Environment and Climate Change Canada

Canada Nature Fund: Community-Nominated Priority Places for Species at Risk

Kootenay Connect: 6CW Columbia Wetlands:

Upland Wetlands Restoration

March 31, 2025. Final Report: Year 6

By Catriona Leven, Jessica Holden, Rylee Haubrich, and Dr. Suzanne Bayley

Columbia Wetlands Stewardship Partners

Contents

1. Executive Summary

In 2023, CWSP surveyed 371 sites by drone on the western benchlands of the Columbia Valley and with in-person site assessments determined that nine were suitable for potential restoration using Beaver Dam Analogues (BDAs). In 2024, we continued this work and further assessed 30 wetlands in-person and determined two more are suitable for potential restoration using BDAs.

BDAs are a low-tech process-based method that mimic natural beaver dams - both in appearance and ecosystem benefit (Pollock *et al.,* 2018). These structures are built out of mostly natural materials (e.g., wooden posts, branches, and mud) and reinforced with minimal man-made materials (e.g., burlap sacks) to ensure a simplistic, cost-effective restoration design that provides great benefit to the system (Pollock *et al.,* 2018). The benefits of these structures include raising the riparian water table, improving floodplain connectivity, creating small open water ponds to help slow water in the stream, moderate stream temperatures, replenish shallow groundwater stores, and nourish streams with sediment (Pollock *et al.,* 2018; Munir and Westbrook, 2020).

In October 2024 we built four BDAs at two sites, S-Land and Beaver Channels. We created wetlands or restored wetlands in the dry upland benchland of Columbia Valley. At the S-Land Site our efforts produced 12,793 m2 of flooded area, 3399 m3 of stored water, and 1.17 ha freshwater atlas wetland polygon. At the Beaver Chanels site our efforts produced 39,700 m2 of flooded area, 8969 m3 of stored water, 12.49 ha freshwater atlas wetland polygon. Site assessments completed in 2023 predicted the increase in water level and potential flood perimeter of our restoration sites. Based on this information, we anticipate that the restorations completed at S-Land and Beaver Channels **stored 12,368 m3 of water flooded over 52,493 m2 of land within these wetlands.** The total wetland area mapped in Freshwater Atlas for these two sites is 13.66 hectares.

At the Beaver Channels site, the upstream dam is 5 m long, 0.45 m wide, and 0.46 m tall, and the downstream dam is 6.5 m long, 0.45 m wide, and 0.45 m tall. These dams are projected to retain an additional 8969 m^3 of water after spring freshet has filled the wetland areas. At the S-Land site, the upstream dam is 3.5 m long, 0.66 m wide, and 0.21 m tall. The downstream dam is 1.8 m long, 0.69 m wide, and 0.32 m tall. Within less than one week both wetlands had filled to capacity behind the newly constructed BDAs, thus retaining an additional 3483 m^3 of water within the wetland areas. This restoration has thus increased wetland habitat, and we will continue to monitor the sites to see the changes post-restoration.

We also continued pre-restoration monitoring work at the nine previously selected sites and began pre-restoration monitoring work at the two new sites. This pre-restoration monitoring includes logging water depths between April and October, measuring water quality, surveying breeding birds in May/June, surveying vegetation communities both by using $1m^2$ vegetation plots to provide detailed plant presence data and as per the BC Biogeoclimatic Ecosystem Classification (BEC) to provide community classification, and using wildlife cameras to detect large mammals.

We detected 77 bird species during our breeding bird surveys, two of which are considered Species At Risk in BC (Evening Grosbeak and Olive-Sided Flycatcher, both Yellow Listed). 24 of these species are wetland dependent and 5 are wetland associated. Different communities were detected between the Reference Site and our other wetland sites, with 8 species, 5 of them wetland dependent, only being found in the Reference Site. This supports our assessment that these other wetland habitats could be improved via our BDA restoration to support more wetland dependent species. Our wildlife cameras detected four species of wild mammal (Black Bear, Moose, White-tailed Deer, and Mule Deer) and one species of domestic animal (Cow). 46% of observations were of cows, indicating the use of these wetlands by this domestic species.

In January 2025, three permit applications for four CWSP sites (Double Dam, Limbo, and Northbound/Big Dam) were prepared and submitted. The preparation of these applications was similar to 2024 but also required a 50-page environmental management plan for each site. If permits are successfully approved for work in 2025, CWSP will be repairing six remnant beaver dams by constructing 39.5 m of BDAs. We estimate that these repairs will allow us to store 17,321 m^3 of water at these sites. The total freshwater atlas wetland area for these four sites is 21.39 ha**,** and we expect to flood water over 41,488 m^2.

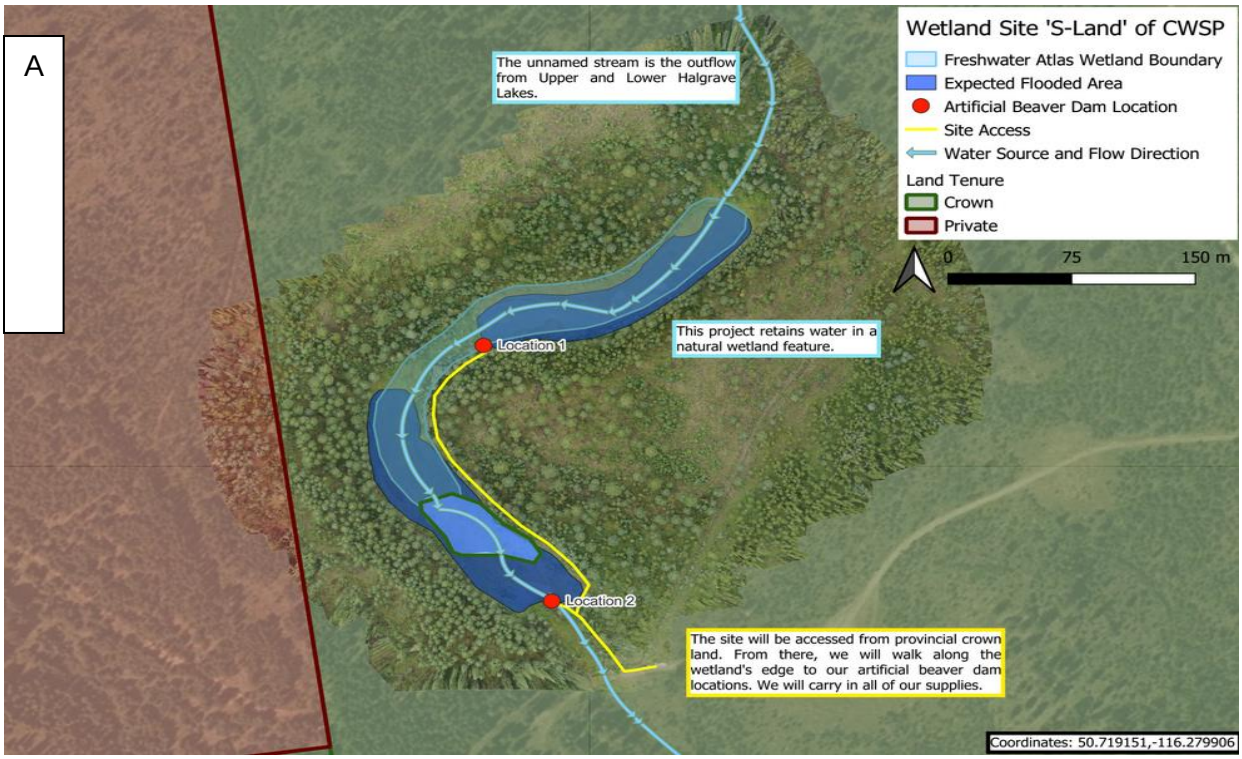
Since CWSP sites Northbound and Big Dam are along the same creek, they were combined into one application. Unfortunately, to complete this work under a Section 11 Change Approval, projects cannot store more than 10,000 m^3 within one system. As such, we will only be able to conduct a mid-sized repair at Big Dam - if we were not subject to this requirement, we could have stored an additional 3,000 m^3 of water at this site.

2. Beaver Dam Restorations Using Beaver Dam Analogues (BDAs)

In 2024, CWSP built four BDAs in two wetland sites. We plan to build eleven more BDAs across six wetland sites. We conducted monitoring in ten potential restoration sites and one site picked as a reference site which already has substantial open water areas.

In January 2024, CWSP submitted Section 11 – Changes In and About a Stream applications for two wetlands (S-Land and Beaver Channels), in order to allow us to repair four beaver dams (Figure 1 A and B) by building BDAs. The approved applications for S-Land (File Number: 127807) and Beaver Channels (File Number: 127810) cover two dams in each wetland and can be found in Appendix B.

We received permission to do this work on October 4th, 2024, which had to be completed by October 15th. On October 7th we built two dams in S-Land, and on October 8th we built two dams in Beaver Channels. We built these with the help of Brian Gustafson and Leonard Townsend from Cirque Ecological, Rick Hoar from the Lake Windermere Rod and Gun Club, Ben Gormley from Living Lakes Canada, and Alex Dufort from Jon Bisset & Associates. Brian Gustafson was our on-site Qualified Environmental Professional with the authority to halt work, as per permit requirements.



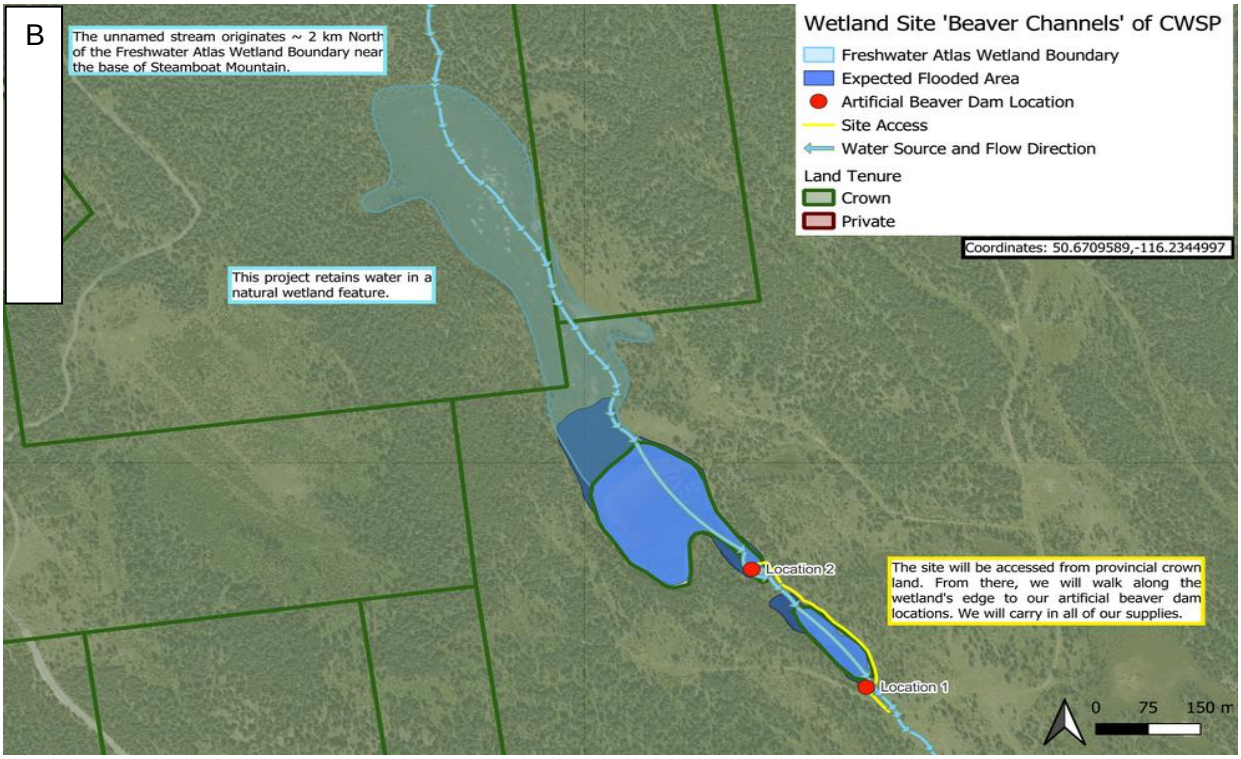


Figure 1. A) Map of S-Land showing location of both beaver dams, current flooded area, and projected flooded area with beaver dam repair. B) Map of Beaver Channels showing location of both beaver dams, current flooded area, and projected flooded area with beaver dam repair.

2.1 S-Land

In S-Land, we built two beaver dams, to retain more water in two wetland areas (Figure 2). The upstream dam is 3.5 m long, 0.66 m wide, and 0.21 m tall, and within one week water levels had increased in the wetland area by 0.21 m (Figure 3, 4). This means that 1168 m^3 more water is being retained in this wetland. The downstream dam is 1.8 m long, 0.69 m wide, and 0.32 m tall, and within one week water levels had increased in the wetland area by 0.32 m (Figure 9, 10). This has resulted in an increase of 2315 m^3 of water being retained in this wetland. Thus, these two structures have increased wetland habitat and specifically open water area.

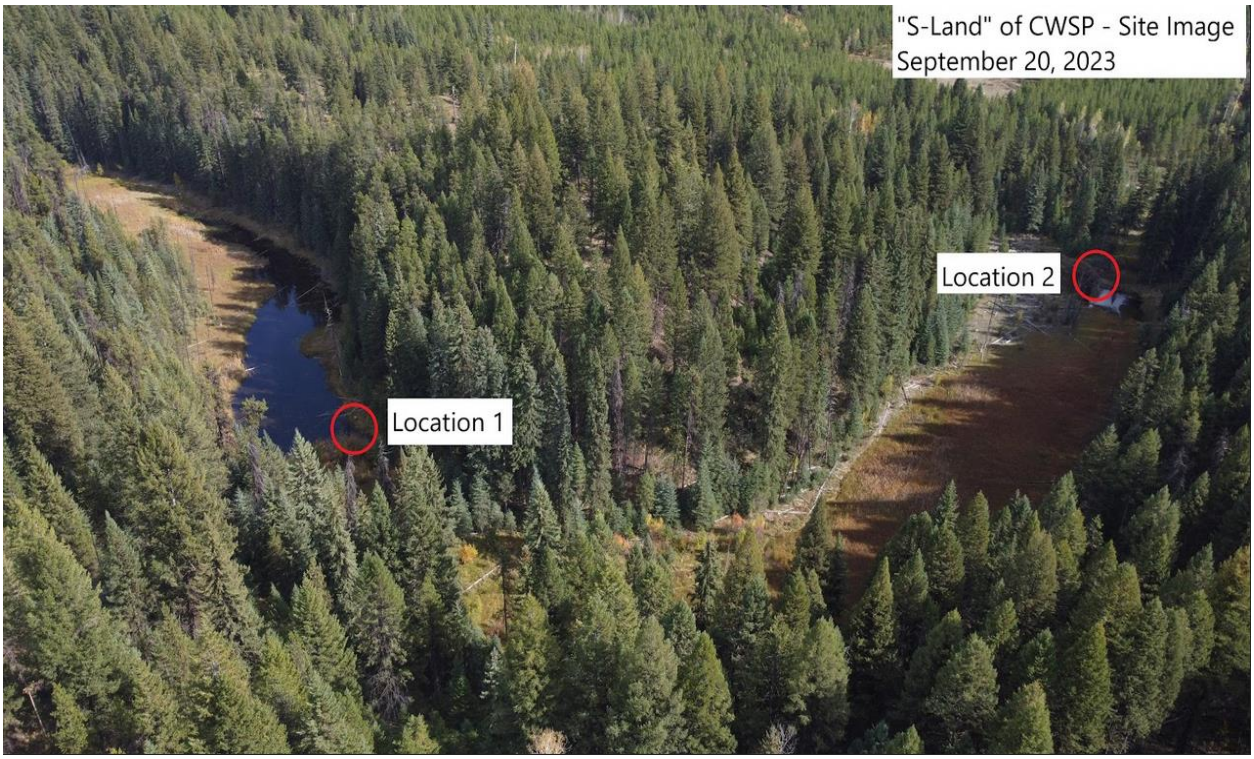


Figure 2. Drone photograph showing the location of the two beaver dams within the S-Land wetland site.

As indicated in our permit applications, these dams were built with entirely natural materials, with wooden posts being pounded at least 0.3 m into the ground in two rows 0.60 m apart, and then the area inside the dams being filled with burlap sacks filled with sand and mud, woven branches, and mud (Figure 5, 6).

We monitored water quality before and after construction, specifically turbidity, in order to detect potential muddying of the creek. While there was a short-term increase in turbidity downstream of the BDA built at location one, turbidity had returned to pre-construction levels a week later, so long-term effects to the creek are not present.

Figure 3. S-land upper dam site (location 1) prior to construction. October 7, 2024.

Figure 4. S-land upper dam site (location 1) post construction.

Figure 5. Pounding posts into the ground at S-Land upper dam site (location 1) during the construction.

Figure 6. S-land upper dam site (location 1) post construction. Photo taken from the pool below the dam, looking upstream.

Figure 7. Water quality parameters being measured upstream of the Upper Dam site following its construction. Oct 8, 2024.

Figure 8. Lower S-land dam (Location 2) during construction, cutting down the posts to required height (left) and infilling the dam with mud and vegetation (right). Oct 7, 2024.

Figure 9. S-land lower dam (Location 2) post construction. Oct 7, 2024.

Figure 10. Post construction monitoring at lower S-land dam (Location 2). Measuring changes to water depth. October 21, 2024.

2.2 Beaver Channels

In Beaver Channels we built two dams, in order to retain more water in two wetland areas (Figure 11). The downstream dam is 5 m long, 0.45 m wide, and 0.46 m tall. The upstream dam is 6.5 m long, 0.45 m wide, and 0.45 m tall. As the creek in this site is ephemeral and stops flowing in May, water levels have not yet increased behind these dams; however, as detailed above we will continue monitoring water levels next year to document increases.

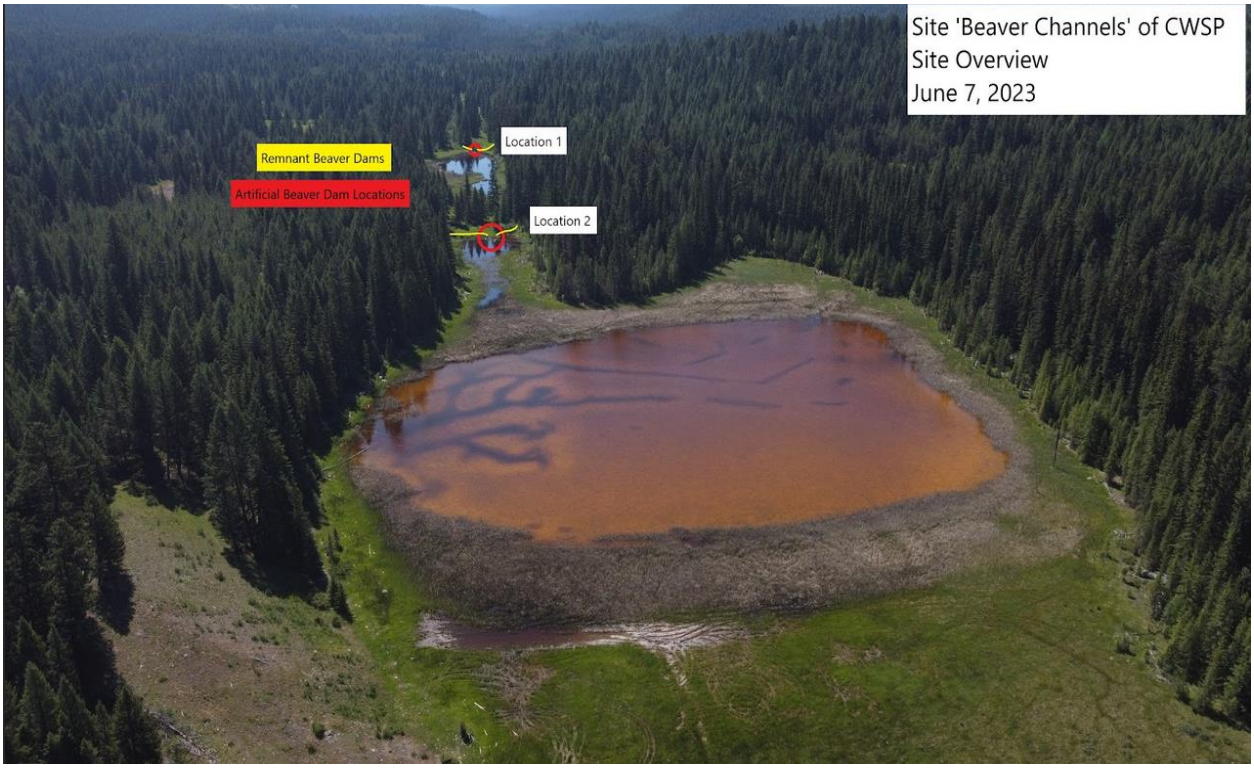


Figure 11. Drone photo of the site Beaver Channels showing the location of the two beaver dams.

Figure 12. Pounding posts into the ground for the upper dam (location 2) at Beaver Channels. Oct 8, 2024.

Figure 13. Weaving vegetation between posts at Beaver Channels' upper dam (Location 2).

Figure 14. Completed dam construction of the upper dam at Beavers Channels site. Oct 8, 2024.

Figure 15. During the construction of the lower dam (Location 1) at Beaver Channels. Oct 8, 2024.

Figure 16. Cutting posts to appropriate height (left) and completed dam (right) at lower Beaver Channels dam (Location 1). Oct 8, 2024.

Figure 17. Completed dam construction of the lower Beaver Channels dam site (location 1). Oct 8, 2024.

As indicated in our permit applications, these dams were built with entirely natural materials, with wooden posts being pounded at least 0.3 m into the ground in two rows 0.45 m apart, and then the area inside the dams being filled with burlap sacks filled with sand and mud, woven branches, and mud (Figure 17).

As we were not actively working in the creek area due to the creek being dry, there were no changes in water quality before and after construction.

2.3 The Permit Process: Approvals and Submissions

Permit applications for BDA projects at two sites (S-Land and Beaver Channels) on the western upland bench of the Columbia Valley were prepared in January 2024. Preparation of these permits required all field surveys to collect required data (e.g., drone survey, water levels, stream flow, beaver dam profile, gap repair measurements). These applications required the portal submission, DFO Request for Review, and multiple information requests that required additional maps and literature reviews. The permits for these sites were submitted on January 3rd and 4th of 2024 and approvals were granted on October 4th, 2024, for work to be completed by October 15th 2024. BDA installations took place on October 7th and 8th, 2024. Conditions of the permit approval include preparation of a construction completion report (submitted for these two sites in January 2025), annual report (required by December 31 each year the authorization is active), and final report (due December 31, 2027). The applications for work on the western upland bench in 2024 were prepared prior to the new Environmental Management Plan requirement (this was implemented in early 2025), thus these documents were not prepared for these sites.

In January 2025, three permit applications for four CWSP sites (Double Dam, Limbo, and Northbound/Big Dam) were prepared and submitted. The preparation of these applications was similar to 2024 but also required an environmental management plan. We have already received additional information requests from the province for these applications, and the province has expressed concern of the risk at these sites. If permits are successfully approved for work in 2025, CWSP will be repairing six remnant beaver dams by constructing 39.5 m of BDAs. We estimate that these repairs will allow us to store 17,321 m^3 of water at these sites. The total freshwater atlas wetland area for these four sites is 21.39 ha**,** and we expect to flood water over 41,488 m^2. Since CWSP sites Northbound and Big Dam are along the same creek, they were combined into one application. Unfortunately, to complete this work under a Section 11 Change Approval, projects cannot store more than 10,000 m^3 within one system. As such, we will only be able to

conduct a mid-sized repair at Big Dam - if we were not subject to this requirement, we could have stored an additional 3,000 m^3 of water at this site.

Table 1: Proposed BDA structures and flooded areas/volumes that will result.

Site Name	**Number of Remnant Beaver Dams**	**Number of BDA Structures**	**Total Length of BDA Structures (m)**	**Total Freshwater Atlas Wetland Area (ha)**	**Total Potential Flooded Area (m2)**	**Total Potential Water Storage (m3)**
Double Dam	2	7	26.5 m	10.88 ha	16,666 m^2	5760 m^3
Limbo	1	1	2.5 m	1.03 ha	5720 m^2	1716 m^3
Northbound	2	2	6.5 m	2.88 ha	13,776 m^2	6673 m^3
Big Dam	1	1	4.0 m	6.6 ha	5286 m^2	3172 m^3
TOTAL	6	11	39.5 m	21.39 ha	41,448 m^2	17, 321 m^3

3. Restoration Site Monitoring

In 2024, we conducted monitoring in 12 sites (Figure 18), nine of which are sites we had previously selected for restoration in 2023, and two of which are new sites we selected in 2024. Of the 12 sites, 11 of these sites are planned sites for restoration using Beaver Dam Analogues (BDAs), while one site is a reference site. This report details the new work conducted in 2024. For the work completed in 2023 please see our 2023 report (Holden *et al.,* 2023).

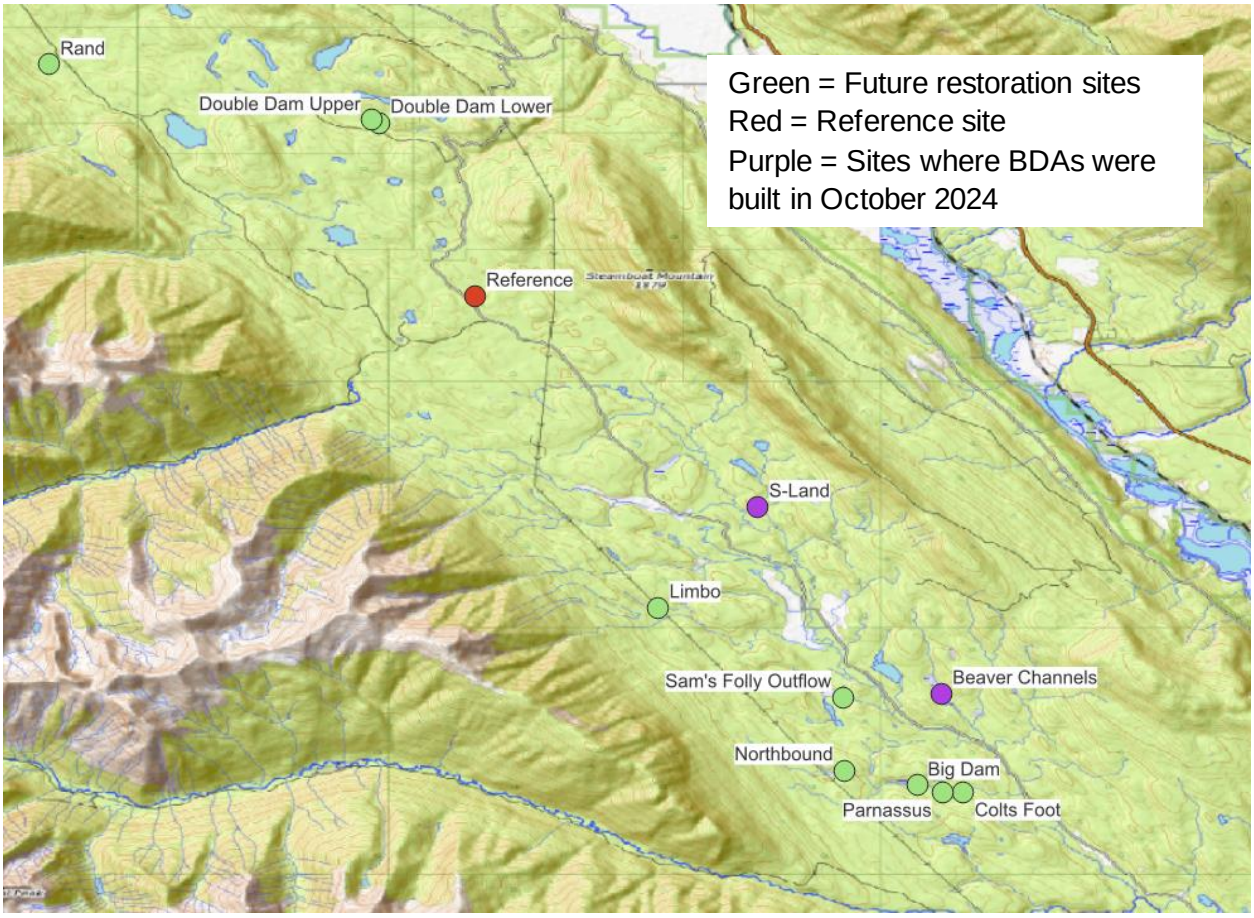


Figure 18. Map showing the location of restoration wetland sites on the western bench of the Columbia Valley, including one wetland being used as a reference site, and showing which wetlands we constructed BDAs within in October 2024. The other nine sites we plan to construct BDAs within in future years.

In April 2024 we installed 11 HOBO U-20 (HOBO by Onset, Cape Cod, Massachusetts, USA water depth loggers in five sites (Appendix A), to monitor water depth and temperature. Between mid-May and the end of June 2024 we conducted breeding bird surveys in nine sites, surveying each site three times across the six-week period. In August 2024 we conducted vegetation surveys in eleven 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). These data are still being analyzed, and only preliminary results are presented below.

2.1 Photographs of Restoration Sites

Figure 19. Beaver Channels wetland, looking downstream/south. Photographed on April 15th, 2024.

Figure 20. Big Dam wetland, looking east. Photographed on September 17th, 2024.

Figure 21. Coltsfoot wetland photographed on September 26th, 2023.

Figure 22. Double dam upper and lower sites, looking east (top) and west (bottom), photographed on September 25th, 2023.

Figure 23. Limbo wetland, looking upstream/west. Photographed on July 20th, 2023.

Figure 24. Northbound wetland, looking downstream/east. Photographed on April 16th, 2024.

Figure 25. Parnassus wetland, looking north. Photographed on September 20th, 2024.

Figure 26. Rand Creek wetland, photographed on July 19th, 2023.

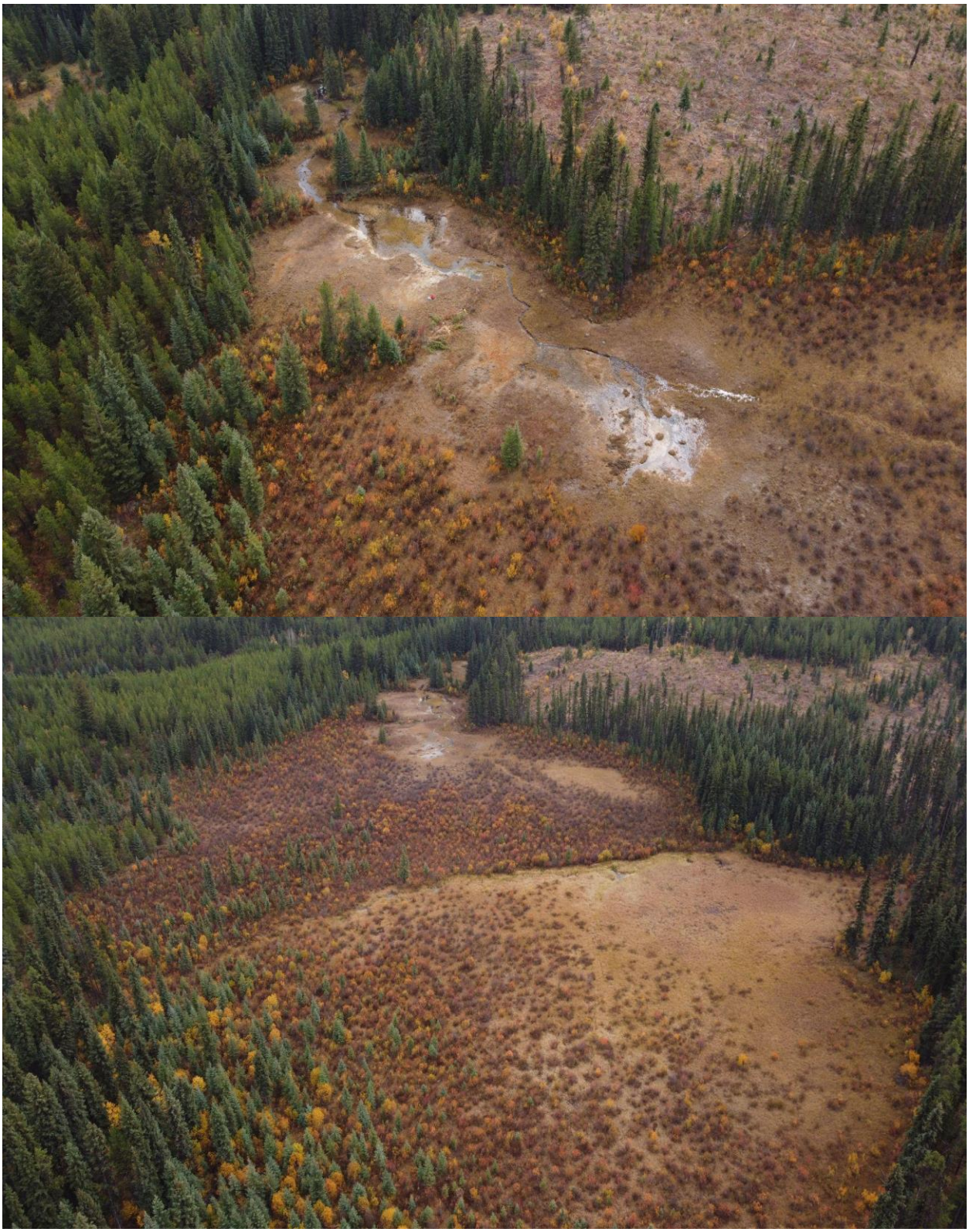


Figure 27. Two images of Sam's Folly Outflow wetland. Photographed on September 26th, 2023.

Figure 28. S-land wetland photographed on September 20th, 2023.

3.4 Breeding Birds

We conducted breeding bird surveys based on the protocols established in the Prairie and Parkland Marsh Monitoring Program (Bird Studies Canada, 2010) 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.

We detected 77 species (Table 2), of which 24 are considered to be wetland dependent and five wetland associated. Wetland dependent birds are those that require wetland habitat at some point in their life cycle, such as ducks, while wetlands associated birds are those that are more common in areas with wetlands, such as Olive-sided Flycatchers. Several of the remaining species are associated with deciduous woodland or willow thickets, which in this area are habitats commonly associated with wetland edges, indicating that though these species are not directly relying on the wetland, they are benefiting from the presence of wetlands in this area.

Table 2: List of species detected during breeding bird surveys in the upland wetland sites.

Species Name	Wetland Dependency
American Goldfinch	
American Redstart	
American Robin	
American Tree Sparrow	
Bald Eagle	Wetland Dependent
Black-crowned Chickadee	
Blue-winged Teal	Wetland Dependent
Brown-headed Cowbird	
Bufflehead	Wetland Dependent
Calliope Hummingbird	
Canada Goose	Wetland Dependent
Canada Jay	
Cassin's Finch	
Cassin's Vireo	
Cedar Waxwing	
Chipping Sparrow	
Clay-colored Sparrow	
Common Goldeneye	Wetland Dependent
Common Loon	Wetland Dependent
Common Raven	
Common Yellowthroat	Wetland Dependent
Dark-eyed Junco	
Dusky Flycatcher	
Evening Grosbeak	
Fox Sparrow	
Golden-crowned Kinglet	
Hairy Woodpecker	
Hammond's Flycatcher	
Hermit Thrush	
Horned Grebe	Wetland Dependent
House Finch	
Lesser Scaup	Wetland Dependent
Lincoln's Sparrow	Wetland Dependent

Figure 29: American Tree Sparrow, a non-wetland dependent species observed during surveys.

Mallard	Wetland Dependent
Marsh Wren	Wetland Dependent
Mountain Chickadee	
Nashville Warbler	
Northern Flicker	
Northern Goshawk	
Northern House Wren	
Northern Waterthrush	Wetland Dependent
Olive-sided Flycatcher	Wetland Associated
Orange-crowned Warbler	
Pied-billed Grebe	Wetland Dependent
Pileated Woodpecker	
Pine Siskin	
Purple Finch	
Red-breasted Nuthatch	
Red-eyed Vireo	
Red-naped Sapsucker	
Red-tailed Hawk	
Red-winged Blackbird	Wetland Dependent
Ring-necked Duck	Wetland Dependent
Ruby-Crowned Kinglet	
Ruby-throated Hummingbird	
Ruffed Grouse	
Sandhill Crane	Wetland Dependent
Say's Phoebe	
Song Sparrow	Wetland Associated
Sora	Wetland Dependent
Spotted Towhee	
Swainson's Thrush	
Tennessee Warbler	
Townsend's Warbler	
Tree Swallow	Wetland Dependent
Trumpeter Swan	Wetland Dependent
Varied Thrush	
Virginia Rail	Wetland Dependent
Warbling Vireo	Wetland Associated
Western Tanager	
Western Wood-Pewee	
White-throated Sparrow	
Willow Flycatcher	Wetland Dependent
Wilson's Snipe	Wetland Dependent
Wilson's Warbler	Wetland Associated
Yellow Warbler	Wetland Associated
Yellow-rumped Warbler	

Figure 30: Lincoln's Sparrow, a wetland-dependent species observed during surveys.

The most numerous species was Pine Siskin, with 112 individuals detected, while the most commonly detected species was Ruby-Crowned Kinglet, detected on 33 counts. The most common wetland dependent species was Common Yellowthroat, with 52 individuals observed over 29 counts. The most common duck species detected was Ring-necked Duck, with 24 individuals observed over 7 counts. 23 species were detected only once, and 13 species only had one individual detected. Of our target species, we detected Sora Rail, Virginia Rail, and Pied-Billed Grebe. Two of the detected species are Species At Risk (Evening Grosbeak and Olive-sided Flycatcher), being Yellow Listed in BC (Appendix C).

Figure 31: Cedar Waxwing and Ring-necked Ducks, two species detected during our breeding bird surveys.

We also noted differences in species between wetlands. For example, Ring-necked Ducks were only observed at the Reference and Beaver Channels sites, where reasonably large areas of open water already exist. Pied-Billed Grebes were only observed on the Reference site. 18 Sora were observed across 10 counts, at three different sites (Beaver Channels, Reference, and S-Land), while five Virginia Rails across four counts were observed at the Beaver Channels and Reference sites.

Eight species were detected at the Reference site that were not detected at any other site: Bufflehead, Canada Goose, Common Goldeneye, Fox Sparrow, Pied-Billed Grebe, Red-winged Blackbird, Say's Phoebe, and Tennessee Warbler. Five of these species are considered wetland dependent, suggesting that habitat is not suitable at our other sites to support these species. As

we selected the Reference site to provide a comparison to our restoration sites, the larger numbers of wetland dependent species there indicates that we picked this site well, and we can indeed use this site to compare to our other sites pre- and post-restoration. Hopefully, our restoration via beaver dam analogues will allow for bird communities more like that of the Reference site to occur in our restored wetlands.

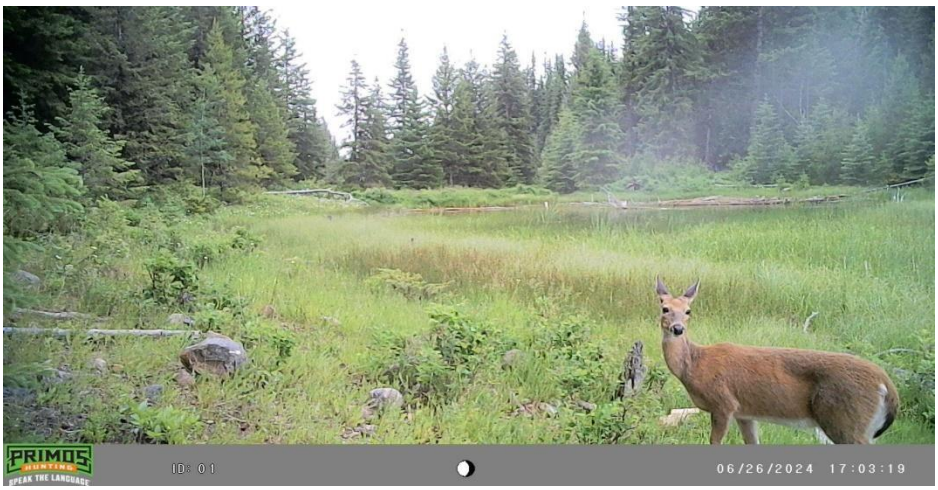
3.3 Trail Cameras

We deployed wildlife cameras at five of our restoration sites: Beaver Channels, Northbound, Sam's Folly Outflow, S-land, and the Reference site.

Figure 32. A wildlife camera attached to a tree at the S-Land wetland site.

3.3.1 Beaver Channels

A wildlife camera was deployed twice over the course of 2024 to monitor the site Beaver Channels. The first deployment occurred from May 29th to June 16th, and the second from June 19th to September 17th. The first deployment detected deer (either Mule Deer or White-tailed Deer) 11 times with a total of 11 individuals being captured. The second deployment detected Black Bear 3 times with a total of 3 individuals and deer 16 times. Five of those times were a buck and the remaining 11 were does, with a total of 16 individuals. Cows were detected 46 times, with a total estimate of 332 individuals observed in the wetland, as well as 1 Coyote and 1 unknown species. Overall, the camera was triggered 78 times between May 29th and September 17th, 2024.



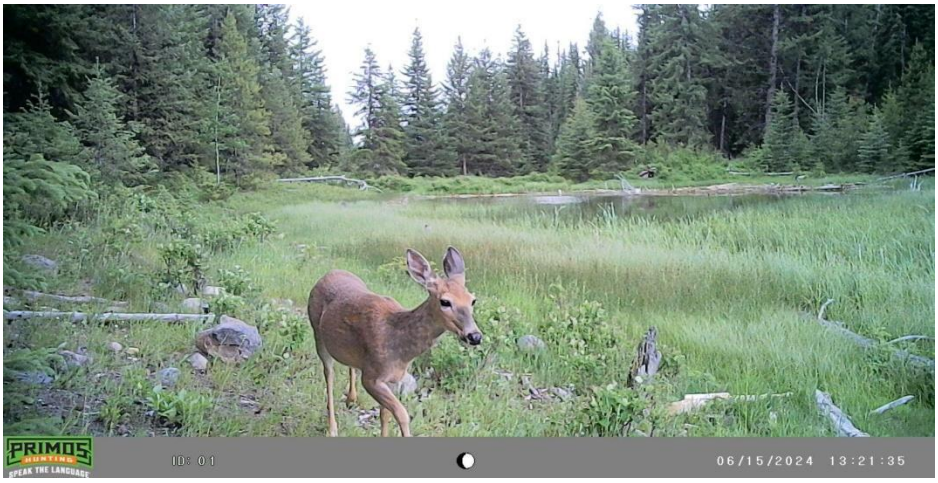


Figure 33. Images of detected wildlife at Beaver Channels wetland site. Mule Deer and Black Bear are pictured.

3.3.2 Northbound

A wildlife camera was deployed twice over the course of 2024 to monitor the site Northbound. The first deployment occurred from May 30th to June 5th and the second from June 5th to August 10th. The first deployment detected deer (either Mule Deer or White-tailed Deer) on 3 separate occasions, totaling 6 individuals. The second deployment of the camera detected deer 11 times, with a total of 12 individuals. A mix of does, bucks, and fawns were captured, with the majority being Mule Deer. Bear were detected 6 times, with 7 individuals captured, 2 Moose detections, and one unknown species detection. Overall, the camera was triggered 23 times between May 30th and August 10th, 2024.

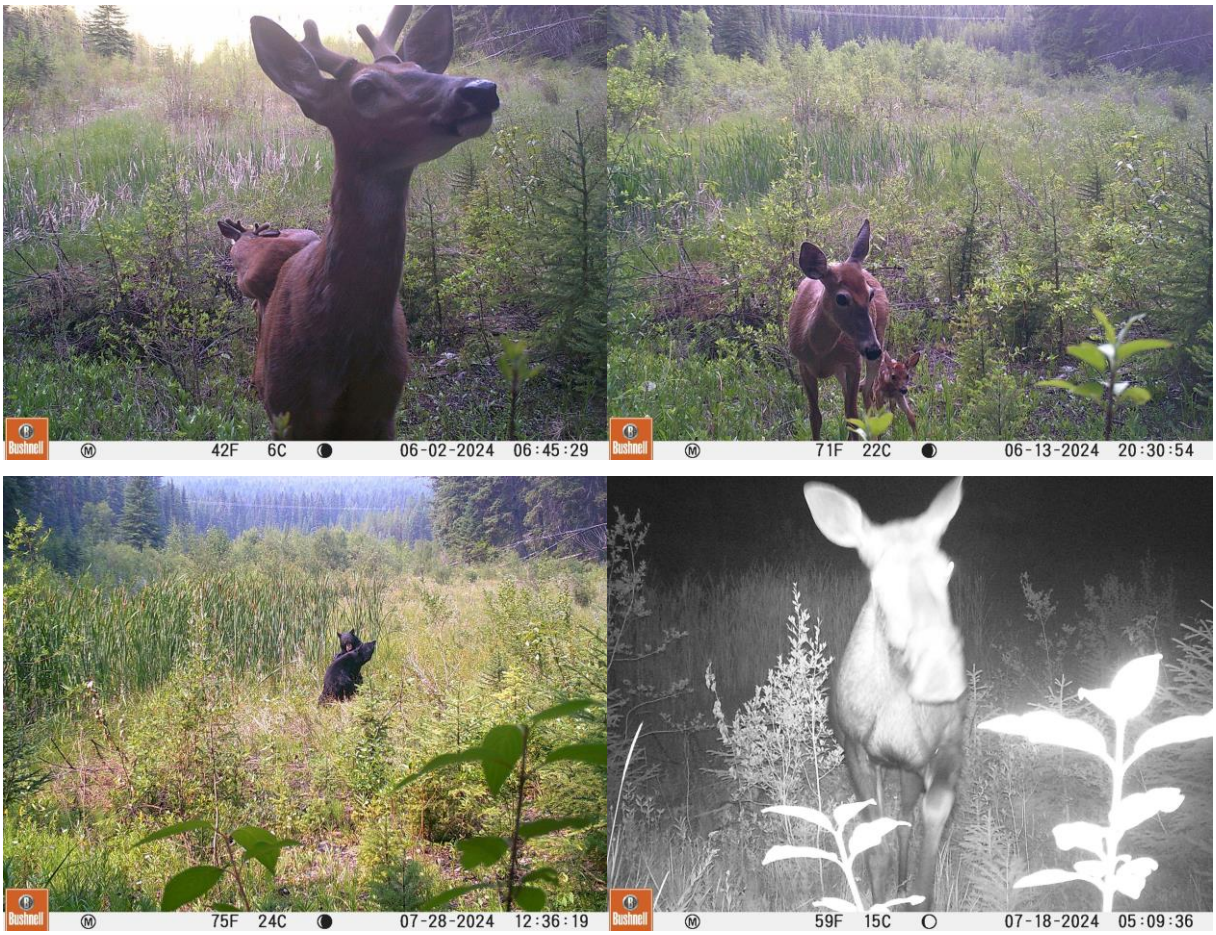


Figure 34. Images of detected wildlife at the Northbound wetland site.

3.3.3 S-Land

A wildlife camera was deployed twice over the course of 2024 to monitor the site S-Land. The first deployment occurred from June 4th to June 19th, and the second from August 14th to September 20th. No wildlife was detected.

3.3.4 Reference Site

A wildlife camera was deployed three times over the course of 2024 to monitor the Reference Site. The first deployment occurred from May 28th to June 6th, the second from June 6th to June 12th, and the third from June 20th to October 4th. Detections during the first deployment included 3 Moose detections with a total of 3 individuals, as well as 3 detections of Canada Goose, totaling 9 individuals. In the second deployment, 11 detections of unknown duck species were

captured with a total of 25 individuals. In the third round, 1 Northern Flicker was detected once, 3 detections of humans were captured, 24 detections of Cows with a total of ~57 individuals, 1 detection of an individual unknown duck species, and 2 detections of unknown species were captured. In total, the camera was triggered 48 times between the dates of May 28th and October 4th.

Figure 35: Camera detections of moose.

3.3.5 Sam's Folly Outflow

A wildlife camera was deployed twice over the course of 2024 to monitor the site Sam's Folly Outflow. The first deployment occurred from May 30th to June 5th, and the second from June 5th to October 2nd. The first deployment of the camera did not detect any motion in front of the camera. During the second deployment, a Black Bear was detected once, a deer was detected once, and a cow Moose with a calf was detected once. In total, the camera was triggered 3 times between the dates of May 30th and October 2nd.

Figure 36. Images of detected wildlife at the Sam's Folly Outflow wetland site.

3.3.6 Summary of Camera Detections

In total, from the five deployed cameras, there were 152 individual detections of wildlife, 70 of which were domestic cattle from either the Beaver Channels or Reference wetlands, meaning that 46% of detections were cattle. This indicates how many cattle are present in these areas, with an estimated 332 cattle being observed in the Beaver Channels site. This clearly has an impact on these wetlands, which we also observed in the evidence of trampling along the wetland edges and vegetation being heavily browsed (Figure 37). There may also be a suppressing influence on wildlife, with large amounts of cattle in an area making it less desirable habitat for wildlife such as deer or bears.

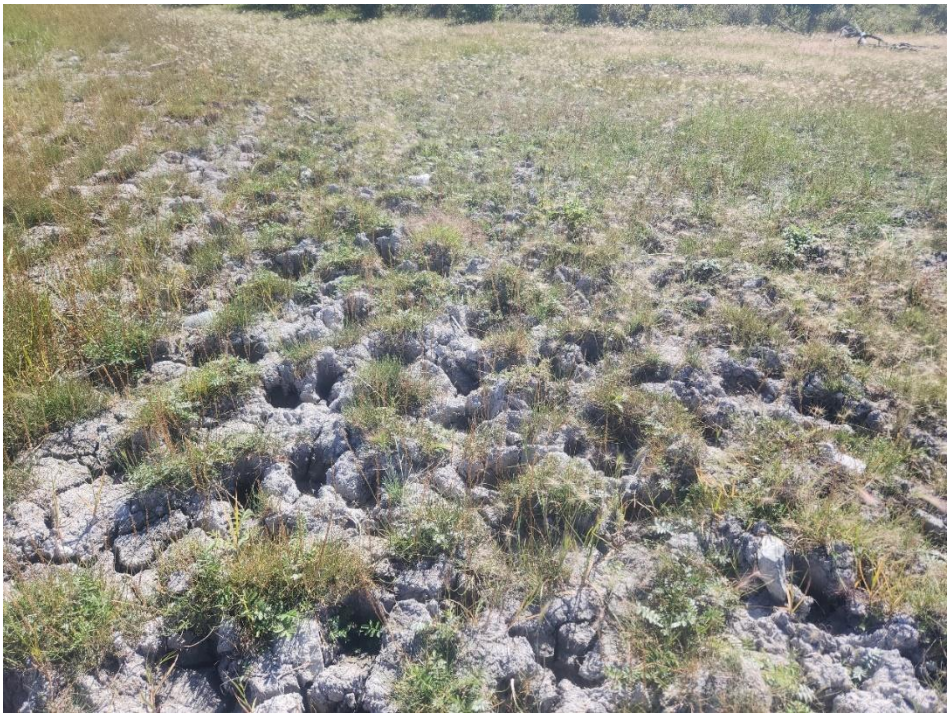


Figure 37. This image displays the negative impact and disturbance from cattle tramping on wetland soils.

For wild mammals, the most observed animals were deer, either White-tailed or Mule Deer, with both the Beaver Channels and Northbound sites having more than ten detections. A variety of age and sexes were detected, with photographs of does, fawns, and bucks being captured. Black Bear were also detected multiple times, with bears being detected at Sam's Folly Outflow, Northbound, and Beaver Channels. Moose were detected at three sites, Northbound, Reference, and Sam's Folly Outflow.

While these camera detections are not sufficient to analyze in detail or draw any conclusions about population density from, they do clearly show that a variety of large mammals are using these wetland areas. Retaining these wetland areas on the landscape is important to the persistence of these animals, especially in the face of climate change, with water becoming an increasingly rare resource in an already dry environment.

In October 2024 we redeployed cameras in these same five wetlands, in order to detect wildlife activity over the winter. As the S-Land camera had no wildlife detections, indicating that this camera was poorly placed, we moved it to a new location. Due to access difficulties over the winter, we will not be able to retrieve these cameras until spring 2025.

3.4 Water Quality

We measured water quality using a YSI ProDSS Multiparameter Digital Water Quality Meter, and found that specific conductance, pH, and turbidity were the most useful measurements.

Specific conductance is a measurement of electrical conductance in water, which therefore indicates the presence of inorganic dissolved ions. Stream conductivity is primarily affected by the geology of the area through which the water flows; areas with clay soils tend to have higher conductivity due to the presence of materials that ionise when washed into water (EPA, 2012). Specific conductance relatively high among all restoration sites (Figure 38), with Beaver Channels having the highest specific conductance of over 900 µS. In comparison, conductivity of the Columbia River at a similar time (August 2024) was 224 µS. This indicates relatively higher inorganic dissolved ions and thus high mineralisation, suggesting that groundwater flow and stream flow are both through materials that ionise when washed into the water.

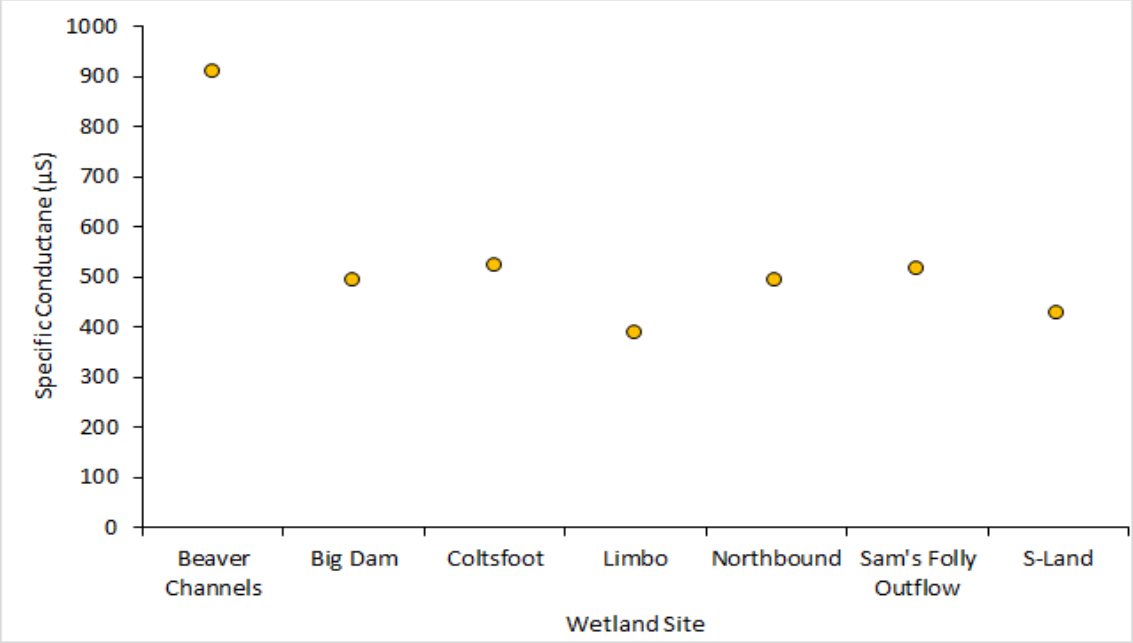


Figure 38. Specific conductance (µS) levels at the 7 wetland sites, with values ranging from 400 to 900 µS.

All the restoration wetlands are alkaline, with pH values over 8.6 (Figure 39), with more hydroxide ions than hydrogen ions in the water. A pH of over 8 is generally considered to be a

limiting factor to aquatic animals, reducing diversity due to physiological stress and reduced reproduction (EPA, 2015).

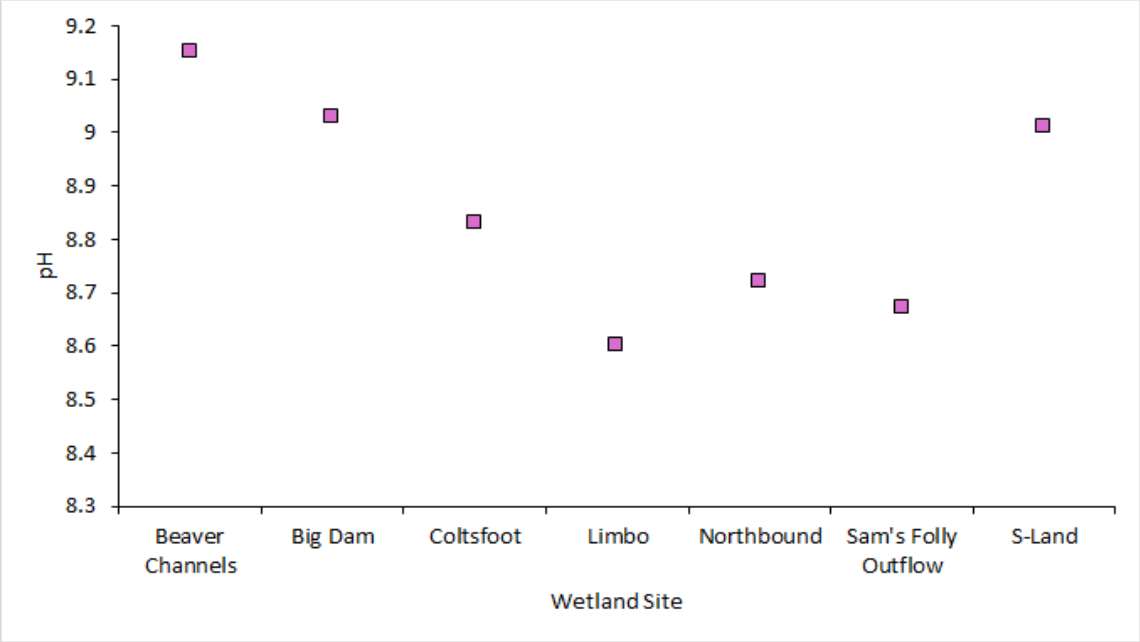


Figure 39. pH levels at various the 7 upland wetland sites. The plot shows the pH measurements, with each square representing a single pH reading at each wetland.

Turbidity in all the restoration wetlands is low, with turbidity ranging between 0.5 and 3 NTU (Figure 40). Low turbidity indicates that the water at these sites has relatively few suspended particles, which is generally a sign of clear water, as well as low levels of sedimentation. Low turbidity is beneficial because it allows for greater light penetration, which is important for the growth of aquatic plants (Austin *et al*., 2017). Clear water also reduces sediment resuspension and minimizes sedimentation, which can lead to healthier ecosystems. Low turbidity supports better water quality by enabling more effective photosynthesis and supporting plant cover, which in turn stabilizes sediments and improves the overall ecosystem health of the wetland.

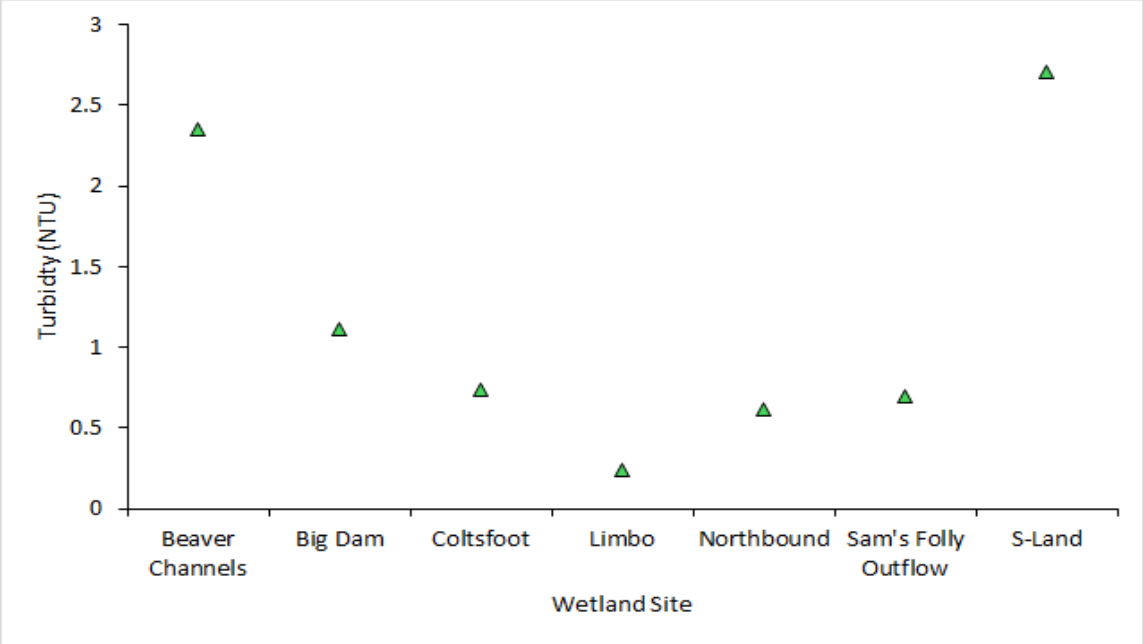


Figure 40: Turbidity (NTU) measurements at various wetland sites. This plot graph shows the turbidity levels from across 7 of the wetland sites, with lower values indicating relatively clear water.

4. Permitting Requirements

There are two permitting pathways for beaver dam analogue projects - Section 11 Change Approvals or Water Licenses. For projects that occur on provincial crown land and store less than 10,000 m3 in the system, a Section 11 Change Approval application can be submitted. Projects that occur on private land, or will store more than 10,000 m^3, are required to be constructed under a Water License. In order to obtain a Water License on private land, the private landowner must be willing to hold the license. To obtain a Water License on provincial crown land, a government or Crown Land Tenure holder must be willing to hold the license. We are told that the provincial government is not willing to hold water licenses for these projects, First Nations governments are not recognized as a government under the *Water Sustainability Act* despite willingness from Shuswap Band to hold this responsibility (Jennifer Bishop, pers. comm), and that the Crown Land Tenure application is a lengthy, and likely not worthwhile, process (Leanne McDonald, pers. comm).

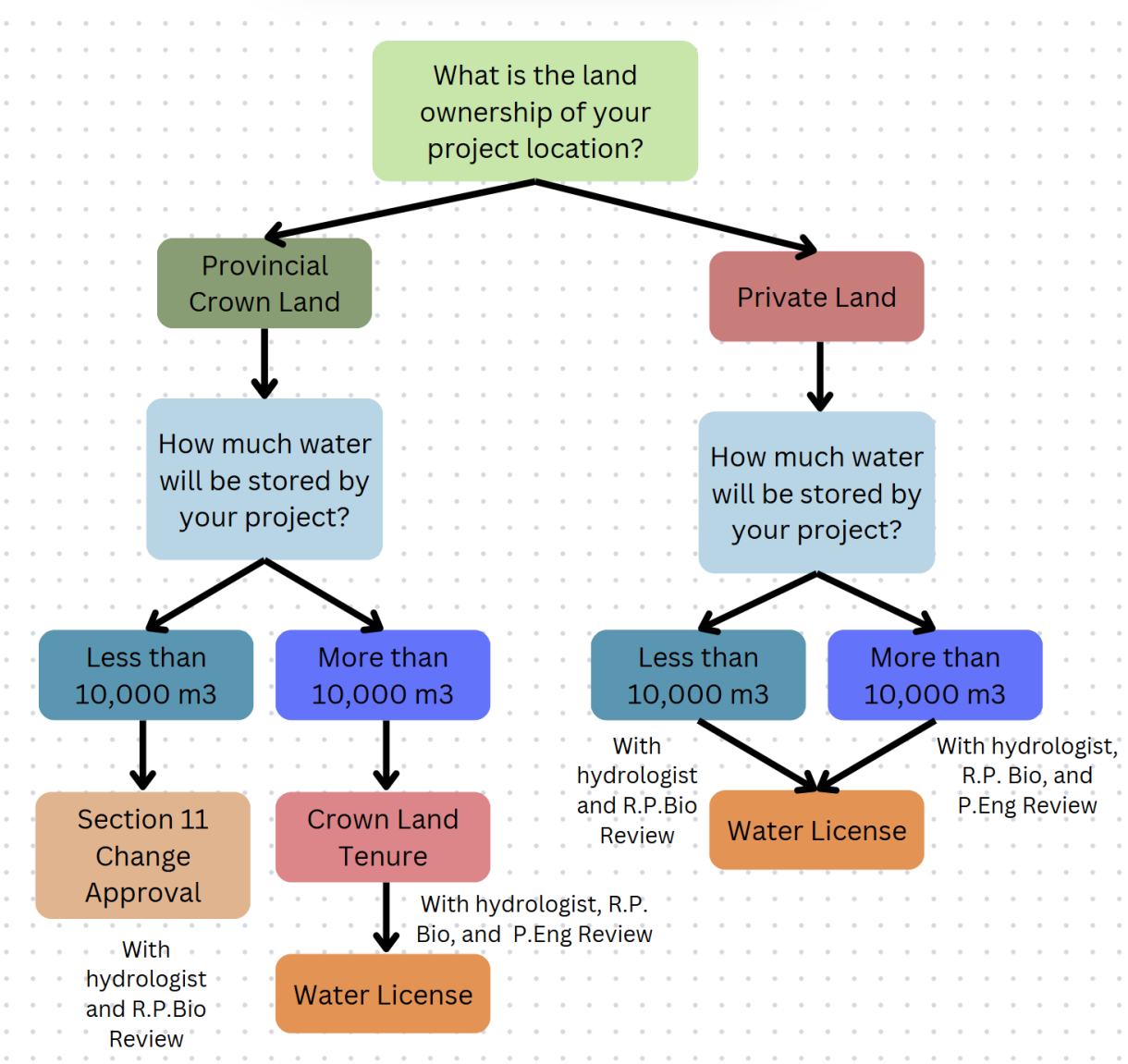


Figure 41: Flowchart showing representation of permitting pathways.

Both of the permitting pathways require online submissions in the BC Government Portal, but requirements differ. The average length of our previous Section 11 Change Approval submissions has been approximately 3 pages as some of the sections must be repeated for each BDA structure (e.g., detailed description of works, footprint, rationale for timing, etc.). CWSP has not yet applied for any water licenses to complete BDA restoration projects, but expects to submit some of these applications soon - we may not yet fully understand the requirements of this application until we have completed one. The sections required for the Section 11 Change Approval application include:

- Various multiple choice questions RE: affiliations

- Identification of Type of Works
- Stream description (name, watershed information, description if unnamed)
- Detailed description of works (includes comment on rationale, location, construction specifications, risk assessment)
- Footprint of project
- Proposed timing
    - rationale if not within approved timing window
- Legal description of location
- Coordinates
- Photos
- Land ownership information
    - landowner permission letters if flooding may impact private land
- Indicate responsible contractors/organizations
- Permit over crown land application (if work is on crown land, additional fee)
- Drawing to scale (map that meets required standards, including location, flooded area, wetland basin, land ownership, access, etc.)
- Geomark URL
- Construction drawings (front view and top-looking-down for each structure)

As of late 2024, the permit applications also require preparation of an Environmental Management Plan (EMP). The average length of EMPs prepared in 2025 is 50 pages, and each requires many maps, figures, and tables. For projects that store less than 10,000 m^3, the EMP must be reviewed and signed by a registered professional (our EMPs were signed by a hydrologist and professional biologist). For projects that store more than 10,000 m^3, the project must be reviewed and signed by a professional engineer (P. Eng.). The requirements of the EMP include:

- Project description
- Strong rationale (watershed and local scale)
- Measurable project objectives
- Qualitative project objectives
- Identify applicable legislation
- Summarize current state and pre-project monitoring
    - Hydrology (mean annual discharge, flood, and low flow regimes)
    - Vegetation
    - Water temperature and other physical parameters
    - Slope of relevant stream reaches

    - Confinement
    - Surface/groundwater connection
    - Aquatic ecology (fish, amphibians, species at risk)
    - Terrestrial ecology (current condition of habitat, species at risk which may be impacted),
    - Presence of beaver and/or existing beaver dams
- Identify current land uses, local infrastructure, and downstream water licensees
- Identify archaeology potential (requires submission to BC Government Team in advance of EMP preparation)
- First Nations outreach/support/project partners
- Project Design
    - Size, type, exact location, number of BDA structures to be implemented, approximate water storage for each structure and whole system, approximate flooded area, source of all construction materials, anticipated life span of structures
- Planting or invasive species management
- Beaver and beaver management
- Anticipated maintenance
- Effectiveness monitoring plan (identify goals and metrics)
- Coarse risk assessment
- Potential impacts to the environment
- Potential impacts to land users, infrastructure, and water licensees
- Potential impacts to archaeological resources and First Nations
- Mitigation measures
    - To address water quality, erosion and sediment control, water quantity, access, protection of species and habitat, 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, chance find procedures, and public safety.
- Maps
    - Multiple maps to identify contours, topography, extent of the project, land parcels and ownership, local watercourses, slope of relevant stream reaches, anticipated flooded area, downstream inundation zone in the event of a failure, infrastructure,

environmental sensitivities, land users, water licenses, archaeological resources, stream boundary/valley bottom margin/floodplain delineation.

- Drawings
    - Show typical construction details (cross sectional and/or profile schematic sketches).
- Photos of the site and surrounding values

In addition to preparation of these documents, a DFO Request for Review must be submitted. The requirements of this application include a fillable PDF and additional attachments to address:

- Description of project
- Address what work will be done
- Address what methods will be used
- Site plan
- Work categories relevant to project
- All other reviewers and file numbers
- Specify location and provide detailed directions
- Provide detailed description of biological and physical characteristics of the project site. Include information on species at risk and critical habitat.
- Identify potential effects of the proposed project
- Identify all maintenance required for the works
- Address any potential impacts to fish
- Describe all changes to fish habitat
- Identify any options for project redesign that would mitigate risk to fish or fish habitat
- Provide comment on project relevant to all DFO standards and codes of practice
- Address aquatic invasive species

Consultation with First Nations and land users must also take place. The BC Government completes administrative requirements regarding the First Nations consultation. For past applications on the western upland bench, CWSP submitted an official letter (has to be sent via registered mail) to Canadian Forest Services Products LTD (CANFOR) to notify them of the works and to allow for comment. In 2024, CANFOR was supportive of our projects and did not require further comment. For the valley-bottom applications, Canadian Pacific Kansas City LTD (CPKC) must be consulted. During initial conversations regarding one of our sites, CPKC was not supportive of these works - it is unclear what happens if they oppose it.

Once these requirements are met, additional work must be completed to adequately address any additional information requests from first nations, land users, the BC Government, and from DFO.

Upon successful award of these permits, work may commence. After the structures have been installed, the province requires submission of a construction completion, annual report, and final report.

4. References

Austin, Å. N., J. P. Hansen, S. Donadi, and J. S. Eklöf. 2017. Relationships between aquatic vegetation and water turbidity: A field survey across seasons and spatial scales. *PloS one*, *12*(8), e0181419. https://doi.org/10.1371/journal.pone.0181419

Davidson, N. 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research* **65**(10): 934 – 941.

EPA, 2012. 5.9 Conductivity. In Water: Monitoring and Assessment. Retrieved from http://water.epa.gov/type/rsl/monitoring/vms59.cfm

Holden, J., S. Bayley, and C. Leven. 2024. Hydrology and Beavers: Wetlands on the Western Upland Bench of the Columbia Valley.

Hupp, C., A. Pierce, and G. Noe. 2009. Floodplain geomorphic processes and environmental impacts of human alteration along Coastal Plain rivers, USA. *Wetlands* **29**: 413 - 429.

Lane, C., E. D'Amico, J. Christensen, H. Golden, Q. Wu, and A. Rajib. 2023. Mapping global non floodplain wetlands. *Earth System Science Data* **15**(7).

MacKenzie, W.H., and J.R. Moran. 2004. Wetlands of British Columbia: a guide to identification. Res. Br., B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 52

McLaughlin, D., D. Kaplan, and M. Cohen. 2014. A significant nexus: Geographically isolated wetlands influence landscape hydrology. *Water Resources Research* **50**(9): 7153 - 7166.

Winter, T. 2007. The vulnerability of wetlands to climate change: a hydrologic landscape perspective. *Journal of the American Water Resources Association* **36**(2): 305 - 311.

5. Appendices

5.1 Appendix A: Monitoring work conducted in each restoration wetland

Wetland Name	FWA Waterbody ID	Wetland area (ha)	Flow	Beaver Dam Measurements	Vegetation Communities	BC Wetland Classification	Vegetation Plots	Macroinvertebrates	Water Quality	Orthoimagery	Water Depth Logger	Wildlife Camera	Breeding Birds	Wildlife Mapping
S-Land	705007160	1.17	2023 and 2024	Yes	Yes	Vegetation but not soil	2023 and 2024	2023	2023 and 2024	Yes	2 in 2024	1 in May 2024	May/June 2024	Complete
Beaver Channels	705005932	12.49	2023 and 2024	Yes	Yes	Vegetation but not soil	2023 and 2024	None planned	2023 and 2024	Yes	2 in 2024	1 in May 2024	May/June 2024	Complete
Upper Double Dam	705005982	10.18	2023 and 2024	Yes	Yes	Vegetation but not soil	2023 and 2024	None planned	2023 and 2024	Yes	None	None	May/June 2024	Complete
Rand Creek	705005933	3.72	2023 and 2024	Yes	Yes	Vegetation but not soil	2024	None planned	2024	Yes	None	None	May/June 2024	Complete
Lower Double Dam	705006513	0.7	2023 and 2024	Yes	Yes	Vegetation but not soil	2023 and 2024	None planned	2023 and 2024	Yes	None	None	May/June 2024	Complete
Northbound	705005960	2.88	2023 and 2024	Yes	Yes	Vegetation but not soil	2023 and 2024	None planned	2023 and 2024	Yes	2 in 2024	1 in May 2024	May/June 2024	Complete
Coltsfoot	705006076	1.91	2023 and 2024	Yes	Yes	Vegetation but not soil	2023 and 2024	None planned	2023 and 2024	Yes	1 in 2024	None	May/June 2024	Complete
Limbo	705006322	1.03	2023 and 2024	Yes	Yes	Vegetation and soil	2023 and 2024	None planned	2023 and 2024	Yes	None	None	May/June 2024	Complete
Sam's Folly Outflow*	705005813	5.7	2023 and 2024	Yes	NA	Vegetation but not soil	2024	None planned	2023 and 2024	Yes	1 in 2024	1 in May 2024	May/June 2024	Complete
Reference	705006001		2024	NA	NA	NA	NA	None planned	2023 and 2024	NA	1 in 2024	1 in May 2024	May/June 2024	None
Parnassus	705005936		2024	Yes	NA	Vegetation and soil	2024	None planned	2024	Yes	None	None	NA	None
Big Dam	705007026		2024	Yes	NA	Vegetation and soil	2024	None planned	2024	Yes	None	None	NA	None

5.2 Appendix C: Detected Species At Risk

Scientific Name	English Name	BC List	SARA Status	Within Species Range?	Identified Management Goals	Potential to Survey
Coccothrausstes vespertinus	Evening Grosbeak	Yellow	Special Concern	Yes - Species occurs, and breeds, throughout most of British Columbia (Environment and Climate Change Canada, 2022).	Achieve a stable (or increasing) 30- yr population trend, maintain a long-term stable population trend, maintain current extant of occurrence (Environment and Climate Change Canada, 2022).	Yes - Songbird surveys in coniferous upland edges around restoration sites.
Contopus cooperi	Olive-sided Flycatcher	Yellow	Special Concern	Yes - Species occurs, and breeds, within all of British Columbia. Occurs in coniferous stands, often located near wetlands (COSEWIC, 2007).	Halt national decline by 2025, ensure a positive 10-year population trend, and maintain the current extent of occurrence (Environment Canada, 2016).	Yes - Song bird surveys at restoration sites.

5.3 Appendix C: Approved Permits for BDA building in S-Land and Beaver Channels

See attached PDF's of the Section 11 cover letter approval from the province and the DFO approval letters