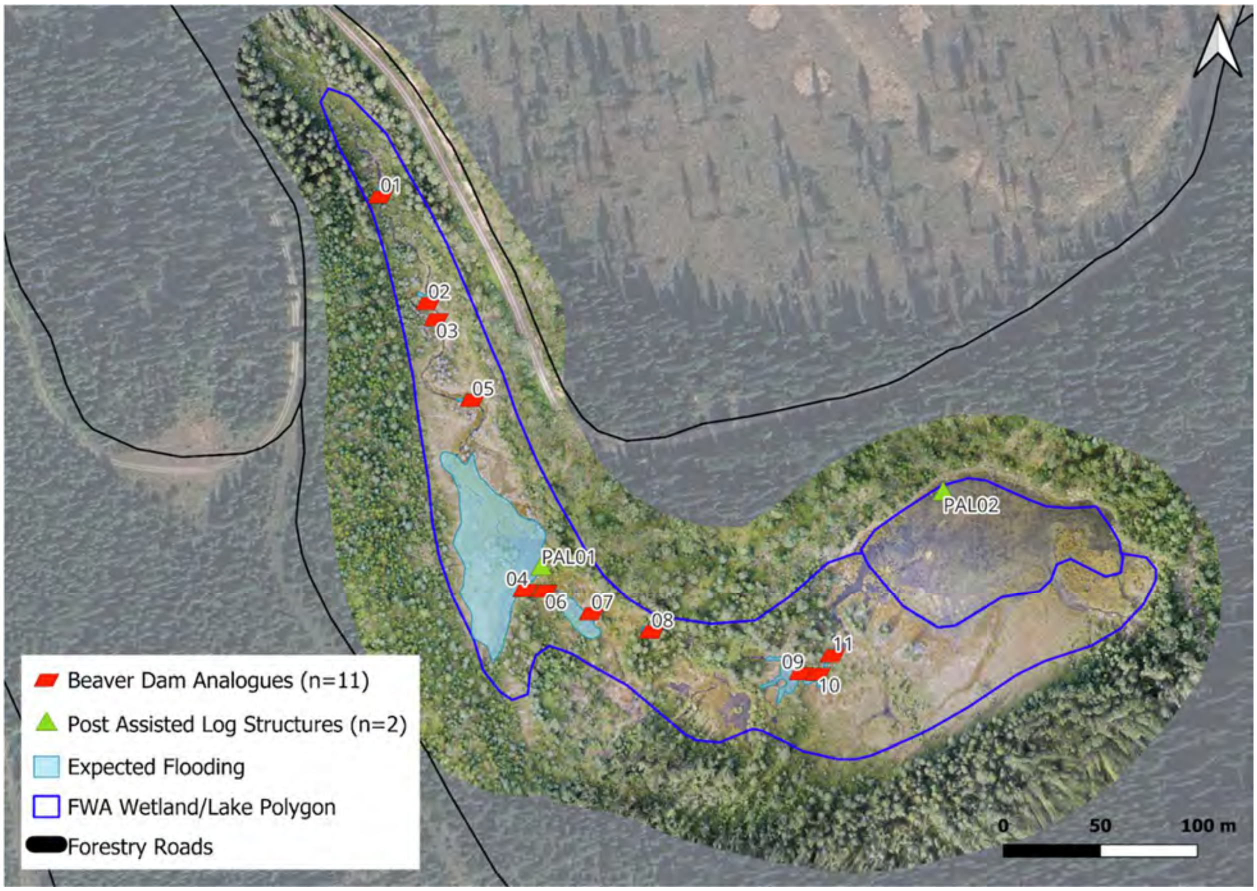

Figure 76: Restoration design for CWSP Site 'Rand Creek' near Brisco, BC. The restoration objective for this site is to reconnect water to the floodplain, increase areas of open water, and improve wetland habitat for the wetland species using this wetland.

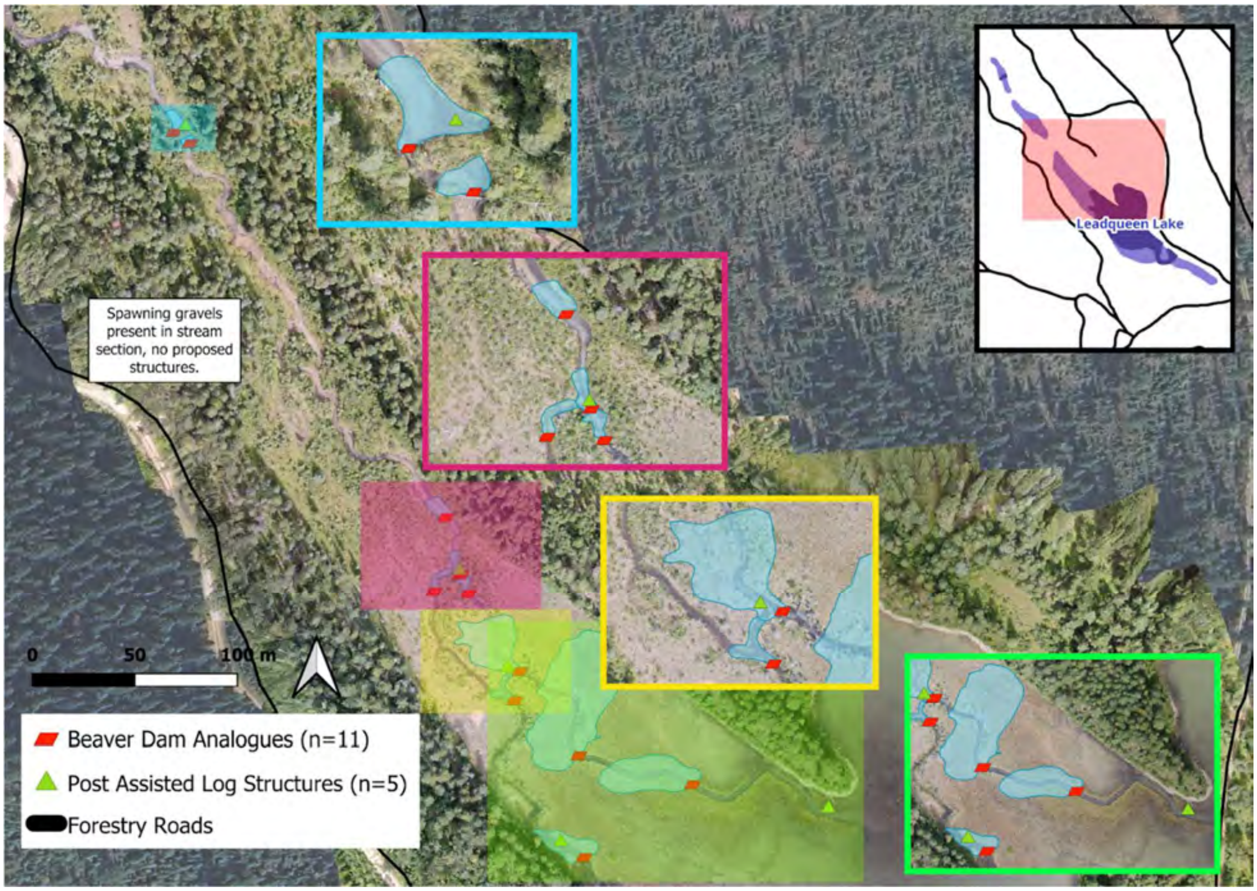

Figure 77: Restoration design for CWSP Site 'Leadqueen' near Brisco, BC. The restoration objective for this site is to reconnect water to the floodplain, increase areas of open water, and improve habitat conditions for the wetland plants observed in isolated pock

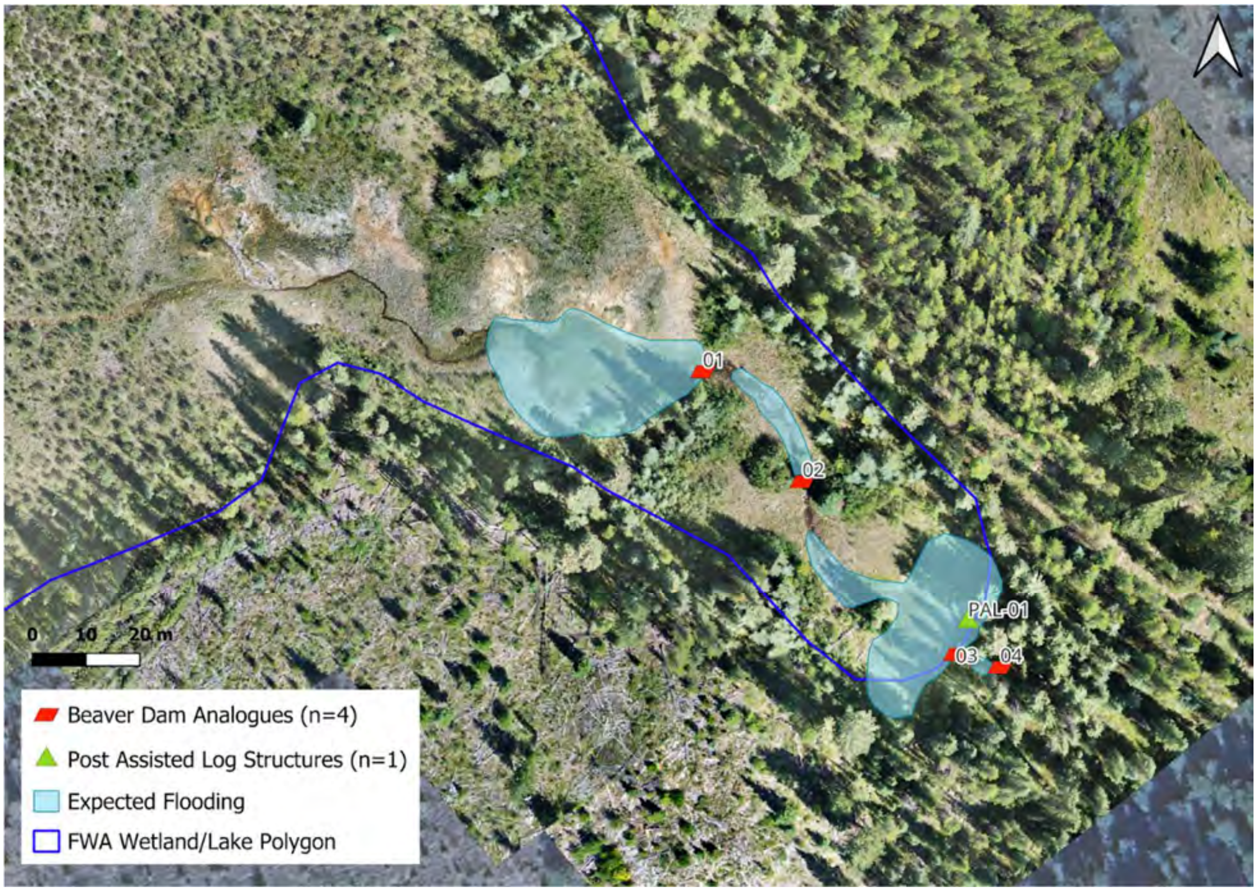

Figure 78: Restoration design for CWSP Site 'Sam's Folly Outflow' near Brisco, BC. The restoration objective for this site is to increase shallow open water habitat and shallow open water edge habitat to improve conditions for the nesting Solitary Sandpipers observed in 2025, a species dependent on small wetlands in forest for breeding habitat. Increasing water stored in this wetland will also improve habitat for other wetland species such as the orchid Hooded Lady's Tresses Spiranthes romanzoffiana *and Common Spike-rush* Eleocharis palustris *both observed in this site.*

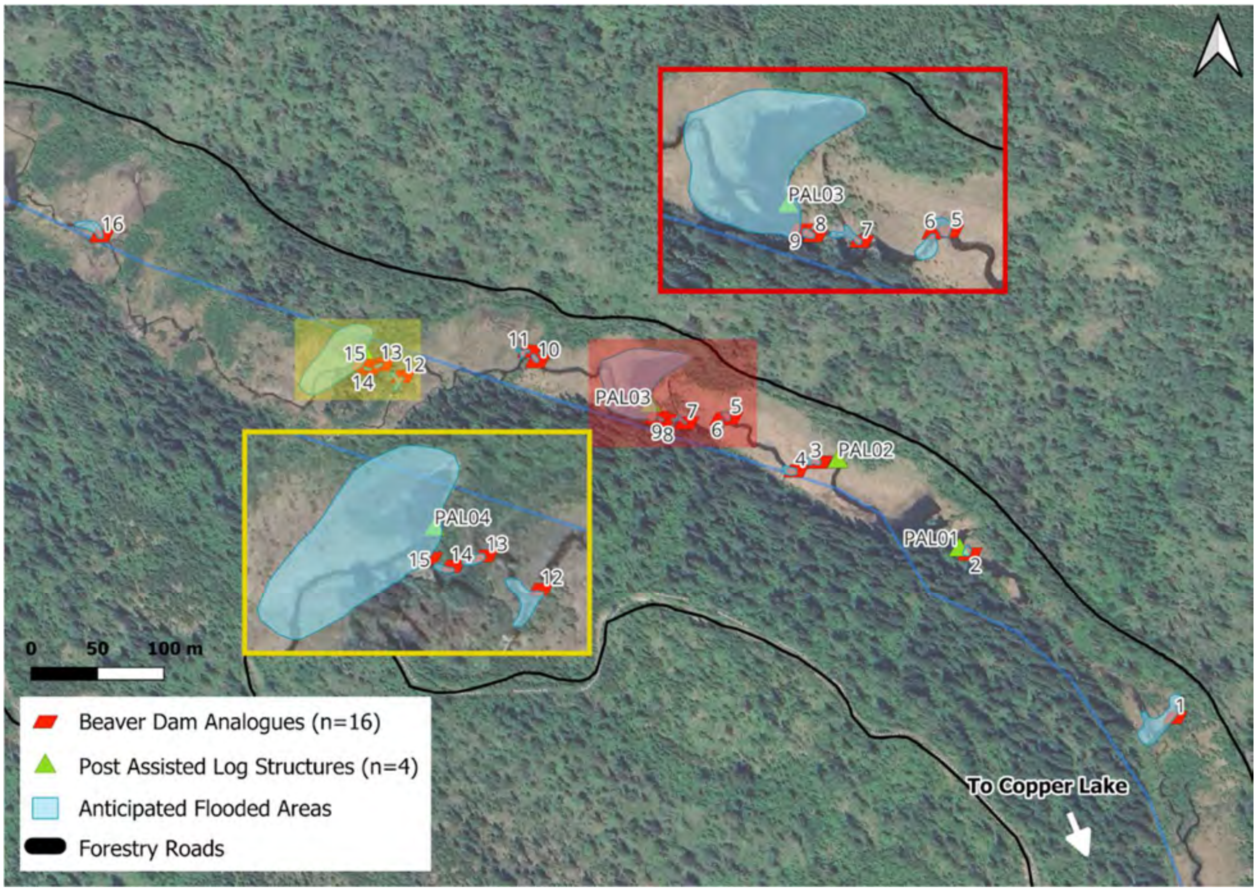

Figure 79: Restoration design for CWSP Site 'Copper' near Canal Flats, BC. The goal of this restoration site is to reconnect water to the floodplain and create more open water habitat.

3.8 Permitting Requirements and Challenges

Beaver Dam Analogues (BDAs) require in-stream work permits under the *Water Sustainability Act.* The only option for NGOs to construct BDAs on provincial crown land is a Section 11 Change Approval Permit for "Changes in and About a Stream"; however, these permits are limited to a storage of 10,000 m^3. If a project exceeds the 10,000 m^3 storage amount, a Water License is required which NGOs cannot hold on provincial crown land. CWSP also explored the route of having the Shuswap Band, as a government entity, hold the water license on crown land but this route was denied by the province. As such, BDA projects are limited to a storage capacity of 10,000 m^3 which limited what work CWSP could complete within some wetlands. NGOs can work with private land owners to obtain Water Licenses for works over 10,000 m^3 on private lands.

The Section 11 Change Approval permit application requires preparation of an Environmental Management Plan (EMP), geospatial files, and short answers to questions included in the online permit portal submission. The EMPs for our applications are between 60 and 100 pages, and are required by the province to describe, at minimum, the following project components:

- Project Description and Objectives
  - Description of activities, strong rationale for chosen location, what will be restored, what specific issues have been noted that need to be addressed.
    - Information must be provided for both the watershed and local scale
  - Measurable and qualitative project objectives
- Applicable Legislation
  - Includes federal, provincial, and local legislation that applies to the project and all permits that are required for the project
- Current State and Pre-Project Monitoring (include items below as relevant, additional items may be needed)
  - Hydrology (mean annual discharge, flood and low flow regimes)
  - Vegetation
  - Water temperature/Other Physical Parameters
  - Slope of relevant stream reaches
  - Confinement
  - Surface/Groundwater Connection
  - Sources of Large Woody Debris
  - Aquatic Ecology (fish, amphibians, species at risk)
  - Terrestrial Ecology (for flooded or impacted areas)
    - Current condition of land and habitat, species at risk which may be impacted by flooded areas
  - Presence of beaver and/or existing beaver dams
  - Current Land Uses (i.e., range, trapping, forestry)
  - Land ownership
  - Local Infrastructure (e.g., roads, culverts, residences)
  - Downstream Water Licensees
  - Archaeology potential and any pre-project studies completed
    - Requires submission of site boundaries to BC Archaeology team for review
  - First Nations outreach/support/project partners
- Project Design
  - Size, type, exact location, and number of structures
  - Approximate water storage behind each structure

- Approximate water storage for all structures proposed in same system
  - Approximate flooded area associated with structures
  - Source of wood, sediment, and other materials required for building the structures
  - Anticipated life span of structures
  - Additional planting and invasive species management
  - Beaver and beaver management
  - Anticipated maintenance (when, how often, over what time period)
  - Effectiveness monitoring – monitoring plan and what metrics will be monitored. Should include "goals" for the metrics.
- Coarse Risk Assessment
  - Using the "Risk Considerations Checklist" from the low-tech process based restoration of riverscapes design manual (Wheaton, et al., 2019).
- Potential Impacts
  - Describe potential impacts to the environment, land users, infrastructure, water licensees, archaeological resources and First Nations from your project
  - Most consider impacts during and post-construction.
- Mitigation Measures
  - Water quality
  - Erosion and sediment control
  - Water quantity
  - Access
  - Mitigation measures for protection of species and habitat
  - Mitigation measures for known species at risk
  - Disturbance and protection of riparian vegetation and soils
  - Considerations for use of machinery/hand tools
  - Worksite isolation/Fish and amphibian salvage
  - Environmental timing windows
  - Environmental monitoring
  - Protection of Archaeological Resources and Chance Find Procedures
  - Public Safety
- Professional Sign Off
  - Low risk BDA projects should be supported by an R.P.Bio or other registered professional with appropriate expertise and experience in stream restoration. Higher risk BDA projects may warrant the support and oversight of a Professional Engineer.

- Maps and Figures
    - Contours at an appropriate scale to understand topography
    - Upstream, downstream, and lateral extents of the project
    - Land parcels and ownership of land parcels
    - Local watercourses
    - Slope of Relevant Stream Reaches
    - Anticipated Flooded Area upstream and lateral to BDAs
    - Downstream inundation zone in the event of a complete failure
    - Stream boundary and valley bottom margin or other floodplain delineation
    - Drawings showing the typical construction details for standard structure types (cross sectional and/or profile schematic sketches)

A Permit Over Crown Land (PCL) is also required for BDA projects and is submitted as part of the Section 11 permit application for an additional fee. The average cost for the Section 11 and PCL is $750.00 for each site, but this does change depending on the size of the PCL. There are often additional information requests from the government during the application review process. In addition, these permit applications require notification letters to be sent via registered mail to other stakeholders (e.g., CANFOR, BC Hydro, range tenure holder). CWSP has had difficulty finding addresses for range tenure holders and has performed in-person consultations instead to meet the provincial requirements. Within the Kootenay Boundary Region, the EMP and Section 11 application must be submitted by March 1st for fall works (i.e., works within the regional fish timing window).

The Section 11 Change Approval permit requires yearly update reports for each year the permit is active and a final report at the end of the permit term. In the 2024 and 2025 constructions, CWSP received active permits until 2028 and will thus have to prepare 3-4 yearly reports to the province for these sites. It is still unclear what will happen to the structures upon permit expiry, but there has been discussion about potential removal of structures, permit extension applications, or establishment of water licenses for the long-term presence of BDAs.

To harvest vegetation from provincial crown land for use in BDA construction (i.e., branches, wooden posts, woody debris), a License to Cut application must be filled out and filed with the local Natural Resource District (NRD). The application involves a short PDF form and preparation of maps (e.g., slope map within requested area of harvest). There is also a consultation period required for these applications, so early submission is best. There is a small fee that must be paid to the NRD for harvest of crown vegetation and is decided by the province depending on the project. In 2025, CWSP used vegetation harvested from a volunteer's private land (e.g., homeowner benefited from fire mitigation services) in the construction of BDAs. In 2026, CWSP has applied for cutting licenses; however, we are still in this process and have limited knowledge of what to expect.

The province has not stated that it is required but has strongly recommended a DFO Request for Review (RFR) to be submitted for each site. The application for an RFR is a multiple page PDF form which is accompanied by the EMP and geospatial files. DFO has 60 days to notify you if the application is complete, and then an additional 90 days for them to complete their review and provide recommendations for the project. This review does not cost the proponent.

Site isolation and salvage efforts are required during BDA construction. This requires submission of a Scientific Fish Collection Permit (SFCP) for Fish Salvage purposes which requires an online portal to be filled out and requests information regarding species, sampling objectives, and techniques. This application only costs $25.00 to submit and must be submitted 30 days prior to the work (however there can be delays). For an amphibian salvage, a General Wildlife Permit (GWP) application must be submitted and can be completed via the online portal. However, for these activities, an Animal Care Application (ACA) must also be completed and uploaded with the GWP but is not prompted during the portal submission. The portal submission requires information regarding potential species and the activities at the site. The ACA is a separate word document (~ 16 pages when complete) that must be filled our for Wildlife Salvage Projects and requires information regarding the crew members experience, project background, management implications, number of animals expected, details of capture and handling, methods, work areas, and rationale for relocation sites. The cost to submit the portal application is free, but a permit cost will be calculated later by the province. Both the GWP and SFCP require a summary report and data to be formatted correctly and uploaded into an online database.

A summarised list of these required permits, their review times, associated fees, and reporting requirements have been detailed in Table 7.

Table 7: List of required permits for BDA projects implemented within the Kootenay-Boundary Region.

Requirement:	Type:	Fee:	Timeline for Permit Approval:	Reporting Requirements:
Section 11 Change Approval	Permit	$500	March 1st deadline for fall works	Yearly update reports, final report upon permit expiry
Permit Over Crown Land	Permit	$250 - $500	March 1st deadline for fall works	~
License to Cut	Permit	TBD	No information online, earlier is better	TBD
DFO Request for Review	Review	Free	120 days	None; Once reviewed, requires notification to DFO 10 days before starting work
Scientific Fish Collection Permit – Fish Salvage	Permit	$25	30 days (with potential delays)	Summary report due within 90 days of permit expiry and submission of properly formatted data to online portal.
General Wildlife Permit (and Animal Care Application)	Permit	Fees vary. In 2025, CWSP paid $110.00 per site.	30 days (with potential delays)	Summary report and submission of properly formatted data to online portal.

4. Ecological Monitoring of Restoration Sites

In 2025, we surveyed vegetation and breeding birds in 12 of our wetland sites (ten restoration sites, and two reference sites). We also used trail cameras to detect large mammals in six sites. The vegetation and breeding bird surveys were repeats of surveys conducted in 2024, to allow us to track yearly variation as well as pre- and post-restoration changes. Our Year 6 report discusses the 2024 monitoring in more detail (Leven *et al.*, 2025).

Between mid-May and the end of June 2025 we conducted breeding bird surveys in 12 sites, surveying each site three times across the six-week period. In August 2025, we conducted vegetation surveys in 12 sites, doing detailed surveys in ten 1 m^2 plots within each site and doing broader community classifications for the different communities within each site as per the BC Biogeoclimatic Ecosystem Classification (BEC).

Across all breeding bird surveys in all wetland sites, we observed 90 species in 2024 and 2025. No significant changes were noted in bird species or numbers in our two restoration wetlands, although 20 species were only observed in the study wetlands during 2024 and 13 only in 2025. Given the large difference in bird species and numbers between wetlands and between years, we hypothesise that bird use of these small benchland wetlands is quite stochastic, with limited site fidelity. More years of data will hopefully allow better conclusions to be drawn.

Across all vegetation plots in all wetlands, we observed 145 species. Despite it being only one year after the construction of BDAs in 2024, we observed differences in vegetation plots in both wetland sites in 2025. In the site Beaver Channels, we observed an increase of water in three of ten plots, and in S-Land in nine of ten plots. Vegetation changes were observed in one of ten plots in Beaver Channels, with increasing species diversity of wetland species.

Detection of large mammals in sites varied widely, partly due to problems with camera functioning and vegetation resulting in small detection areas. The Beaver Channels and Northbound sites had the most detections (151 and 150, respectively), however at Beaver Channels almost half (69 of 150) of these detections were domestic cows. Species detected included American Black Bear, Moose, Mule and White-tailed Deer, and Elk.

4.1 Breeding Birds

We conducted breeding bird surveys based on the protocols established in the Prairie and Parkland Marsh Monitoring Program (Bradley *et al.*, 2021) and the Columbia Wetlands Marshbird Monitoring Project (Darvill and Westphal, 2020). We surveyed each of our study sites three times between mid-May and the end of June, identifying birds by both sight and sound. At each location, the survey protocol was as follows: 5 minutes silent observation, 5 minutes playback for target species, then 5 minutes silent observation. For all species either heard or observed we recorded whether they were estimated to be within 100 m of the survey location or further away. We also recorded a running total of large, vagile species such as raptors that might well be recorded from multiple locations, and of birds that were observed while moving between sites and outside the fifteen-minute survey period. We also recorded weather (temperature, precipitation, and wind), background noise, and any disturbances. We started surveys not more than half an hour before sunrise and finished by 9 AM; typically, the first count began about 5:30 AM. Target species were identified as Sora Rail, Virginia Rail, American Bittern, American Coot, and Pied-Billed Grebe.

Between 2024 and 2025, we have observed 90 species (Appendix A); 77 in 2024 and 70 in 2025. 20 species were observed only in 2024 and 13 only in 2025, while 25 species were observed on only one survey. 25 species observed are considered Wetland Dependent, and six are Wetland Associated, so most species observed except at the Westside Junction site, one of our reference wetlands, are not wetland dependent or associated species. At the Westside Junction site, 23 of 52 species are Wetland Dependent or Associated, and several Wetland Dependent species such as Pied-billed Grebe and Red-winged Blackbird were only observed at this site, so this wetland is providing different wetland habitat to the wetland sites we are working to restore.

The differences between years and the high incidence of species only observed once suggests high stochasticity of bird observations in these wetlands, i.e. there is a high element of chance determining which wetlands birds choose to breed in. Selection of breeding habitat by birds is complex, especially in migratory species (Kristan *et al.*, 2007), and both local and landscape scale variables influence abundance, diversity, and success of wetland species (Tozer *et al.*, 2010). In our study area, most breeding species are migratory, and so are leaving and returning to the area every year, and therefore may well simply stop in the first wetland they find with suitable habitat and show little site fidelity year on year.

During 2025 surveys, we observed Wood Duck chicks at the Beaver Channels wetland (Figure 80) and active nest defense by Solitary Sandpipers at the Sam’s Folly Outflow wetland; most other species observed were singing (i.e. an indication of territory defense) but no other chicks or direct nesting behaviour were observed. However, many of the species observed are small passerines or cryptic marsh species and their nests are difficult to find without active searching, so observation of direct nesting behaviour is not necessarily expected.

Figure 80: Wood Duck adult male and chicks at Beaver Channels wetland.

Olive-sided flycatchers are a Yellow-listed species in BC that we have observed at six sites. Olive-sided Flycatchers are more abundant in forested landscapes with frequent small wetlands, and use the edges of these wetlands to feed (Altman and Sallabanks, 2020), so will be positively impacted by our wetland restoration activities.

It is hard to draw conclusions about bird use of these wetlands from only two years of nature, due to birds being vagile animals for whom habitat selection is complex (Kristan *et al.*, 2007; Tozer *et al.*, 2010), and where habitat changes post-restoration may take years to be significant enough to change bird selection of these habitats. We anticipate that with more years of monitoring we will be able to draw better conclusions.

4.2 Large Mammals

We deployed wildlife cameras at six benchland wetland sites from fall 2024 to fall 2025 to document wildlife presence and site use; coverage was not continuous throughout that period at all sites due to a limited number of cameras. In the fall of 2025, we adjusted camera coverage to allow for monitoring at more sites, so eight sites had cameras deployed in October 2025 that will be checked in April 2026, once benchland sites are accessible. All cameras were set to motion detection (i.e. they took photos when they detected motion) and took three photos at a time.

The camera at the Northbound site had the most camera detection events, with 151 separate incidents captured. Species photographed included White-tailed and Mule Deer, Elk, Moose, American Black Bear, Coyote, Columbian Ground Squirrel, Red Fox, and Striped Skunk.

This indicates this camera is located in a good position to capture activity within this wetland, and many species of mammals are using this wetland throughout the year.

The site Beaver Channels had almost the same number of camera detection events, however the majority of these were domestic cows (68 of 150 camera events). Cows were frequently photographed within the wetted area of the wetland, and during site visits we observed heavy trampling of mud and vegetation, damaging the wetland edges.

Detection of wildlife at other sites was low, which we believe is a combination of technical problems with the cameras (three cameras stopped recording for no apparent reason during the deployment period), non-ideal camera positioning within the wetland (many wetlands are heavily vegetated so fields of view are small), and limited coverage of the wetland due to limited cameras (to intensively monitor wildlife with this method, we would need far more cameras within each wetland).

4.2.1 Sam's Folly Outflow

A wildlife camera was deployed at Sam's Folly Outflow from October 2nd 2024 through to May 29th 2025 and was triggered seven times. The first period was from October 2nd, 2024, to April 28th, 2025, and the second from April 28th,2025 to May 29th, 2025. These detections included an adult Moose (*Alces alces*) with a calf (Figure 81) and one American Black Bear *(Ursus americanus)*. The camera was removed at the end of May due to limited activity and few triggers, and it was redeployed in the fall of 2025 in an improved location to hopefully better capture wildlife activity.

Figure 81: Moose captured at the wetland site, Sam's Folly Outflow on November 26th, 2024.

4.2.2 Westside Junction

A wildlife camera was deployed at the Westside Junction Wetland from October 2024 to April 2025. Photos were captured between October 10th, 2024, and November 18th, 2024, after which the camera ceased taking pictures for unknown reasons. A total of seven camera trigger events linked to animal activity were recorded during this period. Five mule deer *(Odocoileus virginianus)* were detected, as well as one coyote (*Canis latrans*) and one White-tailed Deer *(Odocoileus virginianus)* (Figure 82). On April 28th, 2025, a camera was deployed again and retrieved at the end of June. The camera was only active for two days, and then stopped recording photos. The reason is unknown, and no animals were captured in the two days that it was active. The camera was then removed from this site and no camera was deployed over the winter of 2025/2026. The status of a camera at this site will be reassessed in Spring of 2026, depending on camera availability.

Figure 82: At the Westside Junction wetland; A white-tailed deer pictured running through the wetland on October 15th, 2024.

4.2.3 Limbo

A wildlife camera was deployed at Limbo from May 2025 to October 2025, and was deployed in October 2025 to capture photos over the winter; this camera will be checked in spring 2026 when this site is accessible again. During these deployments, there were a total of three triggers associated with animal activity. Two white-tailed deer and one American black bear were observed (Figure 83). The camera stopped taking photos on June 21st, 2025, for an unknown reason, although batteries were still functional. When the camera was collected in

August, signs of animal activity such as tracks and scat were abundant, suggesting that triggering issues may have prevented additional captures.

Figure 83: On August 12th, an American black bear triggered the camera while grazing through Limbo and (bottom left) was also interested in the camera. A white-tailed deer captured on June 13th, 2025, in the wetland (bottom right).

4.2.4 S-Land

A wildlife camera was deployed at S-Land from September 2024 to July 2025. A camera was deployed in the fall of 2025 and will be monitoring activity throughout the winter until it is retrieved in the spring of 2026. A total of 19 events triggered the camera during the 2024 to 2025 deployment period. Nine deer (*Odocoileus sp.*) and three moose (*Alces alces*) were captured on the camera (Figure 84). Three unknown species were recorded. Human activity was recorded, coinciding with fieldwork or camera maintenance visits.

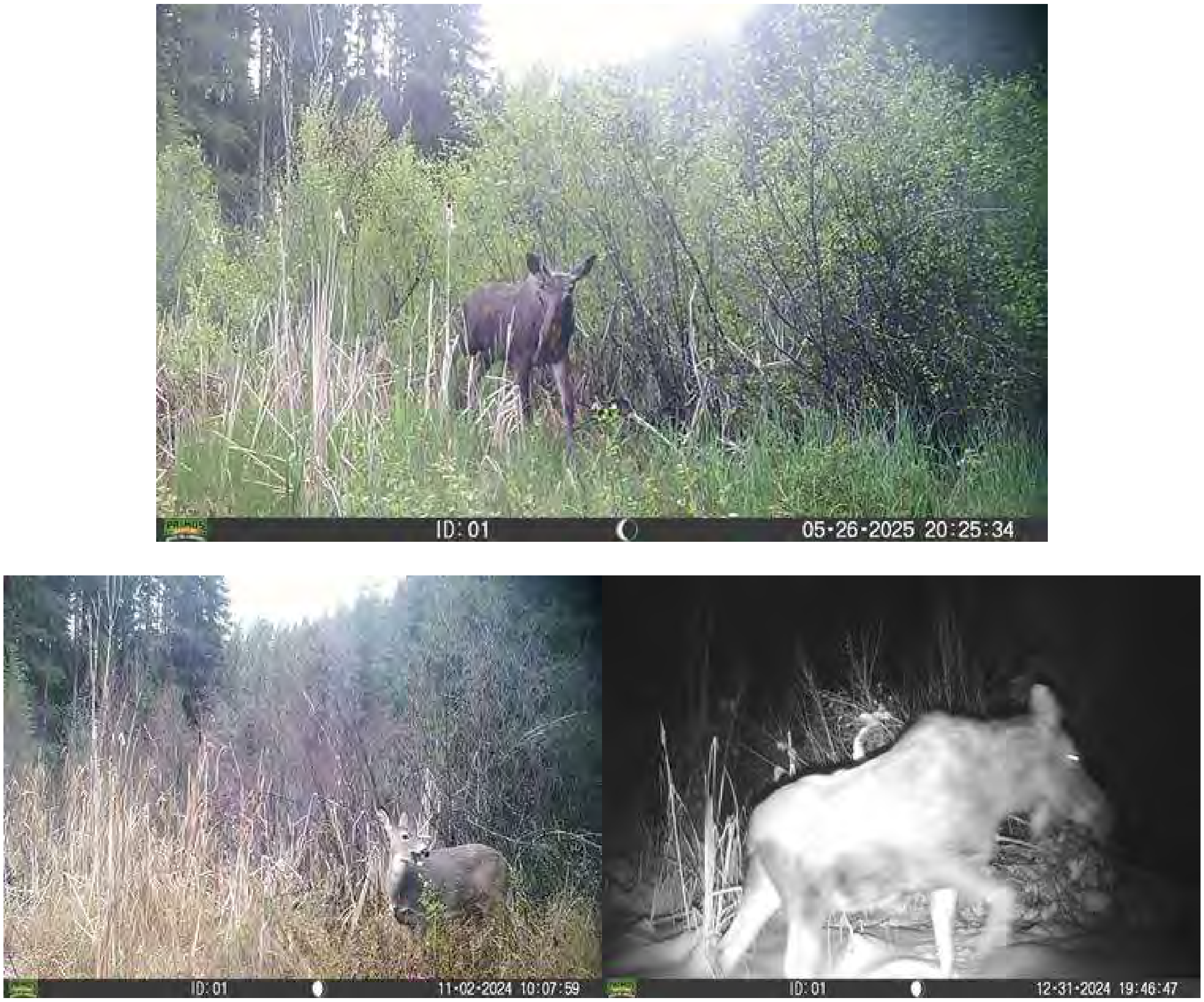

Figure 84: Moose were recorded on two separate occasions at S-Land (top and bottom right) on December 31st, 2024, and May 26th, 2025. A white-tailed deer was also captured (bottom left) on November 2nd, 2024.

4.2.5 Beaver Channels

A wildlife camera was deployed at Beaver Channels across three periods from September 2024 to August 2025, capturing a total of 150 camera trigger events. A camera was deployed in the fall of 2025 and will be monitoring activity throughout the winter until it is retrieved in the Spring of 2026.

Domestic Cows (*Bos taurus*) were detected on 68 occasions in and around the wetland with 501 individuals recorded; however, individual animals may have been recorded multiple times, and the total count of 501 likely includes repeat detections. Cows were frequently seen within the wetted area of the wetland, and on-site visits we observed heavy trampling of mud and vegetation, damaging the wetland edges. Coyotes were also observed, triggering the camera 11 times. Deer were captured on 52 separate occasions, which included does, bucks, and fawns of Mule Deer and White-tailed Deer. A sandhill crane (*Antigone canadensis)* was detected twice on the camera in the spring, as well as Canada Goose *(Branta canadensis)* three times. A Moose was observed once, as well as five occurrences of Elk *(Cervus canadensis)*. Two sightings of American Black Bear were observed at this site throughout the monitoring period. Human activity was recorded, coinciding with fieldwork or camera maintenance visits.

Figure 85: An American black bear and her two cubs (top) were captured playing at the Beaver Channels wetland on May 30th, 2025. Also, a coyote (bottom left) on June 27th, 2025, and a herd of cows grazing on July 27th, 2025 (bottom right).

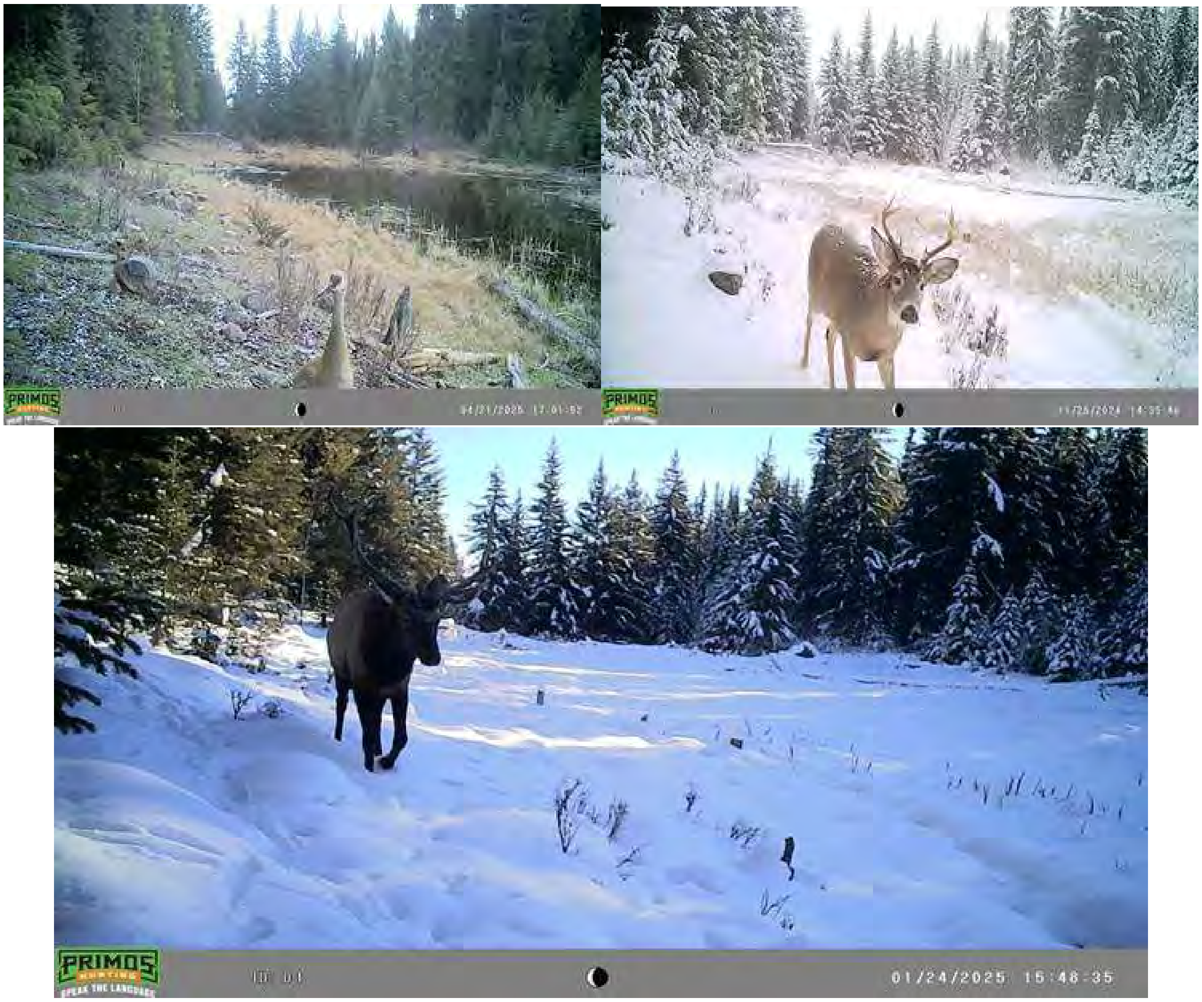

Figure 86: A sandhill crane (top left) is pictured on April 21st, 2025 in Beaver Channels, as well as a white-tailed deer on November 25th, 2024, and an elk on January 24th, 2025.

4.2.6 Northbound

A wildlife camera was deployed and monitored at Northbound from October 2024 through October 2025, capturing a total of 151 camera trigger events. A camera was deployed in the fall of this year and will be monitoring activity throughout the winter until it is retrieved in the Spring of 2026.

Ungulates were the most frequently detected large mammal, including 27 sightings of White-tailed deer and Mule Deer. Elk sightings were captured twice as well as two detections from Coyotes. Moose were observed on seven occasions, while 14 sightings of American Black Bear were captured. Various bird species were documented, with four sightings of American Robins (*Turdus migratorius*), two Common Ravens (*Corvus corax*), one Northern Flicker (*Colaptes auratus*), and two Spruce Grouse (*Canachites canadensis*). Smaller mammals such as Columbian Ground Squirrels (*Urocitellus columbianus*) were often detected, with 76 individual sightings. Other notable detections included one Striped Skunk (*Mephitis mephitis)*, three Red Fox *(Vulpes vulpes*) detections, and one detection of an unknown Mustelid. Human activity was recorded on 3 occasions, coinciding with fieldwork or camera maintenance visits.

Figure 87: On August 19th, 2025, an American black bear triggered the camera while passing through the wetland Northbound (top). A red fox was captured on camera on August 26th, 2025, (bottom left) as well as a cow moose on June 2nd, 2025 (bottom right).

4.3 Vegetation

We conducted vegetation surveys in 11 sites in 2024 and 2025. These surveys consisted of broad-scale vegetation mapping in line with BC Ecosystem Classifications, and of repeat surveys of 10 1m^2 plots set up in each wetland (Figure 88). In these plots, we identified plants to species (or as close as possible) and estimated percent cover of each species within the plot. This allows for more detailed tracking of changes in vegetation pre- and post-wetland restoration, which can be hard to track on a larger scale, especially within the time-scale of this project. Plots are GPS-located and marked with stakes to make them relocatable year after year, so the same area will be resurveyed each year.

Across all sites, we identified 145 plants to species or genus level IDs, 61 of which are Wetland Associated species and 13 of which are Submerged Aquatic species. Three are non-native plants; *Cirsium arvensis*, *Cirsium vulgaris*, and *Agrostis gigantea*. The two thistles are a common invasive to drying wetlands in this area, while *A. gigantea* is a species of grass commonly planted for fodder, so it is likely that cattle have spread these to wetlands in this area. This large plant list shows how diverse these small benchland wetlands can be, with many differences between individual wetlands even if they superficially appear similar. The full plant species list can be found in Appendix B.

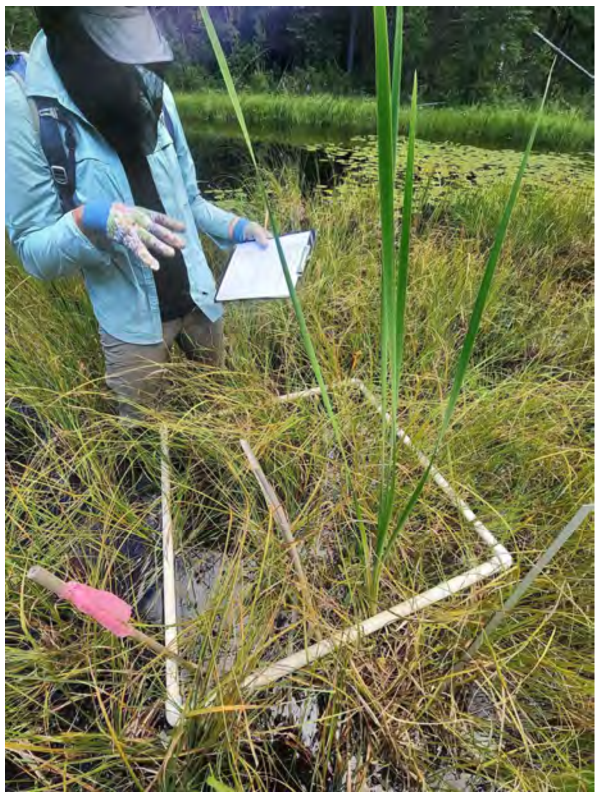

Figure 88: Vegetation plot being surveyed using a 1m2 quadrat; note flagged stakes marking corners.

4.3.1 Beaver Channels

In 2024 we observed 19 species in our vegetation plots and 30 in 2025. While it is hard to draw definitive conclusions from only two years of data, and only one year of data post-construction, even within this short time frame we observed differences in our vegetation plots. Two plots in the Beaver Channels wetland were wetted in 2024 and three were in 2025; in 2024, one of these plots was 20% open water, while in 2025 it was 70% open water. The other wetted plot in 2024 did not have an open water cover, but in 2025 was 70% open water; the third wetted plot in 2025 was 45% open water, from a dry plot with 65% open ground in 2024 (Figure 89).

Figure 89: A) Beaver Channels Plot 5 on August 6th 2024, dominated by Carex utriculata and open ground, with open water adjacent; B) the same plot on August 6th 2025, C. utriculata is still the dominant vegetation, but is now growing in open water an average of 0.11 m deep.

Interestingly, by the end of August and through September, the Beaver Channels wetland was observed to have less water in it in 2025 and 2024, with the open water areas retreating, and water depth was lower in 2025 than 2024. However, it does seem that up until mid-August, including during the period of these vegetation surveys, there was an increase in wetted area; this was also observed with during BDA surveys through

While no other plots showed an increase in water depth, one plot did show a dramatic change in vegetation; this was unexpected, as we did not think that a single growing season would be enough for vegetation to change. In 2024, Plot 04 was surveyed to be 50% *Potentilla anserina* (Common Silverweed), 5% *Mentha arvensis* (Wild Mint), 1% *Plantago major* (Common Plantain), and 45% Open Ground. In 2025, it was surveyed to be 30% *Mentha arvensis*, 1% *Schoenoplectus acutus* (Hard-stemmed Bulrush), 20% *Potentilla anserina*, 2.5% *Hippuris vulgaris* (Common Mare's-tail), 2.5% Unidentified seedling, and 40% Open Ground (Figure 90). This is an increase of two wetland species, and a loss of one dryland species. This plot was located in the area of the wetland directly behind one of our constructed BDAs, that remained flooded until the end of June, when it had previously been dry much earlier. Clearly this longer inundation period changed growing conditions for plants and resulted in different vegetation growing within this plot.

Figure 90: A) Plot 4 in 2024, showing open ground and low growing Potentilla anserina as the dominant cover; B) Plot 4 in 2025, showing taller growing Mentha arvensis and Potentilla anserina as the dominant cover. The differences extend beyond the plot, with vegetated ground cover visibly increasing around the plot.

4.3.2 S-Land

In S-Land we observed 49 species in our vegetation plots in 2024 and 2025. While it is hard to draw definitive conclusions from only two years of data, and only one year of data post-construction, even within this short time frame we observed differences in our vegetation plots. In 2024, four of ten plots were wetted, with water depths ranging from 0.04 m to 0.50 m; in 2025, nine of ten plots were wetted, with water depths ranging from 0.07 m to 0.83 m. In 2024, two of ten plots had open water cover of 30% and 50%, while in 2025 seven had open water cover (Figure 91).

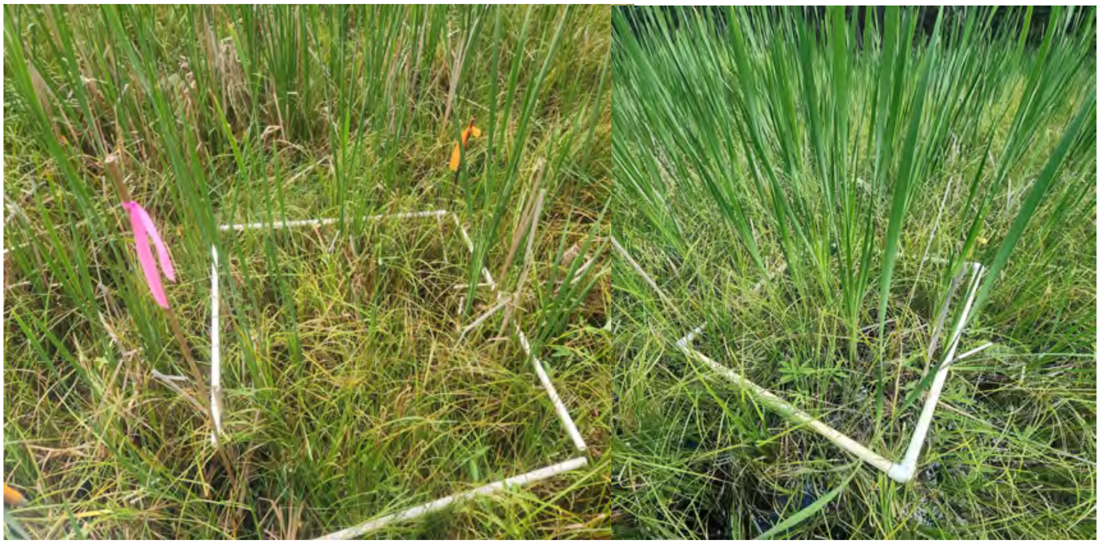

Figure 91: Plot in 2024, with Carex aquatilus, C. utriculata, and Typha latofolia, and no open water; the same plot in 2025, with the same species mix and also measurable open water.

No large changes in vegetation occurred within our plots, which is as we expected due to the short period between BDA restoration and these vegetation surveys. We will continue to monitor the plots in this wetland to detect changes in the future.