Indian Creek Riparian and Wetland Habitat Restoration Plan

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1 INTRODUCTION

The Columbia Basin has experienced significant losses of low elevation riparian and wetland habitats due to the construction of dams and the subsequent flooding of river valleys (Wilson et. al. 2004, Utzig 2011). The Fish and Wildlife Compensation Program – Columbia (FWCP) was created to compensate for the losses of valley bottom fisheries and wildlife habitat associated with BC Hydro projects in the Columbia Basin. The maintenance of productive and diverse ecosystems is a key objective of the FWCP, and the restoration of degraded riparian and wetland habitats is one means to achieve this goal (FWCP 2012).

This report outlines a detailed restoration plan for wetland and riparian areas along the Goat River South Channel (also called Indian Creek), located south of Creston B.C. The project is a collaboration between the Yaqan Nukiy people – called the Lower Kootenay Band (LKB), the Canadian Columbia Intertribal Fisheries Commission (CCRIFIC) and Masse Environmental Consultants Ltd (MEC). The location was selected due to the cultural significance of the site and because the restoration of ecological and First Nations cultural values in the South Channel has previously been identified as providing the best opportunity for ecosystem restoration in the area (Amec 2005, Masse Environmental 2009). A riparian planting project was implemented along the southwest bank near the confluence with the Goat River approximately 10 years ago by CCRIFIC and the LKB; however, the project had limited success due to impacts from grazing (Appendix 1 Site Plan).

The Goat River South Channel will be referred to herein as “Indian Creek” as it is traditionally called by the LKB.

1.1 Defining Ecological Restoration

The Society for Ecological Restoration International defines restoration as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (Society for Ecological Restoration International Science and Policy Working Group, 2004). Ecological restoration is an intentional activity that initiates or accelerates recovery of an ecosystem with respect to its function (processes), integrity (species composition and community structure), and sustainability (resistance to unnatural disturbance and resilience). Ecological restoration activities need to be ecologically, methodologically and economically effective and socio-culturally engaging.

This project is based on the concept of ecological restoration, in which an appropriate mix of native species is re-established in a disturbed area to initiate the natural processes of succession. The goal is not to restore the site to its original (pre-European) condition, as the natural disturbance patterns required for that type of landscape no longer occur. Instead, the idea is to initiate and accelerate the processes of natural succession with native plant species. Future climate regimes and growing conditions must be considered in planning; however this area may not be as affected by potential drought predictions for the region due to its location within the floodplain (Utzig and Holt 2012). The project aims to restore a natural, self-perpetuating landscape under the current and future environmental regimes.

1.2 Framework for Planning and Implementation of Ecological Restoration

This plan adapts the Parks Canada framework for planning and implementation of restoration activities (Parks Canada 2007). This involves the following seven steps:

1. Identify natural and cultural values.
2. Define the target ecosystem.
3. Develop restoration goals.
4. Develop specific objectives.
5. Develop a detailed restoration plan.
6. Implement the restoration plan.
7. Monitor, report on and adapt to the outcomes.

2 STUDY AREA

Indian Creek is located on the Lower Kootenay Indian Reserve 1B, at the confluence of the Goat and Kootenay rivers near Creston B.C (Figure 1). The Goat River is the largest tributary to the Kootenay River between Bonners Ferry and Kootenay Lake, contributes the greatest volume of cold water to the system (Paragamian, 2000). The Goat River splits into north and south channels, approximately 3.9 km upstream of the confluence with the Kootenay River, and the lower 2.8 km is in the floodplain (Amec 2005). The North Channel is the larger of the two and flows year round, while the South Channel (Indian Creek) only flows during the spring high water period. However, the portion of Indian Creek within the restoration area remains wetted year round, as it is fed by a spring located just upstream of the project boundary. Water levels in Indian Creek vary considerably throughout the year, exposing steep, silty banks at low flows, with significant exposed soils, slumping and erosion where cattle access the channel.

The target restoration area comprises approximately 7.5 ha of the riparian zone along the lower 2 km of Indian Creek, from the confluence with the Goat River North Channel up to the forested area (Figure 1 and Appendix 1 Site Plan). It is part of the 445 ha Yaqan Nuki Wetland Complex, which is composed of six wetland compartments that are actively managed with a series of pumps and dykes by the Yaqan Nuki Wetlands Friendship Society. The restoration area is located within the Waxwik (Dragonfly) compartment at an elevation of approximately 530 m. A flood control dyke defines the site on the north side of Indian Creek and separates Waxwik from the Happy Hunting Ground marsh (Appendix 1 Site Plan). Flood control structures within the dyke allow water to move from Indian Creek to the Happy Hunting Grounds. The north pump house and screened intake sits at the downstream end of the restoration area, adjacent to the site of a decommissioned access bridge which used to provide access to Happy Hunting Grounds. The north pump house is instrumental in managing water levels in the other wetland compartments. Water levels in the Waxwik compartment cannot be managed; once flood waters recede the site is essentially dry.

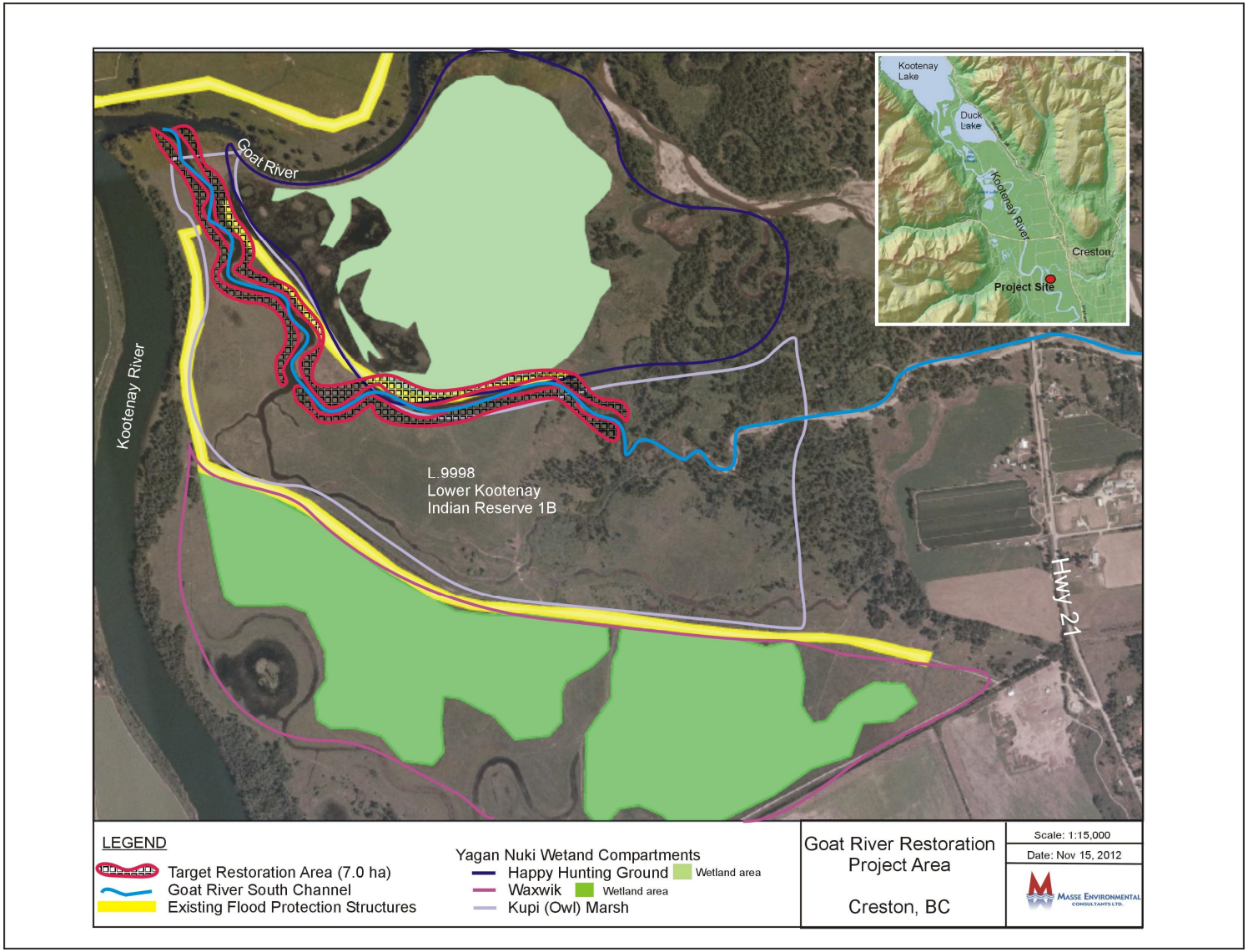

Figure 1. Location Map

3 NATURAL AND CULTURAL VALUES

3.1 Natural Values

3.1.1 Biogeoclimatic Classification

The restoration area is located within the Interior Cedar Hemlock very dry warm (ICHxw) biogeoclimatic zone, characterized by hot, dry summers and mild winters with light snowfall (Braumandl & Curran 1992).

It is a marsh wetland class, defined by shallow flooded areas dominated by emergent grass-like vegetation. Early season high groundwater levels drop through the growing season (McKenzie and Moran 2004).

3.1.2 Disturbance History

The ICHxw is generally considered a natural disturbance type 4 ecosystem (NDT4), subject to frequent, stand maintaining fires. However, as the site is located within a floodplain wetland complex, seasonal flooding of the Kootenay River was the primary historic disturbance that influenced the vegetation communities on the site.

The Creston Valley has experienced large losses of native riparian and wetland habitat due to dam construction that altered the natural hydrologic regime of the Kootenay River, and due to the shift to agricultural use of most of the Kootenay River floodplain. Prior to European influence, the floodplain was active across the valley floor, resulting in a complex mosaic of wetland habitats comprised of species like sedges (*Carex* spp.*)* and horsetail (*Equisetum* spp.). Dense stands of black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) bordered the river and grew in patches throughout the floodplain (Jamieson and Braante, 2001; Wilson et. al. 2004). It was a dynamic system, characterized by a meandering primary river channel whose side channels fed a maze of wetlands and backwater habitats. When the river overflowed its banks every spring, it deposited rich silt over the valley floor and replenished the associated wetlands.

Seasonal flooding to a more limited extent still occurs but the intensity and duration varies annually and is dependent on Libby Dam flows. Spring backwatering from the Kootenay River causes Indian Creek to overflow its banks, and initiates shallow flooding through most of the project area, normally for 3-4 months until mid-summer. However during high Kootenay River flow years, flooding can occur for longer periods.

3.1.3 Wildlife in the Creston Valley

The Creston Valley supports a diverse array of wildlife species, including many that are of federal and/or provincial conservation concern. The riparian and wetland habitats of the Yaqan Nuki provide core wildlife habitat and connectivity through the region. All vertebrate wildlife species (as well as dragonflies) occurring in the Creston Valley have been reviewed (Wilson et al. 2004), and bird species checklists for

the valley are provided by van Damme (2002 and 2012). Species at risk (SAR) occurring in the ICH zone of Ktunaxa Traditional Territory and the ICH zone of Creston Valley have been reviewed by Machmer and Steeger (2008) and Machmer and van der Marel (2012), respectively (Appendix 2).

A total of 387 vertebrate wildlife species (and 371 terrestrial vertebrates) are confirmed in the valley, including six amphibian, six reptile, 303 bird, 56 mammal and 16 fish species. A summary of species richness by guild and conservation status is provided in Table 1. Only a small proportion of this diversity is realized within the Yaqan Nuki Wetland Complex.

Table 1. Number and conservation status of vertebrate species confirmed in the Creston Valley, based on Wilson et al. 2004 and van Damme 2013. Status is based on 2014 designations of the BC Conservation Data Centre (CDC) and federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

	Vertebrate Class					Total
	Amphibians	Reptiles	Birds	Mammals	Fish	Vertebrates
Total # species	6	6	303	56	16	387
CDC Red list	1	0	15	3	2	21
CDC Blue list	1	2	27	4	2	36
Total CDC list	2	2	42	7	4	57
COSEWIC Endangered	1	0	5	2	1	9
COSEWIC Threatened	0	0	5	1	0	6
COSEWIC Special Concern	2	3	5	2	1	13
Total COSEWIC listed	3	3	15	5	2	28

Each class of vertebrates (amphibians, reptiles, birds, mammals and fish), would benefit from the increase in habitat complexity that riparian restoration would create. Reduction of invasive plant species cover and the reintroduction of native species would increase the productivity of vegetation on the site. Native vegetation and the presence of large woody debris (LWD) (both terrestrial and in-stream) would result in more structurally complex habitats that support wildlife cover/loafing, resting/perching and rearing. The number of invertebrate and small animal prey species could increase, and support predators of all sizes and types. Livestock exclusion would reduce the risk of trampling, soil compaction and channel-edge instability. Restoration would also increase the functional connectivity of Indian Creek to the surrounding landscape.

Of the six amphibians and six reptiles known to use the Creston Valley, four amphibians (Columbia spotted frog, long-toed salamander, Pacific tree frog and western toad) and four reptiles (including the common gartersnake, terrestrial gartersnake, rubber boa, and painted turtle) have good potential to use the Yaqan Nuki Wetland Complex and the adjacent shrubby and woodland habitats.

Of the 56 mammal species known to occupy the Creston Valley, many would be likely to use the restored project area. These include various rodents (shrew, woodrat, vole, mouse, porcupine, squirrel and chipmunk spp.), several bat species, both aquatic (American beaver, mink, North American river otter, common muskrat) and terrestrial furbearers (various weasel spp., marten, raccoon, red fox, coyote, bobcat, lynx, wolverine), and wide-ranging carnivores (cougar, black and grizzly bears). Indeed, protecting plantings from resident beavers and ungulate browsing will be an important consideration during the restoration.

The ICH zone of Creston Valley supports the highest diversity of birds in the Ktunaxa Traditional Territory, with an estimated 303 bird species occurring, of which approximately 172 species are confirmed local breeders (van Damme 2013). These include at least 36 species of waterfowl (i.e., ducks, geese and swans), and 70 other species of waterbird (loons, grebes, pelicans, cormorants, herons, bitterns, egrets, ibises, coots, rails, cranes, kingfishers) or shorebird (plovers, stilts, avocets, sandpipers, phalaropes, gulls, terns, jaegers). Also included in this tally are six species of upland game birds, 18 birds of prey, 13 owls, 10 woodpeckers, 134 passerines, and 15 “other” species (i.e., pigeons, doves, cuckoos, goatsuckers, swifts, hummingbirds).

3.1.4 Species at Risk

3.1.4.1 Vertebrate Wildlife Species at Risk

As many as 55 vertebrate SAR are known to occur within the ICH zone of the Creston Valley (Appendix 2). Of these, 16 species are considered to have “no potential” to use the project area, seven species are “unlikely” to use the area, 26 species have some “potential” to use the area (either on migration, seasonally or year-round), and the remaining six species have been confirmed on site. These six include the barn swallow, double-crested cormorant, great blue heron, grizzly bear, northern rubber boa and painted turtle. Northern leopard frogs, the focus of a captive rearing program could benefit as it requires shallow water (20-30 cm) herbaceous wetlands, with sparse cattail and spikerush vegetation and a muck bottom near the edges of open water (Adama et al. 2004). Breeding sites must remain wetted until after mass emergence, and then foraging takes place in grassy meadows and semi-aquatic sites along pond margins. Restoration should make the project area more suitable for this species. However, to date, leopard frogs are only known to breed in a fairly defined area within the CVWMA. The western toad is expected to benefit in the project area for the same reasons.

Federally listed northern rubber boas have been observed at the study area (M. Macher pers. obs.). As they are typically found in open woodland, shrub and grassland areas, often under rotting logs, stumps and rocks, any addition of woody debris should benefit this species. Painted turtles are present in the project area (M. Macher pers. obs.), and they require shallow open water areas for feeding and large floating debris for loafing. They would most likely benefit from the addition of large woody debris and reduction in reed canary grass.

3.1.4.2 Vascular Plant Species at Risk

A total of 45 vascular plant SAR are known to occur within the ICH zone of the Creston Valley. Of these, 23 taxa are considered to have some "potential" to occur (Appendix 3) and 20 taxa considered "unlikely" to occur within the project area. Three species at risk were confirmed within the project boundary: fox sedge (*Carex vulpinoidea*), mountain sneezeweed (*Helenium autumnale var. grandiflorum*) and two-edged water-starwort (*Callitriche heterophylla*) (Appendix 3).

3.2 Cultural Values

The LKB is responsible for the lands and resources within the Yaqan Nuki, and are committed to ensuring environmental stewardship within their traditional lands. They are the original inhabitants of the Lower Kootenay area, and are one of six communities that make up the Ktunaxa Nation. They settled in the fertile floodplain, and relied upon the healthy fish, wildlife and plant populations for long-term subsistence and cultural uses. Indian Creek has significant cultural value to the Yaqan Nukiy due to its historic fisheries and ongoing use for hunting and gathering. It was a productive harvest location where they fished for burbot and kokanee (Prince, 2001); white sturgeon were also an integral part of the fishery and were observed coming up Indian Creek to spawn in the warm, slow, dirty waters near the edges of the wetlands (Prince 2008). Wetland plants also provided important foods and medicines. Wapato (*Sagittaria latifolia and S. cunneata* or ?awisi in Ktunaxa) was a keystone plant species, a significant source of carbohydrates. Tule (*Shoenoplectus* spp.), water parsnip (*Sium suave*), stinging nettle (*Urtica dioica*), highbush cranberry (*Viburnum opulus*) and Indian hemp (*Apocynum cannibinum*) were other culturally significant species that were once abundant in the wetlands (Masse Environmental 2009). Due to the significant impacts to Indian Creek over the last century the LKB can no longer rely on these natural resources for subsistence. The restoration of native fisheries, wildlife and cultural values in Indian Creek is a long term goal of the LKB.

The project area and surrounding land on the south side of Indian Creek is currently leased for domestic grazing and has been used for hay production. The LKB intends to continue to use the surrounding land for grazing, but wants to protect riparian values and reduce impacts along Indian Creek by eliminating cattle access. Off channel water sources for cattle may have to be explored to alleviate additional pressure this may put on adjacent wetland areas. Human access to Indian Creek must be maintained for hunting and trapping, and also to the north pump house to manage water levels in the other wetland compartments. In the future, the LKB intends to restore access to the Happy Hunting Ground wetland compartment for dyke maintenance, cattle grazing, hunting and trapping. The land at the confluence of the Goat and Kootenay Rivers is utilized as a cultural camp.

In addition, the Goat River Residents Association plans to use Indian Creek to relieve flood pressure on infrastructure on the main North Channel. An engineered inlet channel is planned to convey flow to Indian Creek during the 9 months of the year the channel is currently dry (Amec 2005). The project

would have limited impact on water levels during the high water period, but will likely benefit fish habitat during all other flows (Amec 2005).

4 METHODS FOR DESCRIBING CURRENT CONDITIONS

A reconnaissance site visit was conducted on July 10, 2013 to walk the site and identify areas of prolonged inundation. On July 23, 2013 a site visit was conducted to identify wildlife values. Vegetation monitoring was conducted on September 11 and 12, 2013 to describe site conditions prior to treatment, and to create a baseline from which to measure the effects of treatments on understory vegetation.

First, the site was stratified into ecological units with similar site conditions and vegetation communities based on observations during initial site visits (Appendix 1 Habitat Units). As the study site has a linear shape, a transect-based sampling method with nested quadrats was selected; ten transects were established in areas that would be most conducive to riparian planting. Each transect line was permanently placed, and ran perpendicular to the river edge for 35 m through the different zones of riparian vegetation (Appendix 1 Habitat Units). The upland end (farthest from the channel) of each transect was marked with a 12 inch metal spike, the top of which was marked by a washer and pink flagging tape. These spikes were pushed into the ground so the tops and washers were flush with the ground surface, and the flagging tape was visible. The GPS coordinates of the metal spikes and the bearings of each transect were recorded.

Quadrat size was based on vegetation type occurring along the transect line. For the grass and forb communities which dominate the site, a 1 m x 1 m quadrat was used. Due to the sparse shrub cover, we used the line-intercept method (Bonham 1989) to estimate shrub cover along each 35 m transect. No tree communities were present within the study area. The quadrats were placed along the right side of each transect at 5 m intervals, or where changes in vegetation were observed. The percent cover of each vegetation species was estimated within each quadrat, plus the percent ground cover of organic matter (litter), moss, exposed mineral soil, animal feces, and water. A soil profile was taken at the upland end of each transect, the soil hand textured and the depths of organic soil, gleying and mottling were measured. The Wetland Keepers Long Form Survey (BC Wildlife Federation, 2013) was used to record information for each transect. Transect data is provided in Appendix 4.

Photographs were taken from the upland end of each transect, looking toward Indian Creek then counterclockwise every 90° at a height of 150 cm. Additional photos were taken from the water edge looking up the transect, upstream and downstream and of each quadrat from directly above. These will provide a visual baseline of the area, and help future field crews to locate the plots.

5 CURRENT CONDITIONS

5.1 Vegetation

The vegetation communities on site are representative of the altered disturbance regime. In general, the site is vegetated with herbaceous species and sparse shrub cover with fairly uniform species composition at the upstream end of the site and higher diversity downstream towards the mouth. The channel edge is uniform, and lacks the complexity of overhanging shrubs, trees and large woody debris (LWD). Unfortunately vegetation on the south side of the channel was heavily grazed at the time of field surveys and a proper inventory could not be completed. Instead, the site was characterized by sub-dividing the area into separate ecological units based on elevation, which determines the frequency and extent of seasonal flooding. Reed canary grass was present in all units; however those that are flooded for longer periods had greater diversity. Because of the subtle elevation changes across the site, there was considerable overlap between them. For example, the sedge/rush unit contained small mounds that were drier, and similar to the wet reed canary grass unit. An inventory of vegetation species identified within the project area is provided in Appendix 5.

The following unit types were identified based on observations made during the 2013 field season (Appendix 1 Habitat Units):

- Aquatic
- Sedge/rush
- Wet reed canary grass
- Dry reed canary grass
- Tree/shrub

5.1.1 Aquatic

This unit was the lowest elevation, and included shallow water wetlands dominated by native submerged and emergent aquatic plants. This unit remains wet through the growing season, and although Indian Creek flows year-round, water levels decline dramatically by late summer. The aquatic unit is mostly located adjacent to the river channel (Photo 1), however two isolated wetlands are present on either side of Indian Creek (Appendix 1 Habitat Units). The wetland on the south side of Indian Creek was dominated by large, vigorous wapato and is a unique feature within the project area because it has not been disturbed by cattle and is dominated by native species (Photo 2).

Wapato was also found growing along the seasonally dry channel margin approximately 100 m upstream of the North Pump station and in the seasonally dry wetland on the north side of the channel approximately 200 m upstream of the old bridge (Appendix 1 Site plan). However, the particular species (either *S. latifolia* or *S. cunneata*), could not be confirmed in these two areas as no flowers were present. The plants along the channel margin were heavily grazed (Photo 3). At both locations the plants were smaller and less robust than those observed in the isolated wetland, probably due to seasonal dryness

(Photo 4). Garibaldi (2003) reports that in some instances, seasonal dry conditions cause *Sagittaria* spp. flower production to be reduced or cease altogether.

Along Indian Creek, the aquatic unit supported submerged plants such as *Nitella* spp., water buttercup (*Ranunculus aquatilis*), Canadian waterweed (*Elodea canadensis)*, duckweed (*Lemna minor*), and pondweed (*Potamogeton amplifolius*).

Photo 1. Aquatic and Sedge/Rush units along Indian Creek September 11, 2013.

Photo 2. Wapato (*Sagittaria latifolia*), growing in isolated wetland south side of Indian Creek.

Photo 3. *Sagittaria* spp. grazed along channel margin.

Photo 4. *Sagittaria* spp. in isolated wetland on north side of Indian Creek.

5.1.2 Sedge/rush

This unit consists of low elevation areas that experience prolonged inundation and have gleysolic soils. This natural flood regime has allowed a community of sedges and rushes to grow amongst the reed canarygrass. The sedge/rush unit occurred at the downstream end of the project area, in the transitional zone along Indian Creek and in depressions within other higher elevation units (Photo 5 – 7). Dominant

sedge species included common spike rush (*Eleocharis palustris*), small flowered bulrush (*Scirpus microcarpus*), wooly sedge (*Scirpus* cyperinus) and fox sedge (*Carex Vulpinoidea)*.

Sparse shrubs of black hawthorn (*Crataegus douglasii*) and willows (*Salix* spp.), (remnants of previous revegetation efforts) were present along the south bank; however they have been heavily browsed and trampled so provide no ecological value in their current condition. Vegetation along the south side of the unit had been entirely grazed by cattle, which may be limiting the reproduction and spread of native species. Exposed soils were present along the stream bank due to cattle access (Photo 8).

Photo 5. View upstream of unit toward North Pump house July 10, 2013.

Photo 6. View upstream from old bridge July 10, 2013. Dark green area dominated by sedge/rush.

Photo 7. Small flowered bulrush growing along north bank.

Photo 8. Exposed soils at cattle access point September 11, 2013.

5.1.3 Wet reed canary grass

This unit was slightly higher in elevation than the sedge/rush unit and mostly located at the upstream end of the site but also present in smaller areas downstream. The unit floods in spring, and the fine textured soils remain moist over summer then become drier further upstream from the mouth. This flood

regime will likely maintain the dense stands of reed canary grass that dominate this unit. Other non-native pasture grasses such as quackgrass (*Elymus repens*), orchard grass (*Dactylis glomerata*), common Timothy (*Phleum pratense*) and redtop (*Agrostis stolonifera*) were also present, and sedges were scattered in pockets throughout. Invasive weeds including curly dock (*Rumex crispus*), absinthe wormwood (*Artemisia absinthium*), Canada thistle (*Cirsium arvense*) and sulphur cinquefoil (*Potentilla recta*) were problematic in this unit, especially along the compacted cattle trails. A few scattered shrubs (black hawthorn and willow) were present in the most downstream polygon, in addition to residual plantings along the south bank from previous revegetation efforts. The plantings were heavily browsed and trampled, so provide no ecological value in their current condition.

Historically, the main polygon in this unit was tilled and harvested for hay which has contributed to the lack of diversity (Photo 9). Vegetation on the south side was heavily grazed by cattle and over steepened banks and exposed soils were present along the stream bank due to cattle access (Photo 10 - 12).

Photo 9. Portion of unit that was historically tilled on left bank July 10, 2013. Dry reed canary grass unit on right bank.

Photo 10. View downstream of unit September 11, 2013.

Photo 11. View downstream of over steepened banks and exposed soils September 11, 2013.

Photo 12. Close up view of oversteepened banks and exposed soils.

5.1.4 Dry reed canary grass

This unit was the highest elevation within the project area, located primarily along the north side of the channel but also present at the upstream end of the site on the south side. Flooding is less frequent on this bench and the fine textured soils generally dry out over the summer months. Dense stands of reed canary grass dominated the vegetation (Photo 13). A few scattered willow (*Salix bebbiana* and *Salix exigua*) and black hawthorn shrubs were present; however the dense stands of grasses combined with disturbance from cattle preclude other native woody vegetation and prevent the growth of most other plant species (Photo 14). Invasive weeds such as Canada thistle, absinthe and oxeye daisy (*Leucanthemum vulgare*) were well established.

Photo 13. View downstream of unit on north side of channel July 23, 2013.

Photo 14. View upstream of unit on south side of channel September 11, 2013.

5.1.5 Tree/shrub

This unit occupied a similar elevation as the dry reed canary grass unit, and was located upstream and downstream of the site. These natural areas were less disturbed and contained predominantly native vegetation. The dominant species included Bebb's willow, sandbar willow, red osier dogwood (*Cornus stolonifera*), black hawthorn and rose (*Rosa* sp.). Black cottonwood was present along the Goat River North Channel from Indian Creek to the Kootenay River. Reed canary grass was the dominant herbaceous cover, and sedges were present in scattered depressions. Invasive weeds were present throughout.

Photo 15. View downstream of cottonwood stand at confluence with Goat River.

Photo 16. Tall shrubs present near confluence with Goat River.

5.2 Wildlife

The conversion of wildlife habitat to agricultural use and the resulting browsing, grazing and trampling in the riparian area have heavily impacted wildlife habitat suitability and use. Aggressive non-native grasses and invasive plants that are unpalatable to herbivores and less productive for insects, now dominate the site. Structural habitat complexity (typically created by diverse native herb, shrub and tree layers, as well as wildlife trees and large woody debris), has been lost. Many of the wildlife guilds which require these structural components (see Machmer and Steeger 1995; Stevens 1997) were either missing, or present at lower than expected levels in the project area.

The area provides key habitat for ungulates (mainly white-tailed deer and rocky mountain elk, with fewer mule deer and moose), as evidenced by the amount of sign (beds, scat, browse, etc.) detected on site. According to the LKB, a resident grizzly bear is detected here seasonally, so the creation of greater tree and shrub cover including berry-producing shrubs is likely to benefit bears, as well as ungulates using the area.

There are a number of bird species that have been confirmed breeding in other areas of the Creston Valley or the CVWMA, that were not found on the project site (e.g., American bittern, bobolink, Forster's tern, Lewis's woodpecker, long-billed curlew, short-eared owl, western grebe, western screech-owl and yellow-breasted chat). The lower diversity and abundance of waterfowl, waterbirds and shorebirds is likely due to the lack of shallow open water with the progression of the season, the density of reed canary grass and invasive plant species, and the presence of livestock and associated habitat impacts. Passerine species richness also appeared lower in the project area than in portions of the CVWMA (Machmer 2014, in press), which likely relates to the degraded plant communities and lack of structure for foraging, nesting and perching.

A pair of breeding sandhill cranes (*Grus canadensis*) was observed on the west side of Indian Creek during the July 23rd site visit. This previously blue-listed species nests on the ground or in shallow water around large marshes, fens, bogs, open meadows. It shows high breeding site fidelity and screening cover and isolation are important, especially during the breeding season. In other seasons, it roosts in shallow water or on islands. If restoration includes the creation of some taller cover and "habitat islands", it should benefit this species.

6 RESTORATION GOALS AND OBJECTIVES

The goal of this project is to restore a naturally functioning riparian ecosystem and enhance cultural values along Indian Creek. To achieve this goal the following broad project objectives were developed:

- Eliminate livestock browse pressure and offer an off-channel water source while maintaining access for hunting.
- Increase bank stability and reduce sediment inputs from eroding banks.
- Enhance fish habitat by increasing cover (native vegetation and LWD).
- Enhance wildlife habitat by improving structure (native vegetation and LWD), and create a habitat mosaic including woody vegetation and open areas.
- Enhance abundance of culturally significant plant species.
- Limit the presence of invasive weeds with mechanical control and native vegetation.
- Protect residual plantings that remain from initial revegetation efforts.

Each of these actions will support the development and maintenance of the target ecosystems.

6.1 Target Ecosystems

The desired future condition of the site is a structurally diverse mosaic of native plant communities in various successional stages that will respond to moisture gradients and topographic variation through the site, and support habitat complexity (Photo 17). Each vegetative unit has unique recommendations based on goals and current conditions.

Photo 17. Reference site: structurally diverse riparian area immediately upstream of project boundary.

6.1.1 Aquatic

The goal for these areas is to maintain the aquatic wetland complex. No physical treatment is currently proposed; these areas should remain undisturbed to prevent invasive species from becoming established. Monitoring the natural recovery of the shoreline *Sagittaria* spp. community in response to cattle exclusion should be conducted. If monitoring does not indicate natural recovery after three growing seasons, the limiting factors should be identified and if possible addressed, then propagation and planting considered.

6.1.2 Sedge/rush

The goal in these areas is to maintain and enhance the existing sedge/rush communities as open marsh habitat. The exposed soil areas (cattle access points) along Indian Creek should be planted with native species to reduce erosion and prevent colonization by aggressive grasses and invasive weeds. Areas where reed canary grass is limited should be left undisturbed, as the plant community consists primarily of desirable species. On drier microsites along Indian Creek where reed canary grass is established and additional control is warranted, habitat islands are proposed. The previously planted residual shrubs located along Indian Creek will be protected from browse to promote growth.

6.1.3 Wet and dry reed canary grass

These areas represent disclimax communities that established or were seeded on low bench sites (McKenzie and Moran 2004). The goal is to increase habitat diversity and reduce the area dominated by reed canary grass by encouraging succession to low and mid bench flood class sites as described by McKenzie and Moran (2004). The low bench flood class occurs on sites that flood for moderate periods of the growing season, limiting the canopy to tall shrubs. Mid bench sites are briefly flooded during freshet, limiting tree growth to flood-tolerant broadleaf species such as black cottonwood. Habitat islands should be planted along the streambank with early successional woody species, and in patches within meander bends.

6.1.4 Tree/shrub

These areas were used as general reference ecosystems and no physical treatment is proposed. The existing habitat should be maintained and disturbance minimized to prevent the further establishment and spread of invasive species.

6.2 Challenges and Limiting Factors

The project has some persistent obstacles that will need to be addressed including:

- Invasive weeds;
- reed canary grass;
- simplified topography; and
- erosion.

6.2.1 Invasive Weeds

The management of invasive weeds should be consistent with the Creston Invasive Plant Management Area (IPMA) Operation Framework (Craig 2012). Invasive weeds present in the project area are widespread throughout the valley and are categorized in the Creston IPMA as one of *Containment*, *Established*, or *Insufficient Information*, and no specific control measures are provided (Appendix 2). Treatment for these species should be based on specific land management objectives (Craig 2012). Therefore, an integrated weed management approach is proposed and will be an important component for restoring the native riparian plant communities on site. This will involve a combination of planting, seeding and mechanical treatments (digging, hand-pulling, mowing). Chemical treatments at this site are not supported by the LKB due to the sensitive nature of the area. To be effective, mechanical treatments will require aggressive management for the first couple of years to reduce weed density and create openings where desirable species can become established. Over the long term the goal is to create conditions throughout the site that will naturally resist competition from invasive species. For this to be successful, desirable species must colonize the openings created by weed control activities. Monitoring will be an essential tool to adapting weed management activities based on the results of initial treatments.

6.2.2 Reed canary grass

Reed canary grass is strongly rhizomatous and produces a dense sod and full canopy. By excluding most other species it creates a monotypic stand (McKenzie and Moran 2004). It prefers seasonally or continually moist habitats, although once established it can survive both prolonged drought and long-term flooding. There are native and introduced cultivars that are difficult to distinguish from one another. Infestations are difficult to control due to the persistent rhizome system and the plant's ability to reproduce both vegetatively (from rhizomes) and sexually (from seeds). Reed canary grass has become well established in the disturbed areas on site and is the dominant species within the restoration area.

Although it can be partially controlled by mechanical and/or chemical means, our approach is to alter site conditions by planting competing native vegetation. The transitional zone between the aquatic and upland plant communities, which characterises most of the restoration area, is where reed canary grass is most difficult to treat. It is intolerant of year round shade, and fast-growing shrubs will eventually dominate if they are allowed to establish (Tu 2004; Kim 2006; BES 2012). The use of live willow stakes to create overstory vegetation can result in significant control of reed canary grass in only a few growing seasons, and thorough site preparation to remove the grass before planting has been found to improve initial establishment (Kim 2006). Planting shrubs where the sod has been removed and covering the soil with mulch is another viable treatment option, and an alternative to chemical herbicides (BES 2012, Tu 2004).

Because reed canary grass also dominates the areas outside the project boundary, this project does not attempt to eradicate it. We will encourage succession and create diversity by planting 'habitat islands' throughout the reed canary grass dominated areas. The habitat islands will act as seed sources for further colonisation and the shade from woody shrubs will eventually inhibit reed canary grass and create favorable conditions for native forbs.

6.2.3 Simplified topography

Cultivation and dyke construction have created a relatively smooth, homogenous floodplain surface with few microsites to provide habitat variation. Restoring topographic heterogeneity in freshwater wetlands is considered beneficial to the overall structure and function of the ecosystem (Larkin et. al. 2008). Under natural conditions wetlands have basins and hollows (such as those in Sedge/Rush Unit) that enhance diversity by creating habitat niches (Larkin et. al. 2008). Topographic variation of as little as 5 cm in elevation can shift hydrologic conditions and biotic responses (Larkin et. al. 2008). It is important to consider the broad ecosystem effects of topographic heterogeneity when planning wetland restoration projects.

Site preparation treatments such as rough and loose patches and stripping, can create topographic heterogeneity. These surface treatments promote revegetation and initiate natural successional processes by creating microsites for the seeds of native pioneering species. They also provide ideal planting conditions for fast growing pioneer species such as willow, dogwood and cottonwood (Polster 2009). Rough and loose configurations in combination with dense live staking will also help control reed canary grass in the treated areas.

The addition of coarse woody debris (CWD) within the planting areas would also create microsite heterogeneity and enhance recovery processes (Polster 2011). CWD would promote native seed recruitment, provide microsites for tree/shrub establishment, create shade, retain moisture and stimulate biological development in soils. A variety of wildlife species including both vertebrates and invertebrates would immediately benefit from the additional cover (Stevens 1997).

6.2.4 Erosion

Eroding, over-steepened banks are present along the channel due to cattle. One section in particular along the channelized section will require heavy equipment to re-slope the bank to a stable angle prior to revegetation (Photo 11 and Photo 12). This project will address eroding banks by planting the transitional zone with sedge and rush species, to control erosion and provide long term diversity. Habitat islands will be planted along the top of the bank, which will provide shade to Indian Creek, bank stabilisation and LWD recruitment over the long term.

In addition to revegetation, a channel assessment should be conducted and opportunities to incorporate LWD within the bank to create fish habitat should be explored. The addition of LWD cover would aid in bank stability, create channel complexity and provide immediate habitat for fish and wildlife. Specific focus should be given to the over-steepened banks in the channelized sections and to the outside meander bends downstream. LWD should not be placed where *Sagittaria* spp. plants are growing along the channel margin upstream of the north pump house.

7 RESTORATION PLAN

The following section describes the recommended restoration treatments to meet project goals and objectives. The treatments include: fencing, residual plant protection, coarse woody debris placement, planting sedges and rushes, tree and shrub planting in habitat islands, brush layers and invasive plant management. A Planting Plan map showing the treatment areas and detailed planting prescriptions are provided in Appendix 6; project implementation guidelines and general specifications for site preparation, planting, maintenance, and monitoring follow.

7.1 Fencing

Unrestricted cattle grazing in the area was recognized as one of the main reasons for the lack of functional riparian vegetation, as well as the greatest limitation to any proposed revegetation. As a result, the first step in the restoration process is to limit cattle within the project area to encourage native plants to grow and prevent further damage to stream banks.

The most effective way to limit cattle access is to fence the site boundaries. The south boundary will be fenced first and the north boundary will be fenced in the future once a new bridge is constructed to restore access. Fencing along the north boundary is proposed along the inside toe (Indian Creek side) of the dyke so the LKB can maintain the dyke and eventually allow cattle to graze and control the grasses on top of the dyke.

The following factors were considered to determine the project boundaries:

- locations of existing vegetation communities and sensitive areas

- need for sufficient width to restore riparian processes such as overstream cover and shade, and allow for potential channel migration at outside meander bends
- need for maintenance of land outside the boundary for cattle grazing
- need for exclusion of cattle from Indian Creek, and the development of off-channel access to water
- need to provide access to the site for hunting,
- need to provide access to the north pump house and water diversion infrastructure
- need for wildlife passage

The fence on the south side of Indian Creek will be setback from the creek edge by a minimum distance of 20m. This distance will vary as the creek meanders, but the fence will be linear as it will be stronger and easier to construct (Figure 2). The fence will include a main gate to maintain access to the bridge and pumps, as well as secondary gates to allow access for hunting.

Various types of fences are available. As the site is located in a high wildlife use area and the purpose of the fence is to help protect sensitive habitats, a wildlife friendly fence is recommended. Wildlife-friendly fences are highly visibly to ungulates and birds, allow wildlife to safely jump over or crawl under, and provide access to important habitats and travel corridors (Hanophy 2009).

The recommended wildlife-friendly fence for cattle is the following (Hanophy 2009):

- a four-strand fence with smooth upper and lower wires,
- the fencing wire located on the livestock side of the fence,
- the top strand a maximum of 42" from the ground,
- a minimum of a 12" gap between the top two wires,
- the bottom strand should be a minimum of 16" off the ground,
- the posts at a minimum of 16' intervals, and
- a visual marker along the top strand.

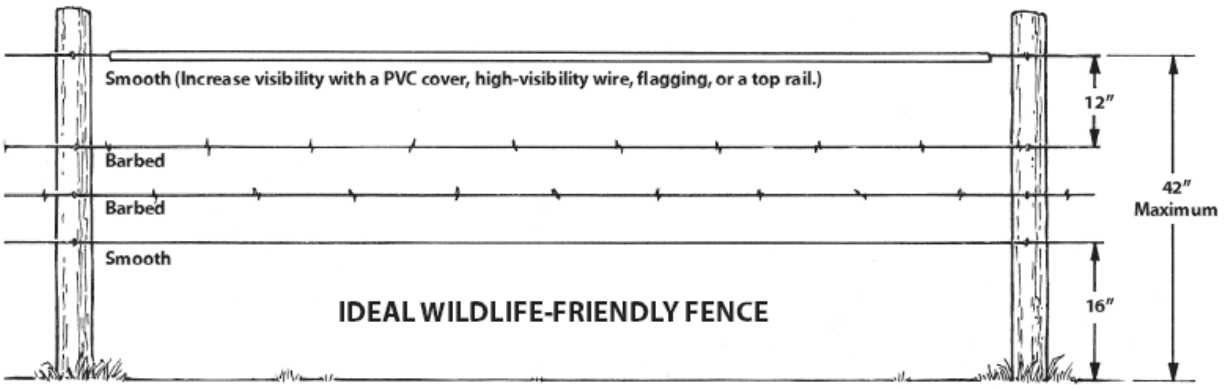

Figure 2. Wildlife-friendly fence diagram.

Signs on all gates and periodically along the fence are recommended so people are aware that the fence is in place to protect sensitive habitat, making them more likely to respect the fence and keep gates closed.

7.2 Residual Plant Protection

The previously planted residual shrubs located along Indian Creek will be protected from browse to promote growth (Appendix 1 Site Plan). Plant growth should be monitored following fence installation to assess if this treatment alone provides sufficient protection, or if further protection from wildlife browse is required. If monitoring determines browse by wildlife is still impacting growth then individual plant protectors should be installed. Browse protection guidelines should follow those described in Section 7.6.3).

7.3 Large Woody Debris

Large woody debris should be placed at or before the time of planting to prevent damage to newly planted areas. Large, hollow logs are preferable as these provide the greatest ecosystem benefits; however, solid LWD is acceptable (M. Machmer pers. comm.). The logs should be placed within the habitat islands to provide micro site planting locations, and depending on supply could also be randomly distributed throughout the remainder of the site. The LWD will shift seasonally during freshet but will continue to provide ecosystem benefits.

Placement of LWD will require the use of a small excavator. A rubber tired or rubber tracked machine should be used to minimize ground disturbance. The mobilization of any equipment to site should only be conducted during dry seasonal conditions such as late summer or fall when there is less chance of impacting wildlife and vegetation. The timing of LWD placement should be planned concurrently with other activities that require an excavator (e.g. site preparation for habitat islands or LWD placement in the channel) to minimize disturbance. In the event that ground disturbance does occur, the exposed soil areas should be seeded with a fast establishing native seed mix to prevent the spread of invasive weeds.

7.4 Invasive Plant Management

Invasive weed control should be a primary focus of ongoing management activities within the restoration area. The preferred method of removal is hand pulling/digging to remove the root structure, and then bagging the plants and roots to be disposed of at the landfill. Alternatively, brushing larger stands before they go to seed (where native plants will not be impacted) can also be an effective control method but would need to be repeated routinely. Species specific requirements are described in Table 2. To be effective, mechanical treatments will require aggressive management for the first couple of years to reduce weed density and create openings where desirable species can become established. Routine

manual weeding should be conducted during the growing season (June to September) to ensure that all species are targeted and reduce the number of invasive plants that go to seed.

Community weeding events can be an effective way to implement weed maintenance while promoting stewardship of the site, and can provide an educational and interactive activity to engage the Yaqan Nukiy School. Weeding should also be conducted during planting activities while personnel are on site.

Invasive weed management should also consider the following:

- seeding or planting any exposed or disturbed areas with suitable native species to prevent colonization by invasive weeds
- minimizing the amount of disturbance to avoid creating areas where invasive weeds can colonize
- removing weeds around plantings to reduce competition and maximize growth of native plants
- removing by hand weeds in small patches in sensitive wetlands
- reducing the abundance of reed canary grass by establishing native overstory vegetation that will eventually out-compete the undesirable vegetation (Section 7.6).

Table 2. Invasive weeds and recommended control.

Species	Control Measures
Curled dock *(Rumex crispus)*	• Manual and mechanical control by hand pulling, constant mowing (not too low) before seeding and grazing.
Mullein *(Verbascum thapsis)*	• Minimize soil disturbances from vehicles, machinery and over-grazing to prevent spread. • Manual and mechanical control by tillage, pulling or cutting below the root crown when the soil is damp. (More effective when done prior to seed production).
Oxeye daisy *(Leucanthemum vulgare)*	• Manual control by hand pulling or digging before seed production. However for this method to be successful, it is important to remove as much of the roots as possible.
Absinthe *(Artemesia absinthium)*	• Minimize soil disturbance from vehicles and machinery, avoid over-grazing, and watch roadsides and fence rows for new populations to prevent spread. In pastures, a healthy stand of perennial grass will resist invasion and reduce spread of this plant. Disturbed areas should be re-seeded to prevent spread of absinth wormwood. • Mechanical control by mowing when buds are emerging.
Canada thistle *(Cirsium arvense)*	• Biological controls in place (2 seed head weevils and 1 gall-forming fly) and continued monitoring by MFLNRO (Craig 2012). • Mechanical control by cutting prior to seed set will wear down plant reserves until native vegetation is established.
Sulpher cinquefoil (*Potentilla recta*)	• Minimize soil disturbance and reseed with grasses in areas of exposed soil to prevent spread.
Common Tansy *(Tanacetum vulgare)*	• Minimize disturbance and maintain healthy native communities to prevent establishment of new infestations. • Mechanical control by mowing before flowering and seed-set to eliminate seed production.
Knapweed sp. *(Centaurea sp.)*	• Manual and mechanical control by hand pulling, mowing, and reseeding with a cover crop.

7.5 Sedge / Rush Planting

Immediately following fence installation, the exposed soils at each cattle access point should be planted with native sedges and rushes to prevent colonization by aggressive grasses and weeds (Appendix 1 Planting Plan). Planting plugs has been found to have a higher success rate and be more cost effective than seeding as seed is very expensive and can be difficult to acquire (M. Keefer pers. comm.). Once planted, seed is often eaten by birds before it has a chance to germinate. The plugs will be faster to establish and provide a more immediate soil cover.

The planting areas range in size from 150 m^2 to 1050 m^2 for a total plantable area of 4110 m^2 (Table 3). Plugs should be planted at an average spacing of 50 cm (400 plugs/100 m^2). The total number of sedges required is 16440 (Table 3). The exact species mix could not be determined at the time of writing, as the dominant species on site were heavily grazed during the site visits. A follow up site visit will be required once the cattle exclusion fence has been installed to identify the dominant species and complete these recommendations. The species listed in Table 4 are recommended based on preliminary observations. It is possible that the planting areas may decrease due to natural colonization and should be reevaluated prior to ordering plant materials.

Table 3. Sedge/Rush planting area (Appendix 1 Planting Plan).

Planting Unit ID	Unit Type*	Area (m^2)	Plugs @ 50cm spacing (#)
a	S/R	300	1200
b	S/R	750	3000
c	S/R	1050	4200
d	S/R	150	600
e	S/R	750	3000
f	S/R	575	2300
g	S/R	260	1040
h	S/R	275	1100
Total		4110	16440

*S/R = Sedge/Rush

Table 4. Recommended species of sedge/rush for plant.

Species	% Composition	Stock Type	Values
Common spikerush (Eleocharis palustris)	TBD	Plug	Wildlife, cultural
Small flowered bulrush (Scirpus microcarpus)	TBD	Plug	Wildlife, cultural
Fox sedge (Carex Vulpinoidea)	TBD	Plug	Species at risk
Slender rush (Juncus tenuis)	TBD	Plug	Cultural

7.6 Habitat Islands

Habitat islands should be planted within the areas identified in the planting plan (Appendix 1). Restoration treatments are aimed at enhancing the native plant community and should not impact desirable natives, so actual locations should be field-fit to avoid disturbance to rare plants and any pockets of desirable native vegetation (such as sedge/rush). The islands range in size from 400 m^2 to 3600 m^2 for a total plantable area of approximately 3 ha along the banks of Indian Creek (Table 5).

Table 5. Habitat Island type and area (Appendix 1 Planting Plan).

Planting Unit ID	Unit Type*	Area (m^2)	Planting Unit ID	Unit Type	Area (m^2)
1	T/S	3360	7.v	T/S	400
2	T/S	1134	8	SH	1600
3	SH	3000	9.i	T/S	400
4	SH	3600	9.ii	T/S	400
5.i	T/S	400	10	T/S	2100
5.ii	T/S	400	11	SH	1850
5.iii	T/S	400	12	SH	4100
6	SH	2640	13.i	T/S	400
7.i	T/S	400	13.ii	T/S	400
7.ii	T/S	400	13.iii	T/S	400
7.iii	T/S	400	14	SH	900
7.iv	T/S	400	Total		29484

*T/S = Tree/Shrub; SH = Shrub

Shrub islands and tree islands are proposed, with dominant species comprised of flood tolerant willow and red osier dogwood mixed with black cottonwood (Table 6). All tree islands are cottonwood stands mixed with shrubs to establish structural diversity. Other species proposed for wildlife and cultural values are black hawthorn, highbush cranberry (*Viburnum trilobum*), prickly rose (*Rosa acicularis*), Saskatoon (*Amelanchier alnifolia*) and elderberry (*Sambucus* spp.). Average plant spacing should be 1.5m as dense planting is recommended to compete with the aggressive grasses, however plantings can be clumped closer together to avoid impact to desirable species. Areas with dense stands of aggressive grasses and weeds within the Habitat Islands should be targeted. Planting prescriptions for each Habitat Island are provided in Appendix 6 and include species, composition, density, plant material type and site preparation recommendations. These prescriptions provide general guidance for project implementation however later phases should be modified based on results of the most successful planting and site preparation techniques.

Table 6. Plant species recommended for Habitat Islands.

Species	Stock Type	Values
Bebb's willow (*Salix bebbiana*)	Live stake, TRS, potted stock	Wildlife, cultural (medicine and technology)
Sandbar willow (*Salix exigua*)	Live stake, TRS, potted stock	Wildlife, cultural (medicine and technology)
Red osier dogwood (*Cornus stolonifera*)	Live stake, TRS, potted stock	Wildlife, cultural (food, medicine, technology)
Black cottonwood (*Populus balsamifera spp. trichocarpa*)	Live stake, TRS, potted stock	Wildlife, cultural (medicine and technology)
Black hawthorn (*Crataegus douglasii*)	Potted stock	Wildlife, cultural (food, medicine, technology)
Highbush cranberry (*Viburnum trilobum*)	Potted stock	Wildlife, cultural (food, medicine, technology)
Prickly rose (*Rosa acicularis*)	Potted stock	Wildlife, cultural (food, medicine, technology)
Saskatoon (*Amelanchier alnifolia*)	Potted stock	Wildlife, cultural (food and technology)

7.6.1 Site Preparation

Due to the aggressive nature of reed canary grass and other agronomic grasses, control measures should be implemented prior to planting to improve establishment of shade producing woody species. Ongoing maintenance will be required for a minimum of 3-5 years until the shrubs and trees are tall enough to shade the area. A number of site preparation options and preventive measures are available for treating the aggressive grasses prior to and during planting. Chemical treatments are not supported on this site. The type and extent of treatment is dependent on the presence of desirable native species. Note that some options require the use of heavy equipment which can cause undesirable effects such as soil compaction, vegetation damage, wildlife impacts and soil exposure. Use of such equipment should be minimized and conducted at appropriate time of year when impacts are reduced. It is recommended that mechanical treatments be conducted only within the reed canary grass habitat units as they are already disturbed. Machinery should be restricted from the sedge/rush and aquatic units as much as possible. Site preparation options include:

- Stripping – Stripping requires removing the sod from an area prior to planting to reduce competition with planted stock. It can be conducted in one of two ways depending on the presence of desirable vegetation; stripping selected planting sites or larger patches within Habitat Islands. For individual planting sites the sod should be removed from a 1 m x 1 m area. The size of larger patches can vary and should be field fit within individual islands. Clusters of trees and shrubs can then be installed within the stripped areas. Stripping can be conducted manually with hand tools such as a grub hoe or Pulaski or with a small excavator. The stripped materials should be placed in a mound adjacent to the planting location to create hummocks which will help restore some topographic heterogeneity to the site. It is important to note that this technique creates exposed soils which are prone to colonization by invasive species in the short term.

Where stripping is used the areas should be planted with annual grasses or heavily mulched to prevent invasive plant growth.

An alternative method to prepare planting sites that causes minimal disturbance is with a hand held Auger. Soils disturbance is limited to the immediate planting site preventing exposed soils and spread of invasive species. The valuable topsoil is also retained.

- Solarization/Brush mats – Solarization requires placement of thick woven geotextile shade cloth over targeted grasses and weeds to suppress or kill growth until vegetation becomes established. Mowing or brushing the area first can facilitate installation. The size of the treatment areas within Habitat Islands can vary depending on the presence of desirable vegetation. Woody vegetation should be installed through the material. Where desirable vegetation is mixed throughout, heavy duty brush mats with a minimum dimension of 90 cm x 90 cm should be installed around individual plantings to target control to the rooting zone. These techniques have been used effectively by the Kootenai River Network in Therriault Creek, northwest Montana (Geum Environmental 2009) and photos can be viewed at http://www.geumconsulting.com/wp-content/uploads/2011/09/Therriault%20Creek_2009_Riparian%20Revegetation%20Monitoring%20Report_Geum%20Environmental.pdf. The edges of shade cloth and brush mats must be secured to prevent displacement. The shade cloth should be kept in place for two-three growing seasons or until the shrubs have become established. Following removal the bare soil can be seeded with native species to prevent invasive weed colonization, however this may not be necessary as natural recruitment of native species may occur.

- Rough and loose – Rough and loose surface treatments create mounds and hollows within the existing ground, breaking up the dense mats of grasses and creating loose soils that can easily be planted with live stakes. An excavator is used to excavate holes and the material generated is then dumped in mounds between the holes. Polster 2011 describes the technique:

  "An excavator with a digging bucket digs a large bucket full of soil and places it to the left of the hole, half a bucket width, so it is half in and half out of the hole. A second hole is dug half a bucket width to the right of the first hole. Material from this hole is placed between the first and second holes. A third hole is now opened half a bucket width to the right of the second hole, with the excavated soil placed between the second and third holes. Care should be taken when excavating the holes to shatter the material between the holes as the hole is dug. This process is continued until the reasonable operating swing of the excavator is reached. The excavator then backs up the width of a hole and repeats the process, being careful to line up the holes in the new row with the space between the holes (mounds) on the previous row."

Once the island has been prepared it should be planted densely.

7.6.2 Planting Techniques

The following planting techniques are recommended to establish woody species in Habitat Islands:

- Live staking – Live staking is the placement of dormant live cuttings of willow, dogwood and cottonwood vertically into the ground. Live stakes should be approximately 1 m long and a minimum of 2 cm diameter at the tip end. About 1/2 of the cutting length should be buried into the ground. The cuttings must be long enough that the stem will remain above the competing vegetation after planting and that the end is buried into the ground a minimum of 50 cm for maximum moisture retention. The ideal planting distance between live cuttings to most effectively outcompete reed canary grass is 0.60 m (Kim et. al. 2006).

- TRS cuttings – Tall Rooted Spike (TRS) cuttings are rooted live cuttings 2-3 m tall grown by Treebear Native Plants in Nelson. TRS cuttings have a well-established root system which accelerates plant establishment and overstorey cover. They can be planted at any time of year and provide an immediate competitive advantage over undesirable tall herbaceous vegetation and are less susceptible to wildlife browse. Where prescribed, TRS cuttings should be spread throughout the planting area.

- Containerized Planting –Containerized plants should be a minimum of one-year-old potted nursery stock in a 1 gallon pot size to help compete with the aggressive grasses. Larger stock would provide greater competitive advantage but may be cost prohibitive (Koning 1999). All plant stock should be acquired from a reputable supplier or commercial growing centre, preferably a local nursery that deals in native plants. Where prescribed, containerized plants should be spread throughout the planting area.

- Brush layering – Brush layering is the placement of dormant live cuttings perpendicular into the riverbank. Brush layers should be planted mechanically using an excavator along the upstream portion of the site as shown in planting plan (Appendix 1). Because planting will be machine assisted, the cuttings can be longer than live stakes. The cuttings should be 1.5-2 m long and a minimum of 2 cm and maximum of 10 cm in diameter. At least 3/4 of the length should be buried into the bank with the tips protruding beyond the soil surface. Six cuttings per lineal meter should be installed at a 45 degree angle to the slope. Usually brush layers are planted in an excavated trench however it is not necessary to cause that much disturbance. It is possible to minimize soil disturbance using an excavator by cutting into the bank and slowly lifting the bucket, creating a gap into which the live cuttings can be inserted by hand. Once the cuttings are inserted the bucket slowly releases the native ground back down on top of the cuttings. This way no backfilling is required and existing vegetation is minimally disturbed. Grass seeding is unnecessary unless there is considerable soil exposed. This machine assisted planting technique allows the cuttings to be easily planted to the sufficient depth. Two rows of cuttings should be installed, one along the top of bank and one approximately 1 m below the top of bank.

7.6.3 Planting Guidelines

7.6.3.1 Care and Handling of Live Cuttings

All live cuttings must be collected and installed during the dormant period (late fall - early spring). The cuttings should be collected from healthy, moderately rapid growing parent plants from as close to the project site as possible and from areas with similar ecological conditions. As a general guideline collect cuttings within 30 km of the project site and within a maximum of 200 m elevation. The cuttings should be kept cool, moist and in a shaded location until planting. Optimally the cuttings should be soaked for up to 10 days prior to planting to stimulate the natural rooting hormones and ensure the cuttings are fully hydrated prior to use. Soaking may not be necessary as the site is inundated annually.

7.6.3.2 Microsite Selection

Unless otherwise specified, planting of woody species should be restricted to the top of bank to prevent mortality from prolonged inundation on the banks of Indian Creek. Flood tolerant species are recommended for lower areas that remain wet for longer periods. Shrubs suitable for drier conditions are only recommended on higher sites. As previously stated, planted woody species should not displace native species and should target areas where aggressive grasses and invasive weeds occur. Although general spacing is recommended to be 1.5 m, actual plant distribution should be variable to mimic natural occurrence as much as possible. Trees and shrubs should be planted in clumps or small groups of 5-10, with a mix of different species combined within each clump.

If LWD is placed during site preparation, it can also provide microsites for planting. Planting locations should be selected on the lee side of LWD for shelter from sun and wind.

7.6.3.3 Container Plant Installation

Container plants should be installed in holes roughly 2-3 times the diameter of the container. The soil in the bottom and sides of the hole should be loosened and the plant roots gently untangled prior to placement in the hole. All container plants must be installed in such a way that the top of the root ball (where the roots end and trunk begins) is flush with the surrounding native soil surface making sure not to cover it. The hole should then be backfilled with the excavated material and firmly compacted around the root mass to ensure no air pockets are present (Figure 3).

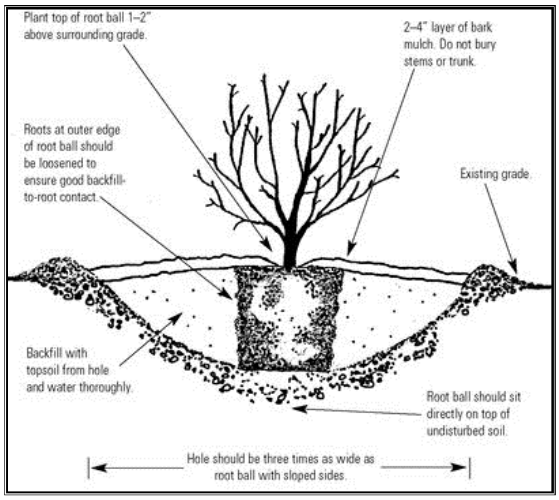

Figure 3. Container plant installation diagram.

7.6.3.4 Plug Installation

Plugs should be installed in holes that are deep enough to accommodate the entire root system without bending. If the roots are curled or bunched up it may be detrimental to water and nutrient uptake causing the plant to weaken and die. Any organic material should be removed from the hole to prevent air spaces once the material decomposes. The plug should be placed by guiding the roots along a shovel blade to the bottom of the hole ensuring that the roots are straight and fully extended. Plugs are planted to the same depth as they were in the nursery container by identifying the colour change on the stem (slightly above the root collar swelling). Air pockets are removed by firmly tamping the soil. A diagram illustrating proper seedling planting is provided as Figure 4.

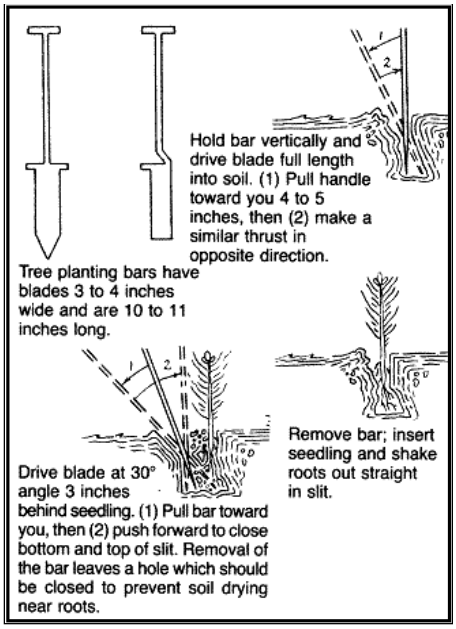

Figure 4. Plug installation diagram.

7.6.3.5 Browse Protection

Newly planted young trees and shrubs that are palatable to wildlife can be susceptible to browse by ungulates. Installing browse protection can increase survival rates, accelerate growth and improve growth form (Keeton 2006). Seasonal inundation of the site, however, may prohibit the effectiveness of this treatment. Trials should be conducted on a small number of plants to determine the ability of plant protectors to withstand seasonal inundation prior to treating a large area. A number of different types of rigid plastic protectors are available, however taller, larger diameter shelters are recommended to reduce maintenance requirements. The tree shelters should be a minimum of 50 cm taller than the plant to be effective in preventing browse.

To prevent beaver damage to planted live stakes and TRS cuttings, the exposed portion of the cutting should be painted with a mixture of sand and latex paint (1.5 cups coarse sand per litre of latex paint). To prevent vole damage, vinyl tree protectors can be installed around the base of the stem (approximately 1 foot). The tubes should be removed once the plant is well established. Photographs of these applications can be viewed online at http://treebearplants.ca/?page_id=681.

7.7 Summary of Restoration Treatments by Ecological Unit

A summary of restoration treatments by Ecological Unit is provided in Table 7.

Table 7. Summary of restoration treatments per Ecological Unit.

Ecological Unit	Current Condition	Target Condition	Treatments
Aquatic	Generally good. No invasive species observed, however aggressive native plant (water buttercup) is widespread. Grazing pressure is impacting *Sagittaria* spp. along shoreline.	Maintain and enhance productive aquatic habitat, free of invasive species. Encourage healthy population of *Sagittaria* spp. along shoreline.	• Eliminate grazing pressure. • Monitor natural recovery of *Sagittaria* spp. along shoreline in absence of grazing. • Monitor for invasives and water buttercup (grows exceptionally well in areas with high water level fluctuation and is capable of forming dense mats) crowding out *Sagittaria* spp. in absence of grazing. • Consider propagation and planting of *Sagittaria* spp. if recovery does not occur in three years and limiting factors have been identified and addressed.
Sedge/Rush	Grazing pressure may be limiting native plant reproduction and spreading invasive weeds. Extensive exposed soils present along streambank from cattle. Residual riparian plantings heavily browsed.	Maintain or enhance open marsh habitat dominated by native emergent species. Stable vegetated streambanks with deep binding root systems to reduce erosion.	• Eliminate grazing pressure. • Plant exposed soils with native sedge/rush plugs. • Protect residual plantings from browse. • Reduce invasive weeds. • Monitor for shifts in species composition and natural recruitment, and survival of planted plugs.
Wet Reedcanary Grass	Stands of reed canary grass mixed with other pasture grasses and pockets of desirable sedges including blue listed fox sedge throughout. Invasive weeds are well established. Lack of structural habitat complexity to support wildlife guilds.	Mosaic of habitats including structurally diverse low bench flood class riparian shrub communities with cottonwood stands and open marsh interspersed. Abundant perching/nesting/ foraging/denning/roosting/loafing and cover for various wildlife species.	• Eliminate grazing pressure. • Protect residual plantings from browse. • Plant habitat islands with various revegetation and site preparation techniques to reduce competition with aggressive grasses including: live stakes, TRS cuttings, potted stock, rough and loose patches, brush mats, screefing individual planting sites and small solarisation plots. • Reduce invasive weeds. • Place coarse woody debris to create depositional areas for native seed recruitment. • Monitor for shifts in species composition and natural recruitment, and survival of planted stock and effectiveness of revegetation treatments.
Dry Reedcanary Grass	Dense stands of reedcanary grass exclude most other species. Invasive weeds are well established throughout. Lack of structural habitat complexity to support wildlife guilds.	Mosaic of habitats including structurally diverse mid bench flood class riparian shrub communities with cottonwood stands and open marsh interspersed. Abundant perching/nesting/ foraging/denning/roosting/loafing and cover for various wildlife.	• Eliminate grazing pressure. • Plant habitat islands with various revegetation and site preparation techniques to reduce competition with aggressive grasses including: live stakes, TRS cuttings, potted stock, screefing individual planting sites, rough and loose patches, brush mats and large solarisation plots. • Reduce invasive weeds. • Place coarse woody debris to create depositional areas for native seed recruitment. • Monitor for shifts in species composition and natural recruitment, and survival of planted stock and effectiveness of revegetation treatments.

8 MAINTENANCE

Regular maintenance of the restoration treatments is critical to the success of this restoration plan. The importance of maintenance during the plant establishment period cannot be overstated. The site should be inspected regularly to identify problems and maintain as necessary.

8.1 Signage

Due to the active use of the site by LKB members interpretive signs area highly recommended in addition to signage on the fence to educate the public of sensitive ecosystem areas. Interpretive signage should include billboard style signs that provide information on the project goals and objectives, the works in progress and contact information.

8.2 Fencing

Fence should be checked once a month to ensure it is intact and does not impact wildlife movement. If damage is observed, the cause should be determined and addressed. For example, excessive damage due to elk passage in one location may warrant modification of the fence to allow better passage. All signs should be assessed to ensure they are legible. Brushing along the fence may be required to ensure it is visible by wildlife.

8.3 Brushing

Removing competing vegetation such as grasses and weeds around new plantings will be required for 3-5 years or until the plants reach a free to grow state. This might include hand weeding of aggressive species growing up through slits or holes in brush mats and solarisation fabric. The plantings should be assessed at least three times a year to monitor the encroachment of competing vegetation and competing vegetation should be removed as required. In addition, damaged brush mats and solarisation fabric may need to be repaired.

8.4 Browse protection

Browse protectors require ongoing maintenance during use. This includes monitoring and fixing (re-securing or straightening) any damage caused by spring flooding or snow press, and expansion or removal as plants increase in size. Maintenance should be conducted as soon as the site is accessible each spring.

8.5 Plant replacement

Replacement planting may be required to ensure that project objectives have been met. Planting will be required if monitoring indicates significant mortality or if plant vigour is noticeably declining. The cause of plant decline should be identified and addressed prior to replanting. The species composition and type of replacement plantings should be determined based on the success of planted species.

9 MONITORING

This restoration plan is based on an adaptive, phased management approach to ensure project goals and objectives are achieved over the long term. Monitoring the success of various revegetation treatments following preliminary phases will direct future treatments based on the lessons learned. General monitoring requirements are described below and specific monitoring details are described by ecological unit in Section 7.7 Table 7.

9.1 Short term (0-5 years)

To compare the effectiveness of various treatments during project implementation, monitoring plots should be established within the treated areas. Due to the size of the site it is unlikely that a sufficient number of planted individuals would be measured if the established transects to determine baseline conditions were used to monitor immediate planting success. Therefore, additional plots should be established to monitor the success of planted species. Species, height and vigour of each planted individual should be recorded within each plot, as well as an estimate of existing vegetation cover. GPS coordinates, planting techniques and site preparation methods should also be recorded and representative photographs taken. These plots should be re-measured every 5 years to determine the most appropriate treatment methods for future phases.

9.2 Long Term (5+ years)

The implementation of this plan is not expected to immediately impact the understory vegetation. Rather, a more gradual change is expected, so the understory vegetation can be re-measured every 3-5 years following treatment. By this time, planted trees and shrubs will become established, natural regeneration will be underway, and understory vegetation communities may start to change.

The transects established to determine baseline conditions should be re-measured following treatment to assess the effectiveness of restoration treatments on understory vegetation (Appendix 1 Habitat Units, Appendix 4 Vegetation Monitoring Data). The baseline methodology described in Section 4 can be used to measure understory vegetation in future years, and provide a direct comparison to pre-treatment conditions. In the future when shrub and tree communities become established, larger quadrats should be utilized, such as 2 m x 4 m for shrubs and 5 m x 20 m for trees (Polzin and Rood 2000). The metal pins that mark the transect ends might be difficult to relocate in the field, even with GPS coordinates. A metal detector may be used to help locate the metal spikes.

While the baseline assessment collected information only on the understory vegetation and few shrubs that are currently on site, these same plot locations can be used to measure other attributes as they develop such as detailed stand and overstory structure, wildlife trees and coarse woody debris. These attributes can be added in future monitoring studies as the physical and biological complexity of the ecosystem develops.

10 PHASED APPROACH

The restoration plan is divided into distinct phases, which allows the project to be implemented as time and funds allow (Table 8 and Appendix 6). The highest priority phases are implemented first. Phasing the restoration also allows for an adaptive approach, with the requirements for subsequent phases dependent on the outcome of earlier phases. For example, if monitoring indicates that a particular species or planting technique had poor survival then it should be replaced in subsequent phases with a species or technique which had good survival. Also, if natural recruitment of native species is observed after cattle have been excluded, then the prescribed planting densities could be reduced and planting would only be required in defined hotspots such as along unstable banks or within extensive areas of reed canary grass.

Planting is proposed to start at the downstream end of the site then work upstream. Activities requiring the use of machinery should be conducted concurrently to reduce disturbance and mobilization costs. Trials should be conducted to determine the most effective site preparation and planting techniques to combat the aggressive grasses. The prescriptions in Appendix 6 provide general guidance for project implementation and later phases should be modified based on monitoring results of preliminary phases.

Table 8. Restoration Plan Phases.

Phase	Activity	Notes
1	Fence south boundary to exclude cattle.	
	Complete vegetation inventory: • Rare plant (SAR) inventory and mapping. • Identify dominant species in Sedge/Rush habitat and complete species composition requirements for planting. • Confirm *Sagittaria* spp. identification growing along channel margin when flowering (September).	• Utilize SAR map during planting of Habitat Islands. • Utilize information to complete sedge/rush planting recommendations (Section 6.5).
	Plant exposed soils on streambanks (cattle access points) with Sedge/Rush plugs (Sedge/Rush Units a,b,c,d,e,g,h).	• Do not plant Unit f until bank has been re-graded to stable angle (Phase 3). Install short term monitoring plots immediately after planting.
	Plant Habitat Islands 1, 2 and 3.	• Install short term monitoring plots immediately after planting (Section 8).
	Conduct initial invasive weed treatment by organizing 'weed pull' event with Yaqan Nuki School or other community group.	• 3 times/year (six weeks apart, beginning six weeks after spring vegetative growth).
2	Maintenance of Phase 1 treatments.	• Spring - check plantings for issues that could negatively impact growth, fix problems such as damaged tree shelters, brush mats or competing vegetation. Check and fix fencing.
	Monitor Phase 1 (refer to Section 8 for details).	• Fall – Year 1 effectiveness of Phase 1 planting treatments (measure short term plots), invasive weeds, *Sagittaria* spp. natural colonization, natural recruitment native plants.
	Conduct channel assessment for LWD placement and prepare prescriptions.	
	LWD placement in channel.	• Should be implemented before additional planting to prevent damage to newly planted areas. Construct in fall to mitigate impacts.
	CWD placement throughout project area.	• Implement consecutively with LWD placement while machinery is on site.
	Grow plants with Yaqan Nuki School for Phase 3 planting.	
	Invasive weed control.	• 3 times/year (six weeks apart, beginning six weeks after spring vegetative growth)

Phase	Activity	Notes
3	Mechanical pull back of over-steepened bank near Sedge/Rush Unit f, plant Sedge/Rush Unit f, install brush layer from Habitat Island 4-6 (approximately 400m), prepare and plant Habitat Islands 4, 5 and 6.	• These activities should be conducted concurrently due to need for excavator. Adapt planting techniques based on monitoring results from Phase 1. Install short term monitoring plots immediately after planting (Section 8).
	Invasive weed control.	• 3 times/year (six weeks apart, beginning six weeks after spring vegetative growth)
	Maintenance of Phase 1 treatments.	• Spring - as described above.
	Monitor Phase 1.	• Fall – Year 2 as described above.
4	Install brush layer from end of Habitat Island 6 to end of Habitat Island 10 (approximately 650m), prepare and plant Habitat Islands 7, 8, 9, 10.	• These activities should be conducted concurrently due to need for excavator. Adapt planting techniques based on monitoring results from Phase 1 and 3. Install short term monitoring plots immediately after planting (Section 8).
	Invasive weed control.	• 3 times/year (six weeks apart, beginning six weeks after spring vegetative growth)
	Maintenance of Phase 1 and 3 treatments.	• Spring - as described above.
	Monitor Phase 1 (Year 3) and Phase 3 (Year 1) treatments.	• Fall – as described above. If no natural recruitment of *Sagittaria* spp. consider propagation and planting.
5	Continue maintenance and monitoring until all planted areas have reached a free to grow state.	• Re-measure long term monitoring transects after 5 years.
	Utilize information to inform future phases.	
Future	The following activities cannot be conducted until a new bridge is installed to access the north side.	
	Fence north boundary to exclude cattle.	
	Install brush layer 16 (approximately 360m).	
	Plant Habitat Islands 11, 12, 13, 14.	
	Invasive weed control.	
	Maintenance and monitoring of north side treatments.	

11 FURTHER INVESTIGATION

The following tasks need to be completed to implement this restoration plan:

- Complete vegetation inventory in absence of grazing, including vascular plant SAR inventory and mapping. Identify dominant species in Sedge/Rush habitat and complete species composition requirements for planting. Confirm Wapato identification growing along channel margin when flowering (September). The rare plant survey and mapping should be conducted prior to any disturbance activities on site. The map should be used during implementation of all project components to ensure rare plants are not disturbed by project activities.
- Conduct channel assessment and prepare prescriptions for in-stream LWD placement. LWD placement should occur prior to planting in designated locations to prevent disturbance to newly planted areas.
- Installation of new bridge to initiate restoration of the north side of Indian Creek.

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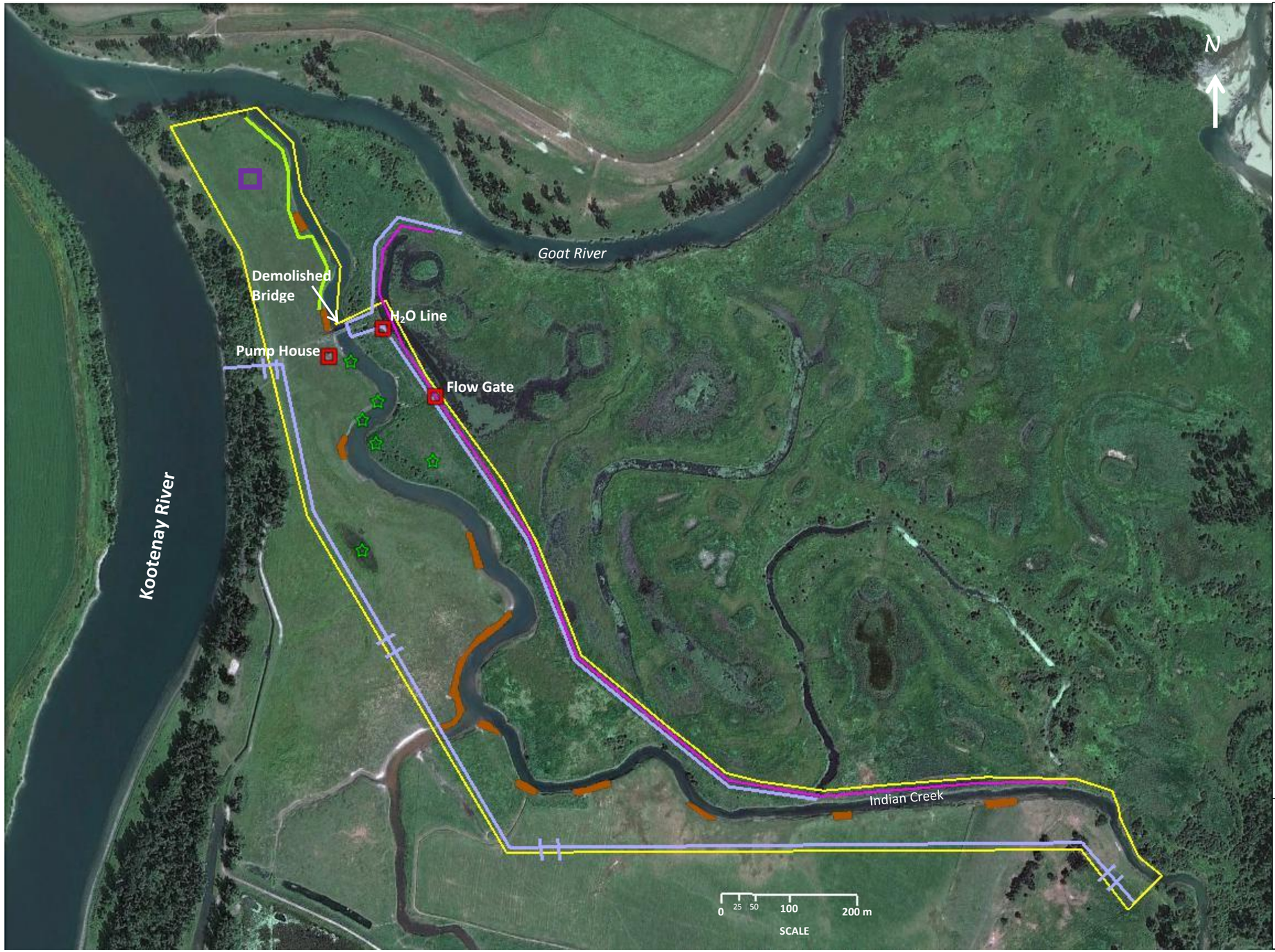
APPENDIX 1

MAPS: SITE PLAN, HABITAT UNITS, PLANTING PLAN



LEGEND

- PROJECT BOUNDARY
- PROPOSED FENCELINE
- DIKE
- OLD PLANTING PROJECT
- EXISTING CATTLE ACCESS POINTS
- EXISTING STRUCTURES
- WAPATO LOCATIONS
- CULTURAL CAMPSITE

INDIAN CREEK RESTORATION

SITE PLAN

APRIL 2014

MASSE ENVIRONMENTAL CONSULTANTS LTD.

LEGEND

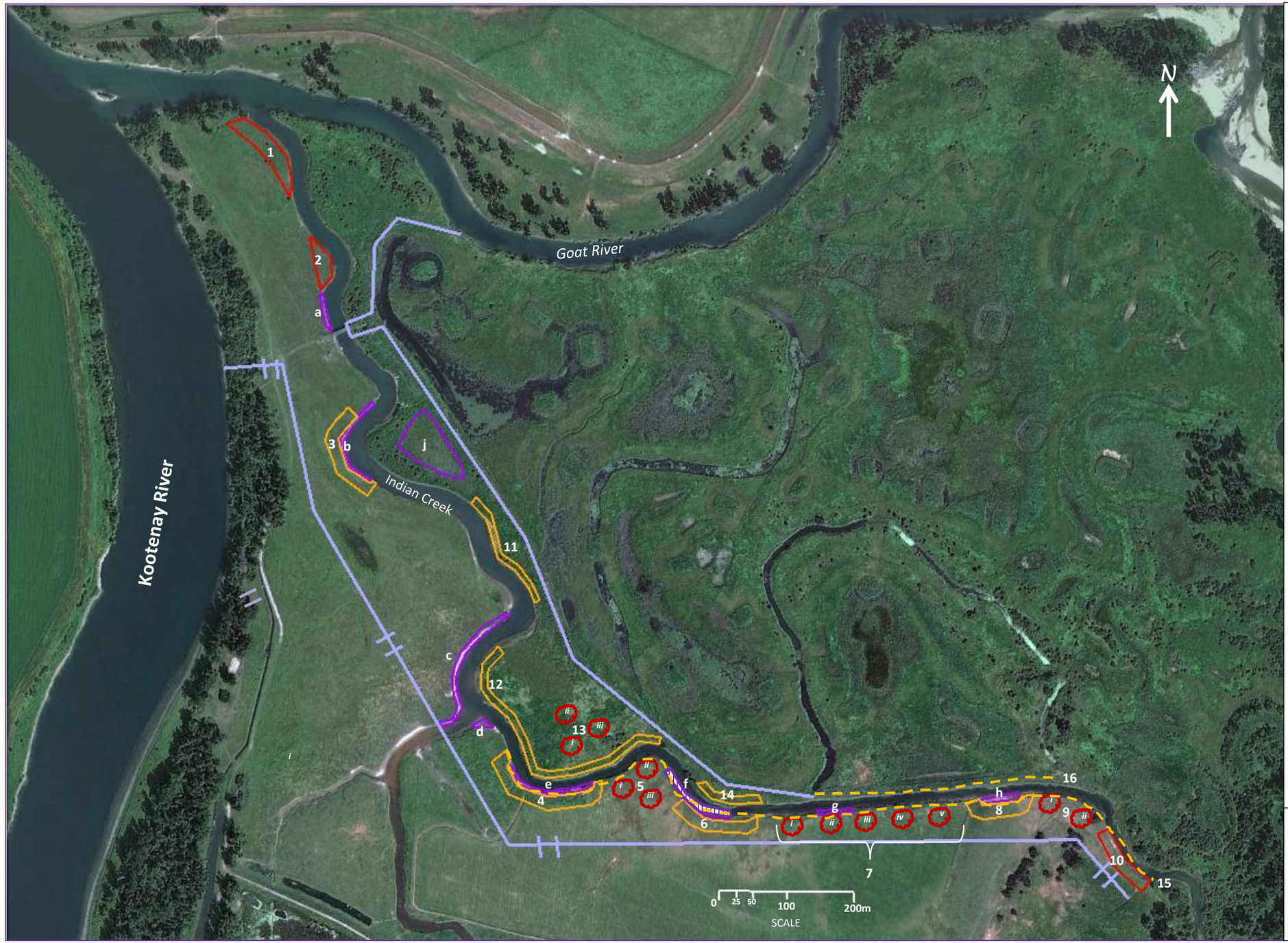
- DRY REED CANARYGRASS
- WET REED CANARYGRASS
- SEDGE/RUSH
- AQUATIC
- PROPOSED FENCELINE
- PROPOSED GATES

INDIAN CREEK RESTORATION

HABITAT UNITS

APRIL 2014

MASSE ENVIRONMENTAL CONSULTANTS LTD.



LEGEND

- TREE/SHRUB
- SHRUB
- BRUSH LAYERS
- SEDGE RUSH
- BANK RE-GRADING REQ'D
- PROPOSED FENCELINE
- PROPOSED GATES

INDIAN CREEK RESTORATION

PLANTING PLAN

APRIL 2014

MASSE ENVIRONMENTAL CONSULTANTS LTD.

APPENDIX 2

VERTEBRATE WILDLIFE SPECIES AT RISK

Appendix 2. English and scientific names, conservation status (CDC or COSEWIC), potential to occur in the project area (N = none; U = unlikely; P = possible; C = confirmed), and habitat associations of vertebrate species at risk in the ICH zone of the Creston Valley.

Listed Species		Conservation Status		Project	
English Name	Scientific Name	CDC	COSEWIC	Potential	Species Habitat Associations
American Avocet	Recurvirostra americana	Blue		P	lowland marshes, mudflats, ponds, alkaline lakes
American Badger	*Taxidea taxus*	Red	E	U	grasslands and open forests with friable soil and abundant prey
American Bittern	*Botaurus lentiginosus*	Blue		P	freshwater wetlands with emergent vegetation and open water
American Golden Plover	*Pluvialis dominica*	Blue		P	short grasslands, pastures, mudflats, flooded fields
American White Pelican	*Pelecanus erythroryhncos*	Red	NAR	P	rivers, lakes, reservoirs, open marshes
Barn Owl	*Tyto alba*	Blue	T	P	grassland, marsh, lightly grazed pasture, hayfields
Barn Swallow	*Hirundo rustica*	Blue	T	C	open habitats, frequently near water and human habitation
Bobolink	*Dolichonyx oryzivorus*	Blue	T	P	tall grass areas, flooded meadows, deep cultivated grains, hayfields
Bull Trout	*Salvelinus confluentus*	Blue	SC	N	bottom of deep pools in cold rivers and large tributary streams
Burbot - Lower Kootenay pop.	*Lota lota pop. 1*	Red		N	Kootenay Lake in summer; hypolimnion or deep river pools with cold water
California Gull	*Larus californicus*	Blue		P	mudflats, marshes, irrigated fields, lakes, ponds
Caribou - southern mountain pop.	*Rangifer tarandus* pop. 1	Red	T	N	mature and old forests with high lichen loads
Caspian Tern	*Hydroprogne caspia*	Blue	NAR	P	lakes, marshes, and rivers
Coeur d'Alene salamander	*Plethodon idahohensis*	Yellow	SC	N	seepages and streamside talus, moist conifer forest
Columbia Sculpin	*Cottus hubbsi*	Blue	SC	N	isolated streams and upstream tributaries
Cutthroat Trout, *lewisi* ssp.	*Oncorhynchus clarkii lewisi*	Blue	SC	N	small mountain streams, main rivers, and large natural lakes
Double-crested Cormorant	*Phalacrocorax auritus*	Blue	NAR	C	lakes, ponds, rivers, lagoons, swamps
Ferruginous Hawk	*Buteo regalis*		T	U	grasslands, pastures, hay fields, cropland and shrub-steppe
Flammulated Owl	*Otus flammeolus*	Blue	SC	N	open conifer forest with large trees, snags with cavities and thickets
Forster's Tern	*Sterna forsteri*	Red	DD	P	inland lakes and marshes
Fringed Myotis	*Myotis thysanodes*	Blue	DD	U	grassland and woodland habitats, snags for roosting
Grasshopper Sparrow	*Ammodramus savannarum*	Red		P	grassland, shrub, meadows
Great Blue Heron	*Ardea herodias*	Blue		C	riparian and wetland areas with mature trees nearby
Green Heron	*Butorides virescens*	Blue		U	swamps, marshes and margins of ponds, rivers, lakes
Grizzly Bear	*Ursus arctos*	Blue	SC	C	broad range of habitats
Gyrfalcon	*Falco rusticolus*	Blue	NAR	U	open country and open coniferous forest
Lark Sparrow	*Chondestes grammacus*	Red		p	grassland, shrub, meadow, old pasture, cultivated field
Lewis's Woodpecker	*Melanerpes lewis*	Red	T	P	open forest, riparian woodland and snags
Long-billed Curlew	*Numenius americanus*	Blue	SC	P	short-grass prairies and grassy meadows, generally near water
Long-tailed duck	*Clangula hyemalis*	Blue		U	large inland lakes and less commonly rivers

Listed Species		Conservation Status		Project	
English Name	Scientific Name	CDC	COSEWIC	Potential	Species Habitat Associations
Northern Leopard Frog	*Lithobates pipiens*	Red	E	P	shallow water herbaceous wetlands, ponds, grassy meadows
Northern Pocket Gopher, *segregatus* ssp.	*Thomomys talpoides segregatus*	Red		P	Lowland meadows and agricultural areas
Olive-sided Flycatcher	*Contopus cooperi*	Blue	T	P	forest/woodland habitats, often near wetlands, lakes, ponds, streams
Painted Turtle - Rocky Mountain pop.	*Chrysemys picta pop. 2*	Blue	SC	C	wetlands, marches, fens, bogs, ponds, shallow open water, riparian areas
Peregrine Falcon, *anatum* ssp.	*Falco peregrinus anatum*	Red	SC	U	rock cliffs above lakes, river valleys or wetlands with abundant prey
Prairie Falcon	*Falco mexicanus*	Red	NAR	N	open habitats especially in mountainous areas, steppe, plains or prairies
Purple Martin	*Progne subis*	Blue		N	open and partly open habitats, frequently near water
Red-necked Phalarope	*Phalaropus lobatus*	Blue	C	P	wetlands, ponds, lakes, open marshes
Red-tailed Chipmunk, simulans ssp.	*Neotomias ruficaudus simulans*	Blue		N	sparsely vegetated rock, grassland, meadow
Northern Rubber Boa	*Charina bottae*		SC	C	woodlands, forest clearings, meadows, grasslands near water
Sage Thrasher	*Oreoscoptes montanus*	Red	E	N	Shrub-steppe habitats
Short-billed dowitcher	*Limnodromus griseus*	Blue		P	mudflats, shallow marshes, pools, ponds, flooded fields, wetlands
Short-eared Owl	*Asio flammeus*	Blue	SC	P	marshes, bogs, old fields, meadows, open woodland
Surf Scoter	*Melanitta perspicillata*	Blue		N	Freshwater lakes and rivers
Swainson's Hawk	*Buteo swainsoni*	Red		P	grasslands, shrub, agricultural fields, old pastures and open country
Townsend's big-eared bat	*Corynorhinus townsendii*	Blue		P	coniferous and mixed forest, grassland/shrub, riparian, wetland, caves
Umatilla Dace	*Rhinichthys umatilla*	Red	T	N	riverine habitat with large substrate, no siltation
Western Grebe	*Aechmophorus occidentalis*	Red	C	P	lakes, wetlands, marshes, large inland rivers
Western Screech-Owl, *macfarlanei* ssp.	*Megascops kennicottii macfarlanei*	Red	T	P	coniferous, deciduous and mixed forests with snags near water
Western Skink	*Plestiodon skiltonianus*	Blue	SC	P	rocky, sparsely vegetated habitats, grassland/shrub, often near water
Western Toad	*Anaxyrus boreas*	Blue	SC	P	shallow littoral zones of lakes and wetlands, ditches and upland sites
White-headed Woodpecker	*Picoides albolarvatus*	Red	E	N	Mature and old montane coniferous forest
White Sturgeon -Kootenay River pop.	*Acipenser transmontanus* pop. 1	Red	E	N	migrate freely from Kootenay Lake to Kootenai River upstream into Montana
Wolverine, *luscus* ssp.	*Gulo gulo luscus*	Blue	SC	N	broad range of habitat types
Yellow-breasted Chat	*Icteria virens*	Red	E	P	shrubby and riparian habitats with open canopies and dense sub-canopy

APPENDIX 3

VASCULAR PLANT SPECIES AT RISK

Appendix 3. Vascular plant species at risk in the ICH of the Creston Valley with potential to occur in the project area.

Species		Status		
Common Name	*Latin Name*	BC Status	Federal Status	Confirmed on Site
Alkali-marsh butterweed	*Senecio hydrophilus*	Red		
American sweet-flag	*Acorus americanus*	Blue		
Bearded sedge	*Carex comosa*	Red		
Beardless wildrye	*Elymus curvatus*	Red		
Blunt-sepaled starwort	*Stellaria obtusa*	Blue		
Crested wood fern	*Dryopteris cristata*	Blue		
Fox sedge	*Carex vulpinoidea*	Blue		√
Hall's willowherb	*Epilobium halleanum*	Blue		
Montana lupine	*Lupinus arbustus ssp. pseudoparviflorus*	Red		
Mountain sneezeweed	*Helenium autumnale var. grandiflorum*	Blue		√
Northern water-meal	*Wolffia borealis*	Red		
Nuttall's waterweed	*Elodea nuttallii*	Blue		
Pointed broom sedge	*Carex scoparia*	Blue		
Prairie golden bean	*Thermopsis rhombifolia*	Red		
Prairie wedgegrass	*Sphenopholis obtusata*	Red		
Purple meadowrue	*Thalictrum dasycarpum*	Blue		
Purple oniongrass	*Melica spectabilis*	Blue		
Slender wedgegrass	*Sphenopholis intermedia*	Blue		
Sweet-marsh butterweed	*Senecio hydrophiloides*	Red		
Tall beggarticks	*Bidens vulgata*	Red		
Tender sedge	Carex tenera	Blue		
Two-edged water-starwort	*Callitriche heterophylla*	Blue		√
Ussarian water-milfoil	*Myriophyllum ussuriense*	Blue		
Water marigold	*Megalodonta beckii*	Blue		
Wild licorice	*Glycyrrhiza lepidota*	Blue		

APPENDIX 4

VEGETATION MONITORING DATA

Transect	Survey Date	UTM Zone	Easting	Northing	Bearing (degrees)	Quadrat ID	Distance from pin (0m)	Description
1	11-Sep-13	11U	532068	5437315	70	T1-Q1	35	~128m US Goat River on grassy bench
						T1-Q2	30	
						T1-Q3	25	
						T1-Q4	15	
						T1-Q5	5	
						T1-Q6	0	
2	11-Sep-13	11U	532130	5437168	60	T2-Q1	35	~105m DS old bridge in low lying sedge rush
						T2-Q2	30	
						T2-Q3	25	
						T2-Q4	15	
						T2-Q5	5	
						T2-Q6	0	
3	11-Sep-13	11U	532203	5436983	140	T3-Q1	35	~88m US old bridge in low lying sedge rush w/Sagittaria along bank
						T3-Q2	30	
						T3-Q3	25	
						T3-Q4	15	
						T3-Q5	5	
						T3-Q6	0	
4	11-Sep-13	11U	532358	5436695	62	T4-Q1	35	~500m US pumphouse, ~15 m US old fenceposts at start of low lying bench
						T4-Q2	30	
						T4-Q3	25	
						T4-Q4	15	
						T4-Q5	5	
						T4-Q6	0	
5	11-Sep-13	11U	532712	5436317	20	T5-Q1	35	Reed canarygrass field on large eroding outside bend DS of channelized section
						T5-Q2	30	
						T5-Q3	25	
						T5-Q4	15	

Transect	Survey Date	UTM Zone	Easting	Northing	Bearing (degrees)	Quadrat ID	Distance from pin (0m)	Description
						T5-Q5	5	
						T5-Q6	0	
6	11-Sep-13	11U	533215	5436341	350	T6-Q1	35	Bench at upstream end of site; US of access Rd.
						T6-Q2	30	
						T6-Q3	25	
						T6-Q4	15	
						T6-Q5	5	
						T6-Q6	0	
7	12-Sep-13	11U	532739	5436394	204	T7-Q1	35.5	Across from T5 on bench betwn chanl and dyke
						T7-Q2	30	
						T7-Q3	25	
						T7-Q4	15	
						T7-Q5	5	
						T7-Q6	0	
8	12-Sep-13	11U	532481	5436456	255	T8-Q1	35	Broad bench inside meander betwn chnl and dyke
						T8-Q2	30	
						T8-Q3	25	
						T8-Q4	15	
						T8-Q5	5	
						T8-Q6	0	
9	12-Sep-13	11U	532443	5436742	238	T9-Q1	35	Across from T4 adjacent to dead shrubs
						T9-Q2	30	
						T9-Q3	25	
						T9-Q4	15	
						T9-Q5	5	
						T9-Q6	0	
10	12-Sep-13	11U	532305	5436868	210	T10-Q1	35	~200m US old bridge in low lying sedge area
						T10-Q2	30	
						T10-Q3	25	

Transect	Survey Date	UTM Zone	Easting	Northing	Bearing (degrees)	Quadrat ID	Distance from pin (0m)	Description
						T10-Q4	15	
						T10-Q5	5	
						T10-Q6	0	

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T1-Q1	35	1mx1m	ELOD CAN	1
T1-Q1			POTA AMP	2
T1-Q1			NITE sp.	15
T1-Q1			ELEO PAL	10
T1-Q1			PHAL ARU	25
T1-Q1			MYSO ARV	1
T1-Q1			water	60
T1-Q1			mineral soil	2
T1-Q2	30	1mx1m	Carex sp.	<1
T1-Q2			Juncus sp.	<1
T1-Q2			Grass sp.	95
T1-Q2			EQUI ARV	<1
T1-Q2			GALI TRI	<1
T1-Q2			TARA OFF	2
T1-Q2			GALE TET	<1
T1-Q2			PERS HYD	<1
T1-Q3	25	1mx1m	CARE VUL	1
T1-Q3			RUME CRI	1
T1-Q3			ELYM REP	18
T1-Q3			Grass sp.	70
T1-Q3			RANU sp.	12
T1-Q4	15		ELYM REP	5
T1-Q4			TARA OFF	1
T1-Q4			Grass sp.	50
T1-Q4			TRIF REP	1
T1-Q4			TRIF sp.	45
T1-Q4			MYSO ARV	1
T1-Q4			CIRS ARV	<1
T1-Q4			RANU sp.	<1
T1-Q4			LYCO sp	35
T1-Q4			Organic matter	1
T1-Q5	5		Grass sp.	65
T1-Q5			PHAL ARU	5
T1-Q5			ELYM REP	3
T1-Q5			LEUC VUL	8
T1-Q5			CIRS ARV	5
T1-Q5			TARA OFF	2
T1-Q5			TRIF REP	1
T1-Q5			MYSO ARV	<1
T1-Q5			EQUI ARV	1

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T1-Q5			VICI sp	<1
T1-Q5			VERB THA	<1
T1-Q5			unidentified seedlings	1
T1-Q5			moss	<1
T1-Q5			mineral soil	5
T1-Q6	0		Grass sp	83
T1-Q6			CIRS ARV	4
T1-Q6			LEUC VUL	3
T1-Q6			TARA OFF	2
T1-Q6			PHAL ARU	1
T1-Q6			ELYM REP	<1
T1-Q6			EQUI ARV	<1
T1-Q6			RANU sp.	<1
T1-Q6			SONC ARV	<1
T1-Q6			TRIF sp.	1
T1-Q6			moss	<1
T1-Q6			organic matter	<1
T1-Q6			mineral soil	<1
T2-Q1	35		NITE sp.	2
T2-Q1			ELOD CAN	1
T2-Q1			POTA sp.	1
T2-Q1			LEMN MIN	<1
T2-Q1			CARE sp.	3
T2-Q1			MYOS ARV	30
T2-Q1			Grass sp	10
T2-Q1			EQUI ARV	<1
T2-Q1			ALOP AEQ	<1
T2-Q1			RANU AQU	<1
T2-Q1			moss	2
T2-Q1			organic matter	2
T2-Q1			mineral soil	7
T2-Q1			water	50
T2-Q2	30		PHAL ARU	40
T2-Q2			Grass sp.	10
T2-Q2			MYOS ARV	1
T2-Q2			EQUI sp.	1
T2-Q2			BRAS sp.	<1
T2-Q2			moss	40
T2-Q2			organic matter	10
T2-Q2			feces (duck)	<1

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T2-Q3	25		CARE sp.	<1
T2-Q3			JUNC sp	3
T2-Q3			PHAL ARU	90
T2-Q3			MYOS ARV	5
T2-Q3			RUME CRI	<1
T2-Q3			Grass sp.	7
T2-Q3			GALI TRI	<1
T2-Q3			HELE AUT	<1
T2-Q3			moss	5
T2-Q3			organic matter	25
T2-Q3			mineral soil	5
T2-Q4	15		CARE sp.	8
T2-Q4			Grass sp.	90
T2-Q4			PERS HYD	<1
T2-Q4			GALI TRI	<1
T2-Q4			EQUI sp	<1
T2-Q4			organic matter	2
T2-Q4			mineral soil	1
T2-Q4			feces (cow)	<1
T2-Q5	5		CARE sp.	1
T2-Q5			JUNC sp.	3
T2-Q5			RUME CRI	1
T2-Q5			Grass sp.	95
T2-Q5			RANU sp.	<1
T2-Q5			moss	<1
T2-Q5			mineral soil	<1
T2-Q5			organic matter	3
T2-Q6	0		CARE sp.	1
T2-Q6			JUNC sp.	5
T2-Q6			RUME CRI	1
T2-Q6			PERS HYD	10
T2-Q6			PHAL ARU	50
T2-Q6			Grass sp.	30
T2-Q6			Organic matter	10
T2-Q6			Feces (cow)	<1
T3-Q1	35		NITE sp.	5
T3-Q1			LEMN MIN	<1
T3-Q1			SAGI LAT	5
T3-Q1			RANU AQU	3
T3-Q1			JUNC sp.	3

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T3-Q1			Grass sp.	35
T3-Q1			MYOS ARV	<1
T3-Q1			water	40
T3-Q1			organic matter	1
T3-Q1			mineral soil	20
T3-Q2	30		MENT ARV	<1
T3-Q2			PLAN MAJ	<1
T3-Q2			HIER sp.	1
T3-Q2			RUME CRI	1
T3-Q2			RANU sp.	<1
T3-Q2			GALI TRI	<1
T3-Q2			EQUI sp.	<1
T3-Q2			Grass sp.	90
T3-Q2			MYOS ARV	7
T3-Q2			organic matter	
T3-Q2			mineral soil	
T3-Q2			feces (duck)	
T3-Q3	25		CARE ANT	20
T3-Q3			JUNC sp.	1
T3-Q3			Grass sp.	50
T3-Q3			RUME CRI	2
T3-Q3			PERS HYD	<1
T3-Q3			EQUI sp.	1
T3-Q3			MYOS ARV	<1
T3-Q3			feces	<1
T3-Q3			organic matter	1
T3-Q3			mineral soil	1
T3-Q4	15		CARE ANT	<1
T3-Q4			CARE sp.	3
T3-Q4			PAHL ARU	10
T3-Q4			Grass sp.	80
T3-Q4			RUME CRI	<1
T3-Q4			PERS HYD	<1
T3-Q4			organic matter	5
T3-Q4			mineral soil	5
T3-Q5	5		CARE sp.	35
T3-Q5			ELYM REP	2
T3-Q5			Grass sp.	55
T3-Q5			PERS HYD	<1
T3-Q5			GALI TRI	<1

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T3-Q5			feces (cow)	2
T3-Q5			mineral soil	1
T3-Q6	0		CARE sp.	4
T3-Q6			JUNC sp.	3
T3-Q6			PHAL ARU	3
T3-Q6			Grass sp.	75
T3-Q6			CIRS ARV	<1
T3-Q6			PERS HYD	1
T3-Q6			organic matter	13
T4-Q1	35		ELOD CAN	<1
T4-Q1			Grass sp.	<1
T4-Q1			organic matter	<1
T4-Q1			mineral soil	60
T4-Q1			water	40
T4-Q2	30		CARE sp.	25
T4-Q2			ASTE FOL	7
T4-Q2			MYOS ARV	1
T4-Q2			Grass sp.	68
T4-Q2			feces (cow)	2
T4-Q3	25		JUNC sp.	2
T4-Q3			PLAN MAJ	2
T4-Q3			PERS HYD	<1
T4-Q3			TARA OFF	2
T4-Q3			RUME CRI	1
T4-Q3			Grass sp.	80
T4-Q3			GNAP ULI	3
T4-Q3			Seedlings	3
T4-Q3			MYOS ARV	2
T4-Q3			organic matter	1
T4-Q3			feces	<1
T4-Q3			mineral soil	5
T4-Q4	15		Grass sp.	98
T4-Q4			TARA OFF	<1
T4-Q4			RANU sp.	<1
T4-Q4			organic matter	<1
T4-Q5	5		Grass sp.	95
T4-Q5			TRIF sp.	<1
T4-Q5			PLAN MAJ	<1

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T4-Q5			feces (duck)	3
T4-Q5			moss	<1
T4-Q5			mineral soil	1
T4-Q5			organic matter	1
T4-Q6	0		Grass sp.	98
T4-Q6			TRIF sp.	<1
T4-Q6			TARA OFF	<1
T4-Q6			RUME CRI	<1
T4-Q6			RANU sp.	<1
T4-Q6			PLAN MAJ	<1
T4-Q6			mineral soil	<1
T4-Q6			organic matter	1
T5-Q1	35		NITE sp.	2
T5-Q1			CALL HET	1
T5-Q1			RANU AQU	1
T5-Q1			Grass sp.	1
T5-Q1			moss	2
T5-Q1			LWD	50
T5-Q1			mineral soil	12
T5-Q1			organic matter	1
T5-Q1			water	25
T5-Q2	30		Grass sp.	1
T5-Q2			POLY AVI	<1
T5-Q2			ARTE ABS	<1
T5-Q2			mineral soil	98
T5-Q3	25		POLY AVI	5
T5-Q3			ARTE ABS	1
T5-Q3			Grass sp.	80
T5-Q3			TRIF REP	5
T5-Q3			PLAN MAJ	7
T5-Q3			mineral soil	3
T5-Q3			organic matter	<1
T5-Q4	15		TRIF sp.	2
T5-Q4			Grass sp.	95
T5-Q4			TARA OFF	1
T5-Q4			RUME CRI	<1
T5-Q4			RANU sp.	<1
T5-Q4			organic matter	1
T5-Q4			feces	1

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T5-Q5	5		PHAL ARU	100
T5-Q5			organic matter	2
T5-Q6	0		Grass.sp.	99
T5-Q6			RUME CRI	<1
T5-Q6			organic matter	1
T6-Q1	35		ELOD CAN	<1
T6-Q1			Emergent	<1
T6-Q1			Grass sp.	<1
T6-Q1			mineral soil	50
T6-Q1			water	50
T6-Q2	30		JUNC sp.	<1
T6-Q2			PHAL ARU	8
T6-Q2			PLAN MAJ	3
T6-Q2			ARTE ABS	10
T6-Q2			EQUI sp.	1
T6-Q2			Grass sp.	42
T6-Q2			MYOS ARV	1
T6-Q2			CIRS ARV	<1
T6-Q2			TRIF sp.	<1
T6-Q2			moss	1
T6-Q2			mineral soil	20
T6-Q3	25		Grass sp.	70
T6-Q3			TARA OFF	2
T6-Q3			CIRS ARV	<1
T6-Q3			TRIF sp.	2
T6-Q3			feces (cow)	15
T6-Q3			organic matter	5
T6-Q4	15		Grass sp.	63
T6-Q4			PHAL ARU	10
T6-Q4			VICI sp.	1
T6-Q4			TRIF sp.	15
T6-Q4			TARA OFF	3
T6-Q4			ARTE ABS	<1
T6-Q4			feces (cow)	5
T6-Q4			organic matter	2
T6-Q5	5		Grass sp.	55
T6-Q5			CIRS ARV	30

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T6-Q5			TARA OFF	2
T6-Q5			VICI sp.	1
T6-Q5			TRIF sp.	2
T6-Q5			PHAL ARU	1
T6-Q5			LEUC VUL	<1
T6-Q5			ARTE ABS	<1
T6-Q5			organic matter	6
T6-Q5			feces (cow)	1
T6-Q6	0		Grass sp.	72
T6-Q6			LEUC VUL	<1
T6-Q6			EQUI ARV	<1
T6-Q6			TARA OFF	1
T6-Q6			feces (duck)	2
T6-Q6			feces (cow)	8
T6-Q6			organic matter	15
T7-Q1	35.5		NITE sp.	<1
T7-Q1			ELOD CAN	2
T7-Q1			POTA AMP	<1
T7-Q1			RANU AQU	<1
T7-Q1			SCIR MIC	5
T7-Q1			JUNC sp.	4
T7-Q1			PHAL ARU	2
T7-Q1			POLY LAP	1
T7-Q1			Grass sp.	1
T7-Q1			SALI sp.	<1
T7-Q1			moss	<1
T7-Q1			water	35
T7-Q1			organic matter	1
T7-Q1			mineral soil	50
T7-Q2	30		PHAL ARU	100
T7-Q2			organic matter	20
T7-Q3	25		NEPE CAT	<1
T7-Q3			PHAL ARU	50
T7-Q3			ROSA ACI	2
T7-Q3			organic matter	60
T7-Q4	15		PHAL ARU	10
T7-Q4			ARTE ABS	2
T7-Q4			VICI sp.	<1
T7-Q4			LEUC VUL	2

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T7-Q4			POTE NOR	1
T7-Q4			Grass sp.	2
T7-Q4			organic matter	85
T7-Q4			mineral soil	1
T7-Q5	5		PHAL ARU	30
T7-Q5			organic matter	70
T7-Q6	0		PHAL ARU	80
T7-Q6			GALE TET	<1
T7-Q6			organic matter	35
T7-Q6			CWD(10cm)	7
T8-Q1	35		NITE sp.	1
T8-Q1			ELOD CAN	2
T8-Q1			RANU AQU	<1
T8-Q1			CARE sp.	<1
T8-Q1			JUNC sp.	<1
T8-Q1			PHAL ARU	10
T8-Q1			Grass sp.	2
T8-Q1			PHLE PRA	1
T8-Q1			moss	<1
T8-Q1			mineral soil	40
T8-Q1			organic matter	2
T8-Q1			water	35
T8-Q2	30		CARE sp.	3
T8-Q2			PHAL ARU	95
T8-Q2			Grass sp.	1
T8-Q2			Unidentified herbaceous	<1
T8-Q2			organic matter	10
T8-Q2			mineral soil	3
T8-Q3	25		PHAL ARU	100
T8-Q3			organic matter	40
T8-Q4	15		PHAL ARU	100
T8-Q4			Grass sp.	2
T8-Q4			POLY AVI	<1
T8-Q4			organic matter	25
T8-Q5	5		CARE sp.	25
T8-Q5			PHAL ARU	75
T8-Q5			Grass sp.	<1

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T8-Q5			organic matter	30
T8-Q6	0		PHAL ARU	90
T8-Q6			Unidentified herbaceous	<1
T8-Q6			organic matter	20
T9-Q1	35		RANU AQU	<1
T9-Q1			CARE sp.	<1
T9-Q1			PHAL ARU	3
T9-Q1			EQUI sp.	2
T9-Q1			Grass sp.	<1
T9-Q1			water	55
T9-Q1			mineral soil	40
T9-Q1			organic matter	1
T9-Q2	30		CARE sp.	4
T9-Q2			PHAL ARU	60
T9-Q2			organic matter	55
T9-Q3	25		CARE sp.	3
T9-Q3			PHAL ARU	70
T9-Q3			organic matter	60
T9-Q4	15		CARE sp.	<1
T9-Q4			PHAL ARU	100
T9-Q4			organic matter	60
T9-Q5	5		PHAL ARU	100
T9-Q5			organic matter	50
T9-Q6	0		CARE sp.	2
T9-Q6			PHAL ARU	95
T9-Q6			organic matter	60
T10-Q1	35		RANU AQU	1
T10-Q1			ELOD CAN	1
T10-Q1			RANU AQU	<1
T10-Q1			PHAL ARU	5
T10-Q1			EQUI sp.	7
T10-Q1			OENO VIL	2
T10-Q1			organic matter	1
T10-Q1			mineral soil	50
T10-Q1			water	55

Quadrat ID	Distance from Pin (0m)	Size	Species	% Cover
T10-Q2	30		CARE sp.	2
T10-Q2			PHAL ARU	98
T10-Q2			organic matter	40
T10-Q3	25		PHAL ARU	100
T10-Q3			organic matter	20
T10-Q4	15		CARE sp.	4
T10-Q4			JUNC sp.	1
T10-Q4			PHAL ARU	90
T10-Q4			organic matter	30
T10-Q5	5		CARE sp.	1
T10-Q5			PHAL ARU	50
T10-Q5			organic matter	65
T10-Q6	0		CARE sp.	1
T10-Q6			PHAL ARU	40
T10-Q6			organic matter	80

APPENDIX 5

PLANT SPECIES LIST

Species		Habitat Units				
Common Name	*Latin Name*	Aquatic	Sedge/Rush	Wet Reed Canarygrass	Dry Reed Canarygrass	Shrubs/ Trees
Aquatic						
Canadian waterweed	*Elodea canadaensis*	√				
Common duckweed	*Lemna minor*	√				
Grass leaved pondweed	*Potamogetan gramineus*	√				
Large-leaved pondweed	*Potamogeton amplifolius*	√				
Nitella		√				
Two-edged water-starwort	*Callitriche heterophylla*	√				
Wapato	*Sagittaria latifolia*	√				
Water buttercup	*Ranunculus aquatilis*	√				
Sedge/Rush						
Common spike rush	*Eleocharis palustris*		√			
Fox sedge	*Carex Vulpinoidea*		√			
Jointed rush	*Juncus articulatus*		√			
Slender rush	*Juncus tenuis*		√			
Slender beaked sedge	*Carex athrostachya*		√			
Small flowered bulrush	*Scirpus microcarpus*		√			
Wooly sedge	*Scirpus cyperinus*		√			
Yellow flowered sedge	*Carex anthoxanthea*		√			
Forbes and Grasses						
Buttercup species	*Ranunculus sp.*	√	√			
Clover species	*Trifolium sp.*		√			
Club moss sp.	*Lycopodium sp.*			√		
Common horsetail	*Equisetum arvense*	√	√	√		√
Common sneezeweed	*Helenium autumnale*		√			
Hemp nettle	*Galeopsis tetrahit*			√		
Indian hemp	*Apocynum cannabinum*			√		
Leafy aster	*Aster foliaceus*		√			
Little meadow foxtail	*Alopecurus aequalis*	√	√			
Mountain sneezeweed	*Helenium autumnale var. grand.*		√			
Narrow-leaved cottongrass	*Eriophorum angustifolium*		√			
Pale smartweed	*Persicaria lapathifolium*			√		
Sweet scented bedstraw	*Galium triflorum*		√			
Wild mustard	*Sisymbrium sp.*			√		
American vetch	*Vicia americana*			√	√	
Yarrow	*Achilla millefolium*			√		
Shrubs and Trees						
Black cottonwood	*Populus trichocarpa*				√	√
Black hawthorn	*Crataegus douglasii*		√		√	√
Prickly rose	*Rosa acicularis*				√	√
Willow Bebb's	*Salix bebbiana*				√	√
Willow Sandbar	*Salix exigua*		√		√	√
Weeds and Exotics						
Wormwood (Absinthe)***	*Artemisia absinthium*			√		
Canada thistle**	*Cirsium arvense*		√	√		
Catnip	*Nepeta cataria*				√	
Common dandelion	*Taraxacum officinale*		√			
Common knotweed	*Polygonum aviculare*		√	√		
Common plantain	*Plantago major*		√	√		
Common tansy*	*Tanacetum vulgare*			√	√	
Common timothy	*Phleum pratense*	√	√			
Curled dock**	*Rumex crispus*		√	√	√	
Dandelion	*Taraxacum officinale*		√	√	√	

Field mint	*Mentha arvensis*		√			
Field forget me not	*Myosotis arvensis*		√	√	√	
Knapweed sp.*	*Centaurea sp.*			√	√	
Marsh cudweed	*Gnaphalium uliginosum*		√			
Marshpepper smartweed	*Persicaria hydropiper*	√	√	√		
Mullein**	*Verbascum thapsus*			√	√	
Orchard grass	*Dactylis glomerata*		√	√		
Oxeye Daisy**	*Leucanthemum vulgare*		√	√	√	
Perennial sowthistle	*Sonchus arvensis*			√		
Perennial rye	*Lolium perenne*		√	√		
Pinapple weed	*Matricaria matricariodes*			√		
Quackgrass	*Elymus repens*		√	√		
Redtop	*Agrostis stolonifera*		√	√		
Reed canarygrass	*Phalaris arundinacea*		√	√	√	√
Rough cinquefoil	*Potentilla norvegica*			√		
Sulphur cinquefoil**	*Potentilla recta*			√		
White clover	*Trifolium repens*			√		
Yellow evening-primrose	*Oenothera villosa O. sp.*			√		

Bold = Species at Risk

Categories for invasive plant species in the Creston IPMA (2012)

* Containment

** Established (Bio-Control or Site Specific Approach)

*** Insufficient Information

APPENDIX 6

PLANTING PRESCRIPTIONS

Location	Area (m^2)	Species	%	Total No. Shrubs	Type/Size			Specifications	Site Preparation
					Live stake	TRS	Potted stock 1 gal.		
Phase 1									
Island 1	3360							Plant along riverbank approx 30 m wide to match adjacent riparian along Goat River. Maintain open area for cultural camp. Variety of plant types to be installed to determine best technique for future phases.	Conduct trials with a variety of techniques to determine most effective for future phases. Brush mats, small solarization plots, stripping, mulch, no treatment and/or planting with auger.
tree/shrub									
		black cottonwood	0.3	448	224	112	112	Plant along top of bank only	
		Bebb's willow	0.2	299	149	75	75	Plant along top of bank only	
		sandbar willow	0.1	149	75	37	37	Plant on riverbank and top of bank	
		red osier dogwood	0.2	299	149	75	75	Plant on riverbank and top of bank	
		black hawthorn	0.05	75			75	Plant along top of bank only	
		saskatoon	0.05	75			75	Plant along top of bank only	
		prickly rose	0.05	75			75	Plant along top of bank only	
		highbush cranberry	0.05	75			75	Plant along top of bank only	
Subtotal			1	1493	597	299	597	Approx. 1.5 m spacing	
Island 2	1134							Plant elevated microsite along top of bank approx 20 m wide. Avoid sedge/rush habitat. Site too wet for potted stock.	Brush mats or mulch on TRS, no treatment for live stakes.
tree/shrub		black cottonwood	0.4	202	151	50		Plant along top of bank only	
		Bebb's willow	0.2	101	76	25		Plant along top of bank only	
		sandbar willow	0.2	101	76	25		Plant on riverbank and top of bank	
		red osier dogwood	0.2	101	76	25		Plant on riverbank and top of bank	
Subtotal			1	504	378	126		Approx. 1.5 m spacing	
Island 3	1500							Plant top of bank outside meander bend approx 20 m wide. Avoid planting above *Sagittaria* spp. to prevent shading species.	Brush mats or mulch on TRS, potted stock and half live stakes. No treatment on remaining live stakes.
shrub		Bebb's willow	0.3	200	150	50		Plant along top of bank only	
		sandbar willow	0.3	200	150	50		Plant on riverbank and top of bank	
		red osier dogwood	0.3	200	150	50		Plant on riverbank and top of bank	
		black hawthorn	0.1	67			67	Plant along top of bank only	
Subtotal			1	667	450	150	67	Approx. 1.5 m spacing	

Location	Area (m^2)	Species	%	Total No. Shrubs	Type/Size			Specifications	Site Preparation
					Live stake	TRS	Potted stock 1 gal.		
Phase 3									
Prescriptions (species, type and site preparation) may be modified based on results of Phase 1.									
Island 4	3600							Plant top of bank outside meander bend approx 20 m wide between brush layer and fence. Do not plant within 10 m of fence.	Determine based on results of Phase 1. Brush mats, solarization, stripping, mulch, no treatment and/or planting with auger.
shrub		Bebb's willow	0.3	480	360	120		Plant throughout	
		sandbar willow	0.3	480	360	120		Plant throughout	
		red osier dogwood	0.3	480	360	120		Plant throughout	
		black hawthorn	0.1	160			160	Plant throughout	
Subtotal				1600	1080	360	160	Approx. 1.5 m spacing	
Island 5								Create 3 - 20x20m tree islands or field fit dimensions around desirable vegetation.	Rough and loose w/ 2 m live stakes
tree/shrub									
5.i	400	black cottonwood	0.3	120	120			Plant throughout	
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
5.ii	400	black cottonwood	0.3	120	120			Plant throughout	
		Bebb's willow	0.2	80	80			Plant throughout	Rough and loose w/ 2 m live stakes
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
5.iii	400	black cottonwood	0.3	120	120			Plant throughout	Rough and loose w/ 2 m live stakes
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
Island 6	2640							Re-slope bank to stable angle. Plant top of bank outside meander bend approx 20 m wide between brush layer and fence. Do not plant within 10 m of fence.	Determine based on results of Phase 1. Brush mats, solarization, stripping, mulch, no treatment and/or planting with auger.
shrub		Bebb's willow	0.3	352	176	88	88	Plant throughout	
		sandbar willow	0.3	352	176	88	88	Plant throughout	
		red osier dogwood	0.3	352	176	88	88	Plant throughout	
		black hawthorn	0.1	117			117	Plant throughout	
Subtotal				1173	528	264	381	Approx. 1.5 m spacing	

Location	Area (m^2)	Species	%	Total No. Shrubs	Type/Size			Specifications	Site Preparation
					Live stake	TRS	Potted stock 1 gal.		
Phase 4									
Prescriptions (species, type and site preparation) may be modified based on results of previous phases.									
Island 7								Create 5 - 20x20m tree islands or field fit	
7.i	400	black cottonwood	0.3	120	120			dimensions around desirable vegetation.	Determine based on results of Phase 3.
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
7.ii	400	black cottonwood	0.3	120	120			Plant throughout	
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
7.iii	400	black cottonwood	0.3	120	120			Plant throughout	
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
7.iv	400	black cottonwood	0.3	120	120			Plant throughout	
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
7.v	400	black cottonwood	0.3	120	120			Plant throughout	
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.1	40			40	Plant throughout	brush mats or mulch
		highbush cranberry	0.1	40			40	Plant throughout	brush mats or mulch
Subtotal			1	400	320	0	80	Approx. 1 m spacing	

Location	Area (m^2)	Species	%	Total No. Shrubs	Type/Size			Specifications	Site Preparation
					Live stake	TRS	Potted stock 1 gal.		
Island 8	2800							Plant top of bank approx 20 m wide between brush layer and fence. Do not plant within 10 m of fence.	Determine based on results of previous phases.
shrub		Bebb's willow	0.3	373	280	93		Plant throughout	
		sandbar willow	0.3	373	280	93		Plant throughout	
		red osier dogwood	0.3	373	280	93		Plant throughout	
		black hawthorn	0.1	124			124	Plant throughout	
Subtotal			1	1244	840	280	124	Approx. 1.5 m spacing	
Island 9								Create 2 - 20x20m tree islands.	
9.i	400	black cottonwood	0.3	120	120			Plant throughout	Determine based on results of Phase 3.
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.05	20			20	Plant throughout	
		saskatoon	0.05	20			20	Plant throughout	
		prickly rose	0.05	20			20	Plant throughout	
		highbush cranberry	0.05	20			20	Plant throughout	
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
9.ii	400	black cottonwood	0.3	120	120			Plant throughout	
		Bebb's willow	0.2	80	80			Plant throughout	
		sandbar willow	0.1	40	40			Plant throughout	
		red osier dogwood	0.2	80	80			Plant throughout	
		black hawthorn	0.05	20			20	Plant throughout	
		saskatoon	0.05	20			20	Plant throughout	
		prickly rose	0.05	20			20	Plant throughout	
		highbush cranberry	0.05	20			20	Plant throughout	
Subtotal			1	400	320	0	80	Approx. 1 m spacing	
Island 10	2100							Plant along riverbank 20-30m wide. Do not plant within 10m of fence.	Determine based on results of previous phases.
tree/shrub									
		black cottonwood	0.3	280	140	70	70	Plant along top of bank only	
		Bebb's willow	0.2	187	93	47	47	Plant along top of bank only	
		sandbar willow	0.1	93	47	23	23	Plant on riverbank and top of bank	
		red osier dogwood	0.2	187	93	47	47	Plant on riverbank and top of bank	
		black hawthorn	0.05	47			47	Plant along top of bank only	
		saskatoon	0.05	47			47	Plant along top of bank only	
		prickly rose	0.05	47			47	Plant along top of bank only	
		highbush cranberry	0.05	47			47	Plant along top of bank only	
Subtotal			1	933	373	187	373	Approx. 1.5 m spacing	

Location	Area (m^2)	Species	%	Total No. Shrubs	Type/Size			Specifications	Site Preparation
					Live stake	TRS	Potted stock 1 gal.		
Future Phases (cannot be completed until new bridge is installed) **Prescriptions (species, type and site preparation) may be modified based on results of previous phases.**									
Island 11	1850							Plant along riverbank 10-20m wide.	Determine based on results of previous phases.
shrub		Bebb's willow	0.3	547	273	137	137	Plant along top of bank only	
		sandbar willow	0.2	364	182	91	91	Plant on riverbank and top of bank	
		red osier dogwood	0.2	364	182	91	91	Plant on riverbank and top of bank	
		black hawthorn	0.1	182			182	Plant along top of bank only	
		saskatoon	0.1	182			182	Plant along top of bank only	
		prickly rose	0.1	182			182	Plant along top of bank only	
Subtotal			1	822	638			Approx. 1.5 m spacing	
Island 12	4100							Plant along riverbank 10-20m wide.	Determine based on results of previous phases.
shrub		Bebb's willow	0.3	547	301	137	137	Plant along top of bank only	
		sandbar willow	0.2	364	200	91	91	Plant on riverbank and top of bank	
		red osier dogwood	0.2	364	200	91	91	Plant on riverbank and top of bank	
		black hawthorn	0.1	182			182	Plant along top of bank only	
		saskatoon	0.1	182			182	Plant along top of bank only	
		prickly rose	0.1	182			182	Plant along top of bank only	
Subtotal			1	1822	1339	319	866	Approx. 1.5 m spacing	
Island 13								Create 3 - 20x20m tree islands.	Determine based on results of previous phases.
tree/shrub									
13.i	400	black cottonwood	0.3	53	53			Plant throughout	
		Bebb's willow	0.2	36	36			Plant throughout	
		sandbar willow	0.1	18	18			Plant throughout	
		red osier dogwood	0.1	18	18			Plant throughout	
		black hawthorn	0.1	18			18	Plant throughout	
		saskatoon	0.05	9			9	Plant throughout	
		prickly rose	0.1	18			18	Plant throughout	
		highbush cranberry	0.05	9			9	Plant throughout	
Subtotal			1	178	124		53	Approx. 1 m spacing	
13.ii	400	black cottonwood	0.3	53	53			Plant throughout	
		Bebb's willow	0.2	36	36			Plant throughout	
		sandbar willow	0.1	18	18			Plant throughout	
		red osier dogwood	0.1	18	18			Plant throughout	
		black hawthorn	0.1	18			18	Plant throughout	
		saskatoon	0.05	9			9	Plant throughout	
		prickly rose	0.1	18			18	Plant throughout	
		highbush cranberry	0.05	9			9	Plant throughout	
Subtotal			1	178	124		53	Approx. 1 m spacing	

Location	Area (m^2)	Species	%	Total No. Shrubs	Type/Size			Specifications	Site Preparation
					Live stake	TRS	Potted stock 1 gal.		
13.iii	400	black cottonwood	0.3	53	53			Plant throughout	
		Bebb's willow	0.2	36	36			Plant throughout	
		sandbar willow	0.1	18	18			Plant throughout	
		red osier dogwood	0.1	18	18			Plant throughout	
		black hawthorn	0.1	18			18	Plant throughout	
		saskatoon	0.05	9			9	Plant throughout	
		prickly rose	0.1	18			18	Plant throughout	
		highbush cranberry	0.05	9			9	Plant throughout	
Subtotal			1	178	124		53	Approx. 1 m spacing	
Island 14	900							Plant bench between river bank and dike.	Determine based on results of previous phases.
tree/shrub		black cottonwood	0.3	120	60	60		Plant along top of bank only	
		Bebb's willow	0.2	80	40	40		Plant along top of bank only	
		sandbar willow	0.1	40	20	20		Plant on riverbank and top of bank	
		red osier dogwood	0.1	40	20	20		Plant on riverbank and top of bank	
		black hawthorn	0.1	40			40	Plant along top of bank only	
		saskatoon	0.05	20			20	Plant along top of bank only	
		prickly rose	0.1	40			40	Plant along top of bank only	
		highbush cranberry	0.05	20			20	Plant along top of bank only	
Subtotal			1	400	140	140	120	Approx. 1.5 m spacing	
Brush layers									
15	1090	black cottonwood	0.25		1635			Plant along top of bank only	
		Bebb's willow	0.25		1635			Plant along top of bank only	
		sandbar willow	0.25		1635			Plant on riverbank and top of bank	
		red osier dogwood	0.25		1635			Plant on riverbank and top of bank	
Subtotal			1		6540			Place 6 cuttings/m	
16	360	black cottonwood	0.25		540			Plant along top of bank only	
		Bebb's willow	0.25		540			Plant along top of bank only	
		sandbar willow	0.25		540			Plant on riverbank and top of bank	
		red osier dogwood	0.25		540			Plant on riverbank and top of bank	
Subtotal			1		2160			Place 6 cuttings/m	