

2010 Riparian Health Inventory

Waiparous Creek Watershed



Alberta Riparian Habitat Management Society
(Cows and Fish)

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Prepared for:

Ghost Watershed Alliance Society

Project Area:

Waiparous Creek Watershed
(Waiparous Creek, Johnson Creek, Meadow Creek, Lost Knife Creek, Four Mile Creek, Aura Creek, Aura basin wetlands, and an unnamed tributary to Waiparous Creek)

Prepared by:

Cows and Fish
(Alberta Riparian Habitat Management Society)
c/o Alberta Beef Producers Office
320, 6715 8th Street NE
Calgary, Alberta, Canada
T2E 7H7
(403) 275-4400

Writers:

Amanda Halawell, Kathryn Hull, Deanna White, Kristi Adair and Cameron Wood

Contributors:

Christy Sikina (mapping) and Nicole Bach (data analysis)

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AERIAL PHOTOGRAPHY ADDENDUM* SEPARATE COVER REPORT

**Contains aerial photographs of each of the 37 individual 2010 Waiparous Creek Watershed Riparian Health Inventory sites, showing upstream and downstream site boundaries.*

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Disclaimer

- *Any release of the information contained in this report, in whole or in part, to parties other than the Ghost Watershed Alliance Society will not be the responsibility of Cows and Fish. Liabilities with the release of this report or use of the information beyond the original intent of the work will be the responsibility of the Ghost Watershed Alliance Society.*
- *The riparian health inventories of Johnson, Meadow, Lost Knife, Four Mile and Aura Creeks do not address any in-stream, hydrological parameters (i.e. issues associated with water flow regimes, water diversions, extractions, dam impacts).*
- *The objective of completing these riparian health inventories is to provide a coarse filter review of the status of riparian health within the project area. The riparian health scores provide a general status of riparian health, not an absolute one. Riparian areas are dynamic and are constantly changing. Because of this natural variability, the range of possible scores in each category is broad and one assessment is only an approximation of health. Inventories over a period of years at the same locations will provide a better picture of whether current management is maintaining, improving or negatively impacting riparian health.*

EXECUTIVE SUMMARY

In 2010, the Alberta Riparian Habitat Management Society partnered with the Ghost Watershed Alliance Society (GWAS) to inventory riparian health along select streams and wetlands within the Waiparous Creek watershed (northwest of Cochrane, Alberta). This project was made possible in large part due to a grant provided by the Alberta Conservation Association and the City of Calgary. This initiative is the first phase of the goal to inventory riparian health in the entire Ghost River watershed to inform watershed management planning. In addition to water quantity and quality benefits within the headwaters of the Bow River, the Ghost River watershed provides important fish and wildlife habitat, including habitat for Threatened westslope cutthroat trout and Sensitive bull trout populations.

During July 2010, riparian health inventories were completed on representative portions of Waiparous Creek, Johnson Creek, Meadow Creek, Lost Knife Creek, Four Mile Creek, Aura Creek and associated wetland complexes, and an unnamed tributary to Waiparous Creek. The majority of these sites are within the Ghost River Forest Reserve Grazing Allotment. Aura Creek and the Aura wetlands are located within the Aura Cache Forest Reserve Grazing Allotment. Of the riparian inventory sites along Waiparous Creek, eight are within the Ghost River Allotment, five are within the Aura Cache Allotment and one is located within the Village of Waiparous. A total of 37 inventories were completed representing a cumulative total of 26 km of stream length and 7 hectares of wetland area. This includes 34 lotic (stream) and 3 lentic (wetland) riparian health assessments. Efforts were made to sample representative land use types (proportionate to their frequency) along at least one third of each stream system.

Based on the results of this riparian health inventory project, most riparian areas within the Waiparous Creek watershed appear to be in proper functioning (*healthy*) condition. However, there are concentrated areas where land use impacts (mainly off-highway vehicle activity and / or livestock grazing) have degraded riparian health. The average health rating for Waiparous Creek and the six tributary streams assessed is 92%. Five sites (15%) rate functional at risk (*healthy, but with problems*) and the remainder (85%) are in proper functioning condition. The overall health rating for the three Aura wetland sites is 86%. Only one of these wetland sites is considered functional at risk. None of the stream or wetland sites assessed are in the non-functional (*unhealthy*) category. Since riparian health inventory sites vary in size, it is important to take into consideration the relative riparian health of the watershed based on the amount of area assessed, rather than the number of sites assessed. For sites evaluated along Waiparous Creek and its tributaries, the area-weighted riparian health rating is 88%. Of the total area assessed, 71% is considered functional and 29% is in the functional at risk category. This is mostly due to two large sites (> 16 ha) along Meadow Creek having a lower health rating.

Aside from an invasive ornamental shrub (yellow clematis) found in the Waiparous Village, no other noxious / prohibited noxious weeds (as listed on the Alberta *Weed Control Act*) were observed along the main stem of Waiparous Creek. Only three noxious weeds (Canada thistle, perennial sow-thistle and tall buttercup) were found along tributaries to Waiparous Creek. These three weeds occur in trace

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amounts at sites where they were found. It is important to keep the watershed weed free through education and awareness activities, ongoing weed monitoring and community weed pull days.

Riparian health is usually an indicator of water quality within a watershed. The high level of riparian health for the Waiparous Creek watershed as a whole would suggest water quality should rate similarly high. However, a 2006 water quality study commissioned by Alberta Environment shows degraded water quality and concerning, high sediment loads in Waiparous Creek (Andrews 2006). This suggests that although few in number, isolated areas of degraded riparian health (e.g. forded vehicle crossing locations), may have a significant impact on water quality. Degraded water quality may also indicate that land uses in the Waiparous Basin may be overtaxing the buffering ability of riparian areas, even those in a healthy condition. If the health and condition of adjacent uplands is degraded, erosion and loss of upland vegetation cover can overburden the ability of riparian areas to absorb and filter sediment from overland runoff. Upland range health monitoring conducted by Alberta Sustainable Resource Development is therefore important to consider in conjunction with the findings of our study.

Next steps and management recommendations for riparian areas are provided in Section 5 of this report. Recommendations include monitoring recreational activities in the watershed and restricting off-highway vehicle use within riparian areas to appropriately designed bridge crossings or natural gravel/cobble stream areas that are not easily eroded. Recommendations are also provided for improved livestock distribution by using strategic salt and mineral placement and low-stress livestock herding techniques.

The overall high level of riparian health in the Waiparous Creek basin and the relatively low abundance of invasive and disturbance plant species represents a good chance of success for restoration and recovery of impacted riparian sites. Collaboration on restoration projects is encouraged between user groups, industry and agencies that have a responsibility or interests in the area. This will likely foster a sense of ownership and responsibility for restoration projects that are undertaken and increase their likelihood of success.

This riparian health inventory project is intended to establish a necessary baseline for monitoring riparian areas in the Ghost River watershed and for focusing attention on riparian health issues. It is intended to compliment and inform con-current cumulative effects studies and ecosystem-based management planning initiatives in the watershed spearheaded by the GWAS. Going forward, careful land use management in the Waiparous Creek basin is a priority, particularly within sensitive riparian ecosystems.

## 1 BACKGROUND

### 1.1 Project Overview

In 2010, the Alberta Riparian Habitat Management Society (Cows and Fish) partnered with the Ghost Watershed Alliance Society (GWAS) to inventory riparian health along select streams and wetlands within the Waiparous Creek watershed. This initiative is the first phase of the goal to inventory riparian health in the entire Ghost River watershed to inform watershed management planning. This project was commissioned by the GWAS with funding provided by the Alberta Conservation Association (ACA) and Cows and Fish.

In 2010, the project scope included inventorying riparian health along representative reaches of Waiparous Creek and associated tributaries and wetlands. Additional riparian health inventories are planned in 2011 as part of Phase Two of the project. The second phase of this project is to assess riparian health of the remainder of the Ghost River watershed. This would include riparian health inventory of representative portions of the North Ghost River, South Ghost River, Ghost River main stem, Lesueur Creek, Robinson Creek, Baymar Creek, Jamieson Creek and associated wetlands. It is proposed that inventory work focus on areas within the Alberta Forest Reserve, provincial lease land and private land. The Ghost River Wilderness Area and Don Getty Wildland Provincial Park are not included since these are considered provincially protected areas. The Stoney First Nations Reserve is also not included due to access restrictions. Once complete, these two phases of the project will provide a representation of the overall picture of riparian health within the Ghost River watershed. However, it is important to realize that due to the broad-scale nature of the representative sampling methodology used, there may be unique areas of riparian zone within each stream system not represented by the overall health rating for that system.

This report outlines the riparian health results for the sites assessed in the Waiparous Creek watershed during the 2010 field season as part of Phase One of this project. Riparian health scores are presented for individual sites and for entire stream systems. Riparian health inventories provide comprehensive information about the diversity, structure and health of plant communities within the project area. The collection of this baseline information will assist the GWAS, resource managers and other user groups in the area with watershed management planning, directing riparian restoration efforts, and monitoring change in riparian health over time.

## 1.2 What Is A Riparian Area?

Riparian areas are the portions of the landscape strongly influenced by water and are recognised by water-loving vegetation along rivers, streams, lakes, springs, ponds and seeps (Figure 1). Riparian areas can be described as the lush “green zones” around lakes and wetlands and bordering rivers and streams.

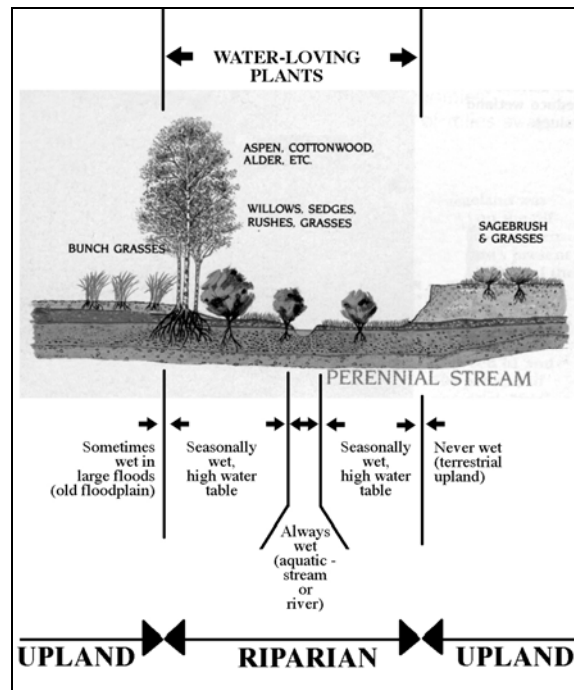


Figure 1 Diagrammatic Representation of a Riparian Area<sup>1</sup>

## 1.3 Why Are Healthy Riparian Areas Important?

When in a properly functioning condition or *healthy* state, riparian areas are one of the most ecologically diverse ecosystems in the world. Healthy riparian areas sustain fish and wildlife populations, provide good water quality and stable water supplies, and support people on the landscape. In doing so they play a role that is disproportionately important to the amount of area that they encompass (approximately 2-5% of the landscape).

Important ecological functions performed by healthy riparian areas include trapping and storing sediment to maintain and build banks, recharging groundwater supplies, providing stable flows and flood protection, and improving water quality by filtering runoff and reducing the amount of contaminants and nutrients reaching the water. Thus, despite occupying only a small percentage of the total land area within a watershed, riparian areas are critical to the long-term sustainability of a healthy landscape.

<sup>1</sup> Source: Fitch *et al.* 2001.

## 2 PROJECT AREA DESCRIPTION

### 2.1 Ghost River Watershed Overview

The Ghost River Watershed (Figure 2) and its main tributary, Waiparous Creek, drain an area of approximately 947 km<sup>2</sup> (Bow River Basin Council 2005). The Ghost River feeds into the Bow River at the Ghost Reservoir approximately 15 km upstream of Cochrane. Stream flows are maintained by snowmelt and a network of wetlands and alluvial aquifers. This is an important component of providing consistent water supply for users within the watershed and downstream. In addition to water quantity and quality benefits, the watershed provides many important ecological services including air quality, carbon storage and sequestration, storm water control and recreation, to name a few. The Waiparous Creek watershed provides important fish and wildlife habitat. It has been identified as having some of the little remaining suitable habitat for Threatened westslope cutthroat trout and Sensitive bull trout populations (Fitzsimmons 2008, Costello 2006).

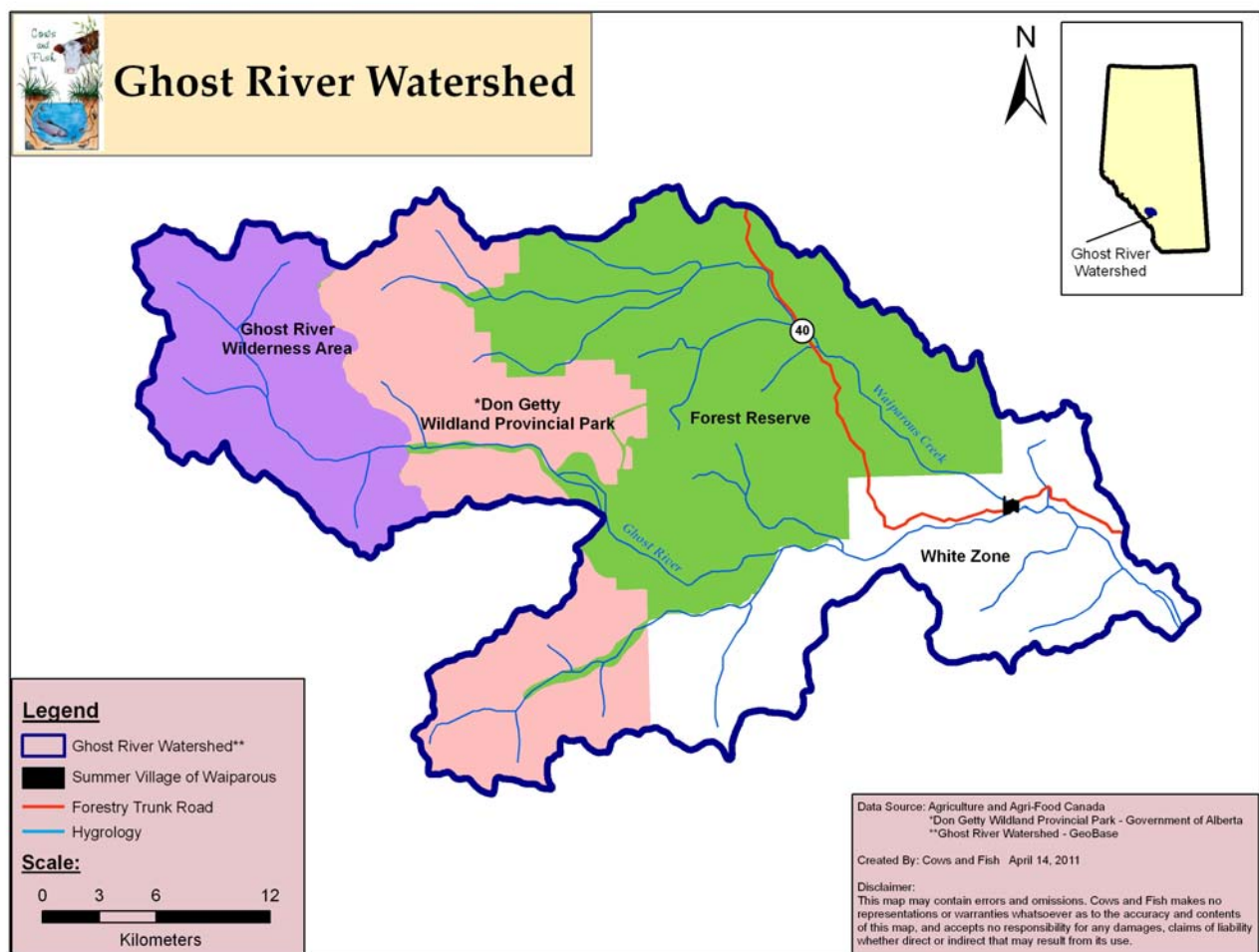


Figure 2 Ghost River Watershed Regional Context.

## **2.2 Land Use and Land Management**

The headwaters of the Ghost River and several tributaries are provincially protected. Approximately 375 km<sup>2</sup> of the area is within the Ghost River Wilderness Area and Don Getty Wildland Provincial Park (Figure 2). The majority of the remainder of the watershed is part of the Alberta Forest Reserve managed by ASRD. Like most Alberta Forest Reserve land, the area is considered to be multi-use. The watershed is used for livestock grazing, logging, oil and gas exploration and recreation. The area is popular with both non-motorized (horseback riding, hiking, biking) and motorized recreational users (various types of off-highway vehicles [OHVs]). Motorized recreation has increased significantly within the project area (ASRD 2005) and will likely continue to increase to the detriment of non-motorized recreational opportunities (ALCES 2011, unpublished report). Commercial forest harvest operations have recently commenced within the Waiparous Creek watershed and are planned to increase into the future. The need for comprehensive management planning is critical to ensure these uses may continue in a planned way while ensuring that the watershed continues to provide the ecological goods and services that those in the watershed and downstream rely on.

Commercial timber harvest within Waiparous Creek watershed is facilitated through a Forest Management Agreement (FMA) with Spray Lake Sawmills, Cochrane, Alberta. There are numerous oil and gas wells and associated facilities in the project area operated by Husky Energy, Shell and Suncor. The Waiparous Creek watershed is largely made up of two Forest Grazing Allotments, including the Ghost River Allotment and the Aura Cache Allotment. The Ghost River Sub-Regional Integrated Resource Plan (1988) was developed by ASRD to be used as a guide for resource managers, industry and public with responsibility or interests in the area in order to manage these activities. A Ghost Waiparous Operational Access Management Plan (2005) was also developed in response to the increased need for management of OHV use and other related recreational access issues.



### 2.3 2010 Riparian Health Inventory Project Area

During July 2010, Cows and Fish completed riparian health inventories on Waiparous Creek, Johnson Creek, Meadow Creek, Lost Knife Creek, Four Mile Creek, Aura Creek and associated wetland complexes, and an unnamed tributary to Waiparous Creek (Figure 3). The majority of these sites are within the Ghost River Grazing Allotment. Aura Creek and the Aura wetlands are located within the Aura Cache Grazing Allotment. Of the riparian inventory sites along Waiparous Creek, eight fall within the Ghost River Allotment, five are within the Aura Cache Allotment and one is located within the summer Village of Waiparous (Figure 3).

A total of 37 inventories were completed representing a cumulative total of 26 km of stream length and 7 hectares of wetland area (Table 1). This includes 34 lotic (stream) and 3 lentic (wetland) riparian health assessments.

**Table 1 2010 Project Area Description**

| <i>Stream</i>                        | <i>No. of Riparian Inventories</i> | <i>Streambank Distance Inventoried (km)</i> | <i>Approximate streambank length within project area (km)</i> |
|--------------------------------------|------------------------------------|---------------------------------------------|---------------------------------------------------------------|
| Waiparous Creek                      | 14                                 | 12.4                                        | 42                                                            |
| Johnson Creek                        | 4                                  | 4.0                                         | 13                                                            |
| Meadow Creek                         | 5                                  | 4.2                                         | 10                                                            |
| Lost Knife Creek                     | 3                                  | 2.5                                         | 6                                                             |
| Four Mile Creek                      | 4                                  | 1.4                                         | 7                                                             |
| Unnamed tributary to Waiparous Creek | 1                                  | 0.6                                         | 14                                                            |
| Aura Creek                           | 3                                  | 1.4                                         | 4                                                             |
| <i>Wetland</i>                       | <i>No. of Riparian Inventories</i> | <i>Wetland area inventoried (hectares)</i>  |                                                               |
| Aura wetlands                        | 3                                  | 7                                           |                                                               |

# Waiparous Creek Watershed Project Area 2010

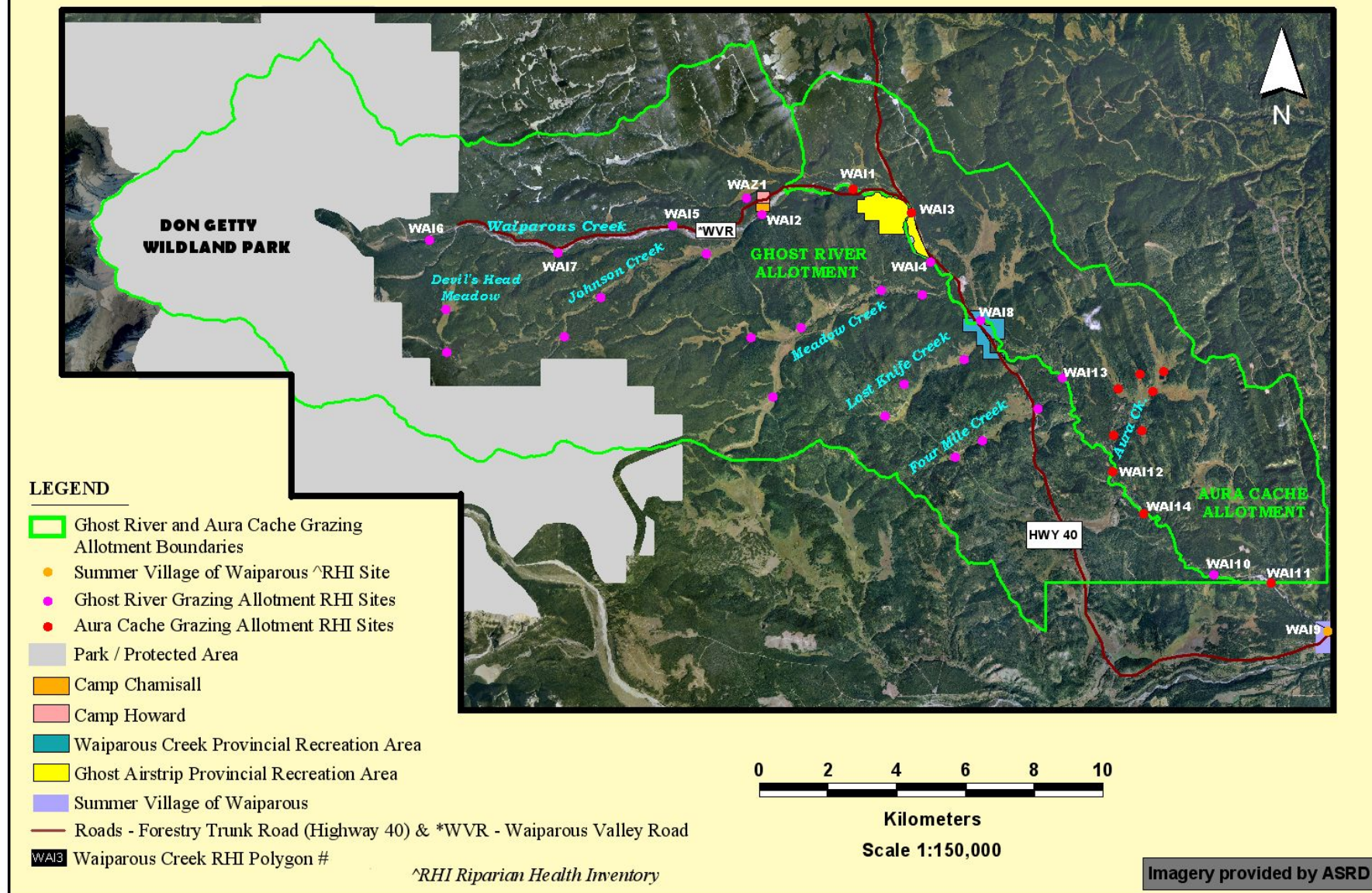


Figure 3 Waiparous Creek Watershed Project Area and Riparian Health Inventory Site Locations

### 3 METHODS

#### 3.1 Polygon (Site) Selection

To select riparian health inventory sites, the project area was initially stratified based on physical and vegetation features. Using air photo interpretation, stream systems were delineated into similar sub-reaches based on valley type, slope and sinuosity (Silvey and Rosgen 1998). A proportionate number of riparian health inventory polygons were assigned to each of these sub-reaches based on length. To achieve adequate representative sampling, approximately one-third of the total stream length was inventoried. Next, the project area was further stratified according to predominant land use, as determined through consultation with resources managers, local knowledge and air photo interpretation. Target areas that best fit representative land use within each sub-reach were identified. Riparian health inventory sites were selected within these target areas. Efforts were made to select a proportionate number of riparian health inventory polygons based on stream length in each land use category. Final field delineation of riparian health inventory polygons was refined on the ground by the assessor to best represent land use types and the physical and vegetative characteristics of the stream.

For Waiparous Creek and tributary assessments, where possible, the upstream and downstream site boundaries were placed at distinct locations or landmarks such as a bridge or stream confluence for ease of future monitoring. The outer boundaries or lateral extents of riparian sites were determined in the field based on vegetation, topography or management features (e.g., fencelines, roadways, etc.). The outer boundary of a site is generally determined by the outer edges of the functional riparian zone. Functional riparian areas are generally characterized by three main features:

- 1) water is present, seasonally or regularly that is either on the surface or close to the surface;
- 2) hydrophytic vegetation is present that responds to, requires and survives in abundant water; and
- 3) hydric soils are present that have been modified by abundant water (either by high water tables, sediment deposition or by lush and productive vegetation) (Fitch and Ambrose 2003).

Of note, for stream, large river and wetland riparian health evaluations the channel bottom (i.e., aquatic zone<sup>2</sup>) is excluded from the site.

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<sup>2</sup> The aquatic zone is the area covered by water and lacking persistent emergent vegetation such as cattails, bulrushes or sedges.

### **3.2 General Inventory Protocol**

Riparian health inventories were conducted from July 5<sup>th</sup> to July 21<sup>st</sup> by a two member team of the Cows and Fish Field Crew. A hand-held Garmin GPS60<sup>TM</sup> Global Positioning System (GPS) receiver was used to record the locations of the upstream and downstream ends of the polygon. For monitoring purposes, benchmark photographs looking upstream and downstream were taken at each end of the polygon. Additional photographs were taken where warranted to document features of interest or concern (e.g., weed infestations, bank erosion etc.).

### **3.3 Riparian Health Inventory**

The riparian health inventory methodology used in this project was developed by Cows and Fish in collaboration with Dr. Paul Hansen and William Thompson (formerly of University of Montana's Riparian and Wetland Research Program), currently of Ecological Solutions Group LLC. The intent of the method is to determine if a riparian site is performing certain ecological functions (e.g. sediment trapping, water filtration, biological diversity and primary production) through examination of parameters that provide indirect evidence of these ecological functions.

During a riparian health inventory, detailed information is collected about the vegetation and the physical characteristics (i.e., soil and hydrology) of the site. Vegetation features evaluated include plant community types, plant species composition and canopy coverage, and the age class breakdown of woody species. Physical characteristics examined include the amount and breakdown by causes of human-caused alterations to the site, estimates of human-caused bare ground, and the degree of bank instability and root mass protection. This information is entered into a provincial riparian health FileMaker Pro database developed by the Ecological Solutions Group LCC for Cows and Fish. Health scores for small streams and wetlands are analyzed (derived) in FileMaker Pro using data collected during the health inventory.

Stream systems with a channel width greater than 15 m are considered "large rivers" in the Cows and Fish riparian health evaluation methodology. Since this description fits Waiparous Creek, it was evaluated as such. In addition to the inventory data, an Alberta Large River System Health Evaluation (Survey) Form was completed for Waiparous Creek to determine the health of this system (Appendix D).

Incidental wildlife and rare plant observations are recorded during riparian health inventories, but these types of studies are not within the scope of the project and therefore findings are not comprehensive. Aquatic flora, benthic invertebrates and water quality measurements are not collected as part of riparian health inventories.



Riparian health scores are derived from an evaluation of 11 key vegetation and soil / hydrology health parameters for small streams and 10 health parameters for wetlands (Table 2). For Waiparous Creek, health scores were based on an evaluation of 8 of these parameters in addition to 7 others mainly related to tree cover and hydrology (Table 2).

By objectively examining each of the health parameters described in Table 2 we can determine which pieces are adequately performing the necessary functions of a healthy riparian area, and which are not. This examination provides us with a better understanding of where to concentrate efforts if improvements in riparian management are required, and what land use practices are currently maintaining riparian health.




**Table 2 List of Riparian Health Parameters Assessed for Streams, Rivers and Wetlands in the Waiparous Creek Watershed Project Area**

| <i>Riparian Health Parameter Assessed</i> |                                                                  | <i>Streams and Small Rivers</i> | <i>Large Rivers</i> | <i>Wetlands</i> |
|-------------------------------------------|------------------------------------------------------------------|---------------------------------|---------------------|-----------------|
| <b>Vegetative</b>                         | Vegetative cover                                                 | ☑                               |                     | ☑               |
|                                           | Cottonwood and poplar regeneration                               |                                 | ☑                   |                 |
|                                           | Regeneration of other tree species                               |                                 | ☑                   |                 |
|                                           | Preferred shrub regeneration                                     |                                 | ☑                   |                 |
|                                           | Preferred tree/shrub regeneration                                | ☑                               |                     | ☑               |
|                                           | Preferred tree/shrub utilization and removal other than browsing | ☑                               | ☑                   | ☑               |
|                                           | Dead/decadent woody material                                     | ☑                               | ☑                   |                 |
|                                           | Total canopy cover of woody plants                               |                                 | ☑                   |                 |
|                                           | Invasive plants                                                  | ☑                               | ☑                   | ☑               |
|                                           | Disturbance plants                                               | ☑                               | ☑                   | ☑               |
|                                           | Human alteration of riparian vegetation                          |                                 |                     | ☑               |
| <b>Physical</b>                           | Root mass protection                                             | ☑                               | ☑                   |                 |
|                                           | Human-caused alterations to banks                                | ☑                               | ☑                   | ☑               |
|                                           | Human-caused bare ground                                         | ☑                               | ☑                   | ☑               |
|                                           | Human-caused alterations to rest of site                         | ☑                               | ☑                   | ☑               |
|                                           | Floodplain accessibility                                         |                                 | ☑                   |                 |
|                                           | Channel incisement                                               | ☑                               |                     |                 |
|                                           | Removal or addition of water from / to water body                |                                 | ☑                   | ☑               |
|                                           | Control of flood peak and timing by upstream dam(s)              |                                 | ☑                   |                 |

Refer to Appendices E, F and G for a detailed description of the riparian health parameters listed in Table 2 and how they are evaluated.

Riparian health scores (ratings) are expressed as a percentage and a health category (*healthy*, *healthy, but with problems*, or *unhealthy*) (Table 3).

**Table 3 Description of Riparian Health Ratings**

| <i>Health Category</i>     |                                                                                   | <i>Score Ranges</i> | <i>Description</i>                                                          |
|----------------------------|-----------------------------------------------------------------------------------|---------------------|-----------------------------------------------------------------------------|
| Healthy                    |  | 80-100%             | little to no impairment to any riparian functions                           |
| Healthy, but with problems |  | 60-79%              | some impairment to riparian functions due to management or natural causes   |
| Unhealthy                  |  | <60%                | severe impairment to riparian functions due to management or natural causes |

### 3.4 What Makes a Riparian Area “Healthy”

Riparian areas are like a jigsaw puzzle and each individual piece or component is important to the successful function of the entire system. How the individual pieces function together affects the function or *health* of the riparian ecosystem including the stream, its watershed, and overall landscape health and productivity.

Healthy riparian areas have the following *pieces* intact and functioning properly:

- successful reproduction and establishment of seedling, sapling and mature trees and shrubs (if the site has potential to grow them);
- light or no browsing of trees and shrubs (by livestock or wildlife);
- floodplains and banks with abundant plant growth;
- banks with deep-rooted plant species (trees and shrubs);
- very few, if any, invasive weeds (e.g. Canada thistle);
- not many disturbance-caused plant species (e.g. Kentucky bluegrass, dandelion);
- very little bare ground or altered banks; and
- ability to frequently (i.e. every few years) access a floodplain at least double the channel width.

When riparian health degrades it usually means that one or more of the pieces has been impacted by natural or human-caused disturbances such as development, recreation, grazing, flooding or fire. As the rate and intensity of disturbance increases, the severity of health degradation can reach a point when the riparian area fails to perform its functions properly and becomes *unhealthy*. Riparian areas with moderate levels of impacts will typically fall within the *healthy, but with problems* category, while those with very few or no impacts will normally be rated as *healthy*.

### 3.5 Classification of Riparian Plant Communities

The 2010 riparian health inventory project area lies within the Upper Foothills Subregion of the Foothills Natural Region and the Montane Subregion of the Rocky Mountains Natural Region of Alberta (Natural Regions Committee 2006).

The *Riparian Classification for the Parkland and Dry Mixedwood Natural Region* guide (Thompson and Hansen 2003) was used to classify riparian plant communities in the project area. Plant communities described in this guide encompass plant community types that commonly occur within the Upper Foothills and Montane Natural Subregions. Plant community types that were encountered in the project area that are not described in the guide were recorded as “unclassified”. Dominant plant species within these unclassified communities were documented during the field assessment.

Typically, a particular species of willow or other shrub will form the understory of a deciduous or coniferous tree canopy, within a riparian area. On smaller systems willows or other tall shrubs might be the dominant plant in the upper canopy with sedges and low-growing shrubs forming the understory. These different combinations of plants occupying the same ecological niche are referred to as the potential natural community. The potential natural community is comprised of habitat types (HT) and community types (CT). Habitat types have the potential to support ‘climax plant communities’ or, final state plant communities that are self-perpetuating and in dynamic equilibrium with their environment. Community types have the potential to support ‘seral plant communities’, or interim plant communities that are replaced by another community or species as succession progresses. Using this classification system, all plant communities within the project area, whether habitat types or community types, were identified and stratified.

Understanding the type of riparian plant communities a stream, river, lake, or wetland system has the potential to grow is important for a number of reasons. Firstly it allows land managers to know if the desired plant communities are growing there already and if not, why not? For example, will a riparian site grow cottonwoods or willows? How extensive should the plant communities be? Secondly, it provides insight into the feasibility of improving existing site conditions and recovering desired and healthier plant communities, if the desired plant community does not exist or is limited. Knowing how much existing plant communities deviate from the potential natural community allows managers to: set realistic goals to either improve or maintain existing riparian health; understand how long recovery may take if improvement is needed; and obtain insight into what management strategies need to be implemented for improvement to occur or to maintain existing riparian health.

## 4 RESULTS AND DISCUSSION

### 4.1 Overview of 2010 Riparian Health Results

Based on the results of this riparian health inventory project, most riparian areas within the Waiparous Creek watershed appear to be in healthy condition (Table 4). However, there are isolated areas where land use impacts have degraded riparian health. The overall high level of riparian health in the Waiparous Creek basin and the relatively low abundance of invasive and disturbance plant species represents a good chance of success for restoration and recovery of impacted riparian sites.

The combined average health rating for Waiparous Creeks and the six tributary streams assessed in the Waiparous Creek watershed is 92% (*healthy*). This represents a combined average healthy rating for 34 individual riparian health inventory sites along these stream systems (Table 4). Five sites (15%) rate *healthy, but with problems* and the remainder (85%) are in the *healthy* category (Table 4). The average health rating for the three Aura wetland sites is 86% (*healthy*) (Table 4). Only one of these wetland sites is in the *healthy, but with problems*. None of the stream or wetland sites assessed are in the *unhealthy* category.

Approximately 91.5 ha of riparian habitat were evaluated in total along 26.4 km of stream length in the project area. Since riparian health inventory sites vary in size, it is important to take into consideration the relative riparian health of the watershed based on the amount of area assessed, rather than the number of sites assessed. Previously riparian health scores were reported based on the average score of sites inventoried. With better estimates of polygon size, a summary of riparian health based on the relative size of each polygon within a project area, specific stream system or wetland complex can be provided. Area-weighted summaries can also describe the amount of riparian area within each healthy category. Table 4 provides the average site score and the area-weighted score in brackets, summarized by system.

For the 34 stream sites evaluated along Waiparous Creek and its tributaries, the area-weighted riparian health rating is 88%. Of the total surface area assessed, 71% is in the *healthy* category and 29% is in the *healthy, but with problems* category. This is mostly due to two large sites ( $\geq 16$  ha) along Meadow Creek (MDW1 and MDX 1) having a lower health rating (77%, *healthy, but with problems*). The area-weighted riparian health score for the Aura wetlands is 87%, which is similar to the average score of the three sites evaluated.



**Table 4 2010 Riparian Health Results Summary**

| <i>Polygon ID</i>                         | <i>Location</i>                | <i>Channel Length<br/>/ Polygon Area</i> | <i>Vegetative<br/>Rating (%)</i> | <i>Soil &amp;<br/>Hydrology<br/>Rating (%)</i> | <i>Health Rating<br/>(%)</i> | <i>Overall<br/>Health<br/>Description</i> |
|-------------------------------------------|--------------------------------|------------------------------------------|----------------------------------|------------------------------------------------|------------------------------|-------------------------------------------|
| <b><i>Waiparous Creek<sup>1</sup></i></b> |                                |                                          |                                  |                                                |                              |                                           |
| WAI1 (north bank)                         | Aura Cache G.A.*               | 0.8 km / 5.4 ha                          | 97                               | 88                                             | 92                           | Healthy                                   |
| WAI2 (south bank)                         | Ghost River G.A.               | 1.2 km / 8.1 ha                          | 97                               | 96                                             | 97                           | Healthy                                   |
| WAI3 (east bank)                          | Aura Cache G.A.                | 0.9 km / 7.1 ha                          | 100                              | 100                                            | 100                          | Healthy                                   |
| WAI4 (west bank)                          | Ghost River G.A.               | 1.3 km / 4.5 ha                          | 95                               | 67                                             | 79                           | Healthy, but<br>with Problems             |
| WAI5 (north bank)                         | Ghost River G.A.               | 0.8 km / 6.7 ha                          | 100                              | 75                                             | 86                           | Healthy                                   |
| WAI6 (north bank)                         | Ghost River G.A.               | 0.8 km / 3.0 ha                          | 100                              | 96                                             | 98                           | Healthy                                   |
| WAI7 (south bank)                         | Ghost River G.A.               | 0.7 km / 3.0 ha                          | 95                               | 100                                            | 98                           | Healthy                                   |
| WAI8 (west bank)                          | Ghost River G.A.               | 0.8 km / 4.6 ha                          | 97                               | 79                                             | 87                           | Healthy                                   |
| WAI9 (west bank)                          | Summer Village of<br>Waiparous | 0.3 km / 0.2 ha                          | 100                              | 92                                             | 95                           | Healthy                                   |
| WAI10 (north bank)                        | Ghost River G.A.               | 1.1 km / 1.6 ha                          | 97                               | 100                                            | 99                           | Healthy                                   |
| WAI11 (west bank)                         | Aura Cache G.A.                | 0.8 km / 3.3 ha                          | 95                               | 96                                             | 95                           | Healthy                                   |
| WAI12 (east bank)                         | Aura Cache G.A.                | 1.0 km / 2.1 ha                          | 97                               | 100                                            | 99                           | Healthy                                   |
| WAI13 (west bank)                         | Ghost River G.A.               | 0.9 km / 2.2 ha                          | 97                               | 100                                            | 99                           | Healthy                                   |
| WAI14 (east bank)                         | Aura Cache G.A.                | 1.1 km / 1.1 ha                          | 95                               | 100                                            | 98                           | Healthy                                   |
| <b><i>Average (Area-weighted)</i></b>     |                                |                                          | <b>97%</b>                       | <b>92%</b>                                     | <b>94% (93%)</b>             | <b>Healthy</b>                            |
| <b><i>Johnson Creek</i></b>               |                                |                                          |                                  |                                                |                              |                                           |
| JON1                                      | Ghost River G.A.               | 1.0 km / 4.0 ha                          | 77                               | 80                                             | 78                           | Healthy, but<br>with Problems             |
| JON2                                      | Ghost River G.A.               | 0.7 km / 4.3 ha                          | 100                              | 90                                             | 95                           | Healthy                                   |
| JON3                                      | Ghost River G.A.               | 0.8 km / 2.4 ha                          | 97                               | 100                                            | 98                           | Healthy                                   |
| JON4                                      | Ghost River G.A.               | 0.7 km / 2.1 ha                          | 97                               | 100                                            | 98                           | Healthy                                   |
| JOX1                                      | Ghost River G.A.               | 0.9 km / 13.1 ha                         | 83                               | 100                                            | 92                           | Healthy                                   |
| <b><i>Average (Area-weighted)</i></b>     |                                |                                          | <b>91%</b>                       | <b>94%</b>                                     | <b>92% (91%)</b>             | <b>Healthy</b>                            |
| <b><i>Meadow Creek</i></b>                |                                |                                          |                                  |                                                |                              |                                           |
| MDW1                                      | Ghost River G.A.               | 0.8 km / 15.8 ha                         | 80                               | 73                                             | 77                           | Healthy, but<br>with Problems             |
| MDW2                                      | Ghost River G.A.               | 0.9 km / 3.7 ha                          | 87                               | 93                                             | 90                           | Healthy                                   |
| MDW3                                      | Ghost River G.A.               | 0.8 km / 4.2 ha                          | 83                               | 100                                            | 92                           | Healthy                                   |
| MDW4                                      | Ghost River G.A.               | 0.6 km / 1.6 ha                          | 87                               | 100                                            | 93                           | Healthy                                   |
| MDX1                                      | Ghost River G.A.               | 1.1 km / 16.2 ha                         | 77                               | 77                                             | 77                           | Healthy, but<br>with Problems             |
| <b><i>Average (Area-weighted)</i></b>     |                                |                                          | <b>83%</b>                       | <b>88%</b>                                     | <b>86% (80%)</b>             | <b>Healthy</b>                            |

| <i>Polygon ID</i>                                  | <i>Location</i>  | <i>Channel Length<br/>/ Polygon Area</i> | <i>Vegetative<br/>Rating (%)</i> | <i>Soil &amp;<br/>Hydrology<br/>Rating (%)</i> | <i>Health Rating<br/>(%)</i> | <i>Overall<br/>Health<br/>Description</i> |
|----------------------------------------------------|------------------|------------------------------------------|----------------------------------|------------------------------------------------|------------------------------|-------------------------------------------|
| <b><i>Lost Knife Creek</i></b>                     |                  |                                          |                                  |                                                |                              |                                           |
| LOK1                                               | Ghost River G.A. | 0.8 km / 1.2 ha                          | 97                               | 100                                            | 98                           | Healthy                                   |
| LOK2                                               | Ghost River G.A. | 1.0 km / 10.0 ha                         | 87                               | 73                                             | 80                           | Healthy                                   |
| LOK3                                               | Ghost River G.A. | 0.7 km / 0.5 ha                          | 90                               | 90                                             | 90                           | Healthy                                   |
| <b><i>Average (Area-weighted)</i></b>              |                  |                                          | <b>91%</b>                       | <b>88%</b>                                     | <b>89% (82%)</b>             | <b>Healthy</b>                            |
| <b><i>Four Mile Creek</i></b>                      |                  |                                          |                                  |                                                |                              |                                           |
| FOU1                                               | Ghost River G.A. | 0.4 km / 0.1 ha                          | 100                              | 100                                            | 100                          | Healthy                                   |
| FOU2                                               | Ghost River G.A. | 0.5 km / 0.8 ha                          | 83                               | 73                                             | 78                           | Healthy, but<br>with Problems             |
| FOU3                                               | Ghost River G.A. | 0.4 km / 7.8 ha                          | 77                               | 100                                            | 88                           | Healthy                                   |
| <b><i>Average (Area-weighted)</i></b>              |                  |                                          | <b>87%</b>                       | <b>91%</b>                                     | <b>89% (88%)</b>             | <b>Healthy</b>                            |
| <b><i>Unnamed Tributary to Waiparous Creek</i></b> |                  |                                          |                                  |                                                |                              |                                           |
| WAZ1                                               | Ghost River G.A. | 0.6 km / 0.3 ha                          | 97                               | 83                                             | 90                           | Healthy                                   |
| <b><i>Aura Creek</i></b>                           |                  |                                          |                                  |                                                |                              |                                           |
| AUR1                                               | Aura Cache G.A.  | 0.6 km / 0.7 ha                          | 93                               | 100                                            | 97                           | Healthy                                   |
| AUR2                                               | Aura Cache G.A.  | 0.4 km / 0.5 ha                          | 100                              | 100                                            | 100                          | Healthy                                   |
| AUY1                                               | Aura Cache G.A.  | 0.4 km / 2.8 ha                          | 80                               | 90                                             | 85                           | Healthy                                   |
| <b><i>Average (Area-weighted)</i></b>              |                  |                                          | <b>91%</b>                       | <b>97%</b>                                     | <b>94% (89%)</b>             | <b>Healthy</b>                            |
| <b><i>Aura Wetlands</i></b>                        |                  |                                          |                                  |                                                |                              |                                           |
| AUX1                                               | Aura Cache G.A.  | 3.6 ha                                   | 97                               | 100                                            | 98                           | Healthy                                   |
| AUZ1                                               | Aura Cache G.A.  | 1.2 ha                                   | 100                              | 97                                             | 98                           | Healthy                                   |
| AUR3                                               | Aura Cache G.A.  | 2.2 ha                                   | 76                               | 47                                             | 62                           | Healthy, but<br>with Problems             |
| <b><i>Average (Area-weighted)</i></b>              |                  |                                          | <b>91%</b>                       | <b>81%</b>                                     | <b>86% (87%)</b>             | <b>Healthy</b>                            |

\* G.A. – Grazing Allotment

<sup>1</sup> Waiparous Creek was assessed as a large river. Only one side of the bank was evaluated.

Riparian plant species inventories for Waiparous Creek, Waiparous Creek tributaries combined, and the Aura basin wetlands are given in Appendix C. The upstream and downstream UTM coordinates of each riparian health inventory site is given in Appendix B. Individual aerial photographs showing the upstream and downstream boundaries and more detail of each riparian health inventory site are provided in the “2010 Riparian Health Inventory, Waiparous Creek Watershed, Aerial Photography Addendum” (submitted as a separate cover report).

Further discussion of findings and management recommendations are provided in **Section 5, “Next Steps”**.

## 4.2 Waiparous Creek Overview

The upper reaches of Waiparous Creek are characterized by a wide, highly sinuous and braided channel with cobble, gravel substrate. The creek channel narrows and is confined by steep sided valley slopes through the downstream reach of this creek near the Waiparous Village where it flows into the Ghost River. White spruce (*Picea glauca*) riparian forests with a native shrub and ground cover understory are typical along the length of this creek. Cobble and gravel substrate in the floodplain and limited organic soil formation creates harsh growing conditions for riparian plants but also limits the potential for invasive species encroachment and trampling impacts from low intensity livestock and recreational use. High intensity recreational use impacts are the main cause of degradation to the soil / hydrology health of four sites in particular: WAI1 (north of the Ghost Airstrip Provincial Recreation Area [PRA]), WAI4 (adjacent to Highway 40 near the south end of the Ghost Airstrip PRA), WAI5 (upstream of the Johnson Creek confluence, adjacent to a designated year-round OHV trail and crossing) and WAI8 (in the Waiparous Creek Group Camp PRA). All of these sites, except for WAI1 (in the Aura Cache Allotment), are in Ghost River Forest Reserve Grazing Allotment (Figure 3).

There is no evidence of channel incisement or active downcutting along Waiparous Creek. The ability of floodwaters to spill out over the banks and out onto the floodplain plays a critical role in the maintenance and recovery of riparian areas. Moisture dispersal and sediment deposition from floodwaters helps to sustain riparian vegetation and improve soil substrate growing conditions.

There are presently no permitted water withdrawals or dams along Waiparous Creek or its tributaries within or upstream of the project area. TransAlta hydroelectric developments and diversions outside of the project area have resulted in substantial changes to the natural flow regime of the Bow River and four of its main tributaries (Cascade, Spray, Kananaskis and Ghost rivers) (Bow River Basin Council 2005).

## 4.3 Waiparous Creek: Ghost River Grazing Allotment

Eight riparian health inventories were completed on Waiparous Creek in the Ghost River Allotment (Figure 3). All but one of these riparian sites are in the *healthy* category (Table 5). The one exception is WAI4 which rated in the *healthy, but with problems* category (79%; Table 5) in part due to recreational use impacts. The average health score rating for the eight Waiparous Creek Ghost River Allotment sites is 92%. Average riparian health, weighted by area of each site, is also *healthy*, with a score of 91%. Riparian sites ranged from 1.6 to 8.1 hectares (4.0 to 19.9 acres) in size. In total, 33.8 hectares (82.3 acres) was assessed along 7.5 kilometres of stream length.

**Table 5 Riparian Health Score Sheet for the Waiparous Creek, Ghost River Allotment Sites**

| Question                                          | Riparian Health Score – Waiparous Creek – Ghost River Grazing Allotment |            |              |            |              |             |              |             |              |             |              |            |              |             |              |             |
|---------------------------------------------------|-------------------------------------------------------------------------|------------|--------------|------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|------------|--------------|-------------|--------------|-------------|
| Vegetation                                        | WAI2                                                                    |            | WAI4         |            | WAI5         |             | WAI6         |             | WAI7         |             | WAI8         |            | WAI10        |             | WAI13        |             |
| Cottonwood and Balsam Poplar Regeneration         | 6/6                                                                     |            | 6/6          |            | 6/6          |             | 6/6          |             | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Regeneration of Other Native Trees                | 3/3                                                                     |            | 2/3          |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Regeneration of Preferred Shrubs                  | 6/6                                                                     |            | 6/6          |            | 6/6          |             | 6/6          |             | 4/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Decadent and Dead Woody Material                  | 3/3                                                                     |            | 3/3          |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Utilization of Preferred Trees and Shrubs         | 2/3                                                                     |            | 3/3          |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |            | 3/3          |             | 2/3          |             |
| Live Woody Removal Other than Browsing            | 3/3                                                                     |            | 3/3          |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Total Cover of Woody Species                      | 3/3                                                                     |            | 3/3          |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Invasive Plant Species (Cover)                    | 6/6                                                                     |            | 6/6          |            | 6/6          |             | 6/6          |             | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Invasive Plant Species (Density Distribution)     | 3/3                                                                     |            | 3/3          |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Disturbance-Caused Undesirable Herbaceous Species | 3/3                                                                     |            | 2/3          |            | 3/3          |             | 3/3          |             | 3/3          |             | 2/3          |            | 2/3          |             | 3/3          |             |
| <b>Vegetation Rating</b>                          | <b>38/39</b>                                                            | <b>97%</b> | <b>37/39</b> | <b>95%</b> | <b>39/39</b> | <b>100%</b> | <b>39/39</b> | <b>100%</b> | <b>37/39</b> | <b>95%</b>  | <b>38/39</b> | <b>97%</b> | <b>38/39</b> | <b>97%</b>  | <b>38/39</b> | <b>97%</b>  |
| Soil/Hydrology                                    |                                                                         |            |              |            |              |             |              |             |              |             |              |            |              |             |              |             |
| Riverbank Root Mass Protection                    | 6/6                                                                     |            | 4/6          |            | 4/6          |             | 4/6          |             | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Human-Caused Bare Ground                          | 6/6                                                                     |            | 0/6          |            | 2/6          |             | 6/6          |             | 6/6          |             | 2/6          |            | 6/6          |             | 6/6          |             |
| Removal or Addition of Water                      | 9/9                                                                     |            | 9/9          |            | 9/9          |             | 9/9          |             | 9/9          |             | 9/9          |            | 9/9          |             | 9/9          |             |
| Control of Flood Peak and Timing                  | 9/9                                                                     |            | 9/9          |            | 9/9          |             | 9/9          |             | 9/9          |             | 9/9          |            | 9/9          |             | 9/9          |             |
| Riverbank Structurally Altered                    | 6/6                                                                     |            | 4/6          |            | 6/6          |             | 6/6          |             | 6/6          |             | 4/6          |            | 6/6          |             | 6/6          |             |
| Human Physical Alteration to the Site             | 4/6                                                                     |            | 0/6          |            | 0/6          |             | 6/6          |             | 6/6          |             | 2/6          |            | 6/6          |             | 6/6          |             |
| Floodplain Accessibility                          | 6/6                                                                     |            | 6/6          |            | 6/6          |             | 6/6          |             | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| <b>Soil/Hydrology Rating</b>                      | <b>46/48</b>                                                            | <b>96%</b> | <b>32/48</b> | <b>67%</b> | <b>36/48</b> | <b>75%</b>  | <b>46/48</b> | <b>96%</b>  | <b>48/48</b> | <b>100%</b> | <b>38/48</b> | <b>79%</b> | <b>48/48</b> | <b>100%</b> | <b>48/48</b> | <b>100%</b> |
| <b>Overall Rating</b>                             | <b>84/87</b>                                                            | <b>97%</b> | <b>69/87</b> | <b>79%</b> | <b>75/87</b> | <b>86%</b>  | <b>85/87</b> | <b>98%</b>  | <b>85/87</b> | <b>98%</b>  | <b>76/87</b> | <b>87%</b> | <b>86/87</b> | <b>99%</b>  | <b>86/87</b> | <b>99%</b>  |

### A) Vegetation Health

A white spruce Habitat Type provides the main cover in the wide floodplain along Waiparous Creek (Table 6). On average, there is approximately 60% canopy cover from native shrubs in the spruce understory. Low growing shrubs such as yellow mountain avens (*Dryas drummondii*) and common bearberry (*Arctostaphylos uva-ursi*) provide a good ground cover layer in most sites. Shrubby cinquefoil (*Potentilla fruticosa*) and silverberry (*Elaeagnus commutata*) are the most common mid-height shrubs. These four shrubs are characteristic of riparian plant communities along the entire length of Waiparous Creek. These shrubs either thrive in shallow, gravelly well drained soils or they are tolerant of a wide variety of soil and moisture conditions (Tannas 2003). Except in localized micro-sites with silt deposits or improved soil conditions, willows are otherwise sparse in the Waiparous Creek floodplain due to limited soil formation and shallow cobble substrate. A water sedge (*Carex aquatilis*) Habitat Type occurs in a low flowing side channel and seepage area in the floodplain of the WAI8 site (Table 6).

**Table 6 Plant Community Types for the Waiparous Creek, Ghost River Allotment Sites**

| Plant Community*                    | Classification* | Polygons Where Found                             | Area Occupied     | Area Occupied (%) |
|-------------------------------------|-----------------|--------------------------------------------------|-------------------|-------------------|
| white spruce / low-bush cranberry** | Habitat Type    | WAI2, WAI4, WAI5, WAI6, WAI7, WAI8, WAI10, WAI13 | 32.6 ha (79.4 ac) | 96.5              |
| water sedge                         | Habitat Type    | WAI8                                             | 0.5 ha (1.1 ac)   | 1.4               |

\* Based on Thompson and Hansen 2003

\*\* **Low-bush cranberry (*Viburnum edule*) does not occur in the Waiparous Creek basin.** For a plant community to fit into this Habitat Type description it may have willows (at least 1% cover), rather than low-bush cranberry, in the white spruce understory (Thompson and Hansen 2003).

Of note, the mat forming low growing shrub, yellow mountain avens, is considered a pioneer ground cover shrub on fluvial flats subject to periodic flooding disturbance. In combination with common bearberry, yellow mountain avens helps to stabilize soils, preventing erosion and increasing the moisture absorption capacity of the soil, allowing succession to occur. Silverberry is another important early colonizer species that spreads quickly by way of its rhizomatous growth habitat. The nitrogen-fixing ability of silverberry is highly beneficial for improving soils.

Graminoid species (i.e. grasses, sedges and rushes) are sparse in the spruce understory due to limiting growing conditions and over-shading. Except for scattered amounts of rush-like sedge (*Carex scirpoidea*) and hairy wild rye (*Elymus innovatus*), most other graminoids occur in trace amounts in the forest understory. Forbs (broad-leaf plants) have variable cover, with the most common species being, alpine hedsarum (*Hedysarum alpinum*), alpine locoweed (*Oxytropis cusickii*) and yellow hedsarum (*Hedysarum sulphurescens*). Locoweed (*Oxytropis*) species and other native forbs in the project area including common horsetail (*Equisetum arvense*) and white

camas (*Zigadenus elegans*) can be poisonous to livestock. However, since these plants generally only occur in trace amounts they do not pose a management concern.

Sparse cover from herbaceous grasses and forbs in the forest understory indicates poor forage availability for livestock. This explains minimal use by livestock in the Waiparous Creek floodplain. Most livestock use impacts near Waiparous Creek appear to be concentrated in upland, open grassy meadows adjacent to the riparian zone.

A total of 166 plant species were identified along Waiparous Creek in the Ghost Allotment, including 5 tree species, 30 shrub species, 37 grass or grass-like species and 94 forb species (broad-leaf plants). Excluding 2 species whose identity could not be confirmed, 156 (94%) of these species are native and 8 (5%) are introduced, non-native species (mostly disturbance increaser species). Remarkably, no invasive species were observed (i.e. weed species listed as “noxious” or “prohibited noxious” on the Alberta *Weed Control Act*). Shallow, dry gravelly soils help limit encroachment from invasive species and non-native disturbance species such as common dandelion (*Taraxacum officinale*) and Kentucky bluegrass (*Poa pratensis*).

#### **B) Soil and Hydrology Health**

Most of the riparian area has good ground cover and protection from soil erosion from a diverse native plant community. However, 15% of the riparian area has been physically altered by human activities, primarily recreational use. These activities have contributed to unhealthy levels (i.e. >5%) of human-caused bare-ground in three sites (WAI4, WAI5 and WAI8) (Table 5) (Figure 3). Bare ground is unprotected soil that is capable of being eroded by rain, overland flow or wind and is susceptible to weedy species encroachment. The aforementioned sites also have unhealthy levels (i.e. >15%) of physical alterations in the floodplain mainly from OHV trails, random campsites and hiking trails. WAI4 is located in close proximity to Highway 40, just south of the Ghost Airstrip Provincial Recreation Area (Figure 3). Several cutlines and non-designated OHV trails criss-cross the site. WAI5 is located upstream of the Johnson Creek confluence, adjacent to a designated year-round OHV trail and major creek crossing (Figure 3). WAI8 is located in the designated Waiparous Creek Group Camp Provincial Recreation Area (Figure 3). Stream crossings and bank alterations from OHV trails impact 5% to 15% of the bank length for the WAI4 and WAI8 sites. The remainder of sites we assessed in this allotment have less than 5% of the bank length structurally altered by human activity (Table 5). The cobble-gravel nature of the streambank, fluvial flats and river terraces helps to buffer soil compaction and trampling impacts from low intensity recreational use and livestock grazing. Nonetheless, high intensity recreational use or grazing can harm fragile riparian plant communities and contribute to accelerated soil and bank erosion and localized loss of rootmass protection along the streambank.





C. Ball, RHIP02WAI004.

The cobble and gravel Waiparous Creek channel is extremely wide and braided through the Ghost River Allotment.



D. White, RHIP04WAI005.

Recreational trails and OHV use has caused some removal of vegetation, soil compaction, bare ground and loss of deep, binding roots in some sections along Waiparous Creek.



C. Ball, RHIP10WAI005.

Due to natural high flows and large amounts of gravel and cobble in the streambanks, there is a substantial amount of natural bank instability and lateral erosion that is not associated with human impacts.



C. Ball, RHIP13WAI004.

The majority of the riparian area is comprised of a white spruce community with a diverse understory of native shrubs, forbs and grasses. No invasive species and only a trace amount of non-native disturbance-caused plants were observed.

### WAIPAROUS CREEK – GHOST RIVER ALLOTMENT REPRESENTATIVE PHOTOS

#### 4.4 Waiparous Creek in Aura Cache Grazing Allotment

##### A) Overall Health and Riparian Area Discussion

Five riparian health inventories were completed on the north and east sides of Waiparous Creek in the Aura Cache Grazing Allotment (Figure 3). All of these riparian sites rated *healthy*, with an average health score of 97% (Table 8). Area-weighted health score is also 97%. This indicates these riparian sites are in a near-pristine condition. There is minimal human disruption of the native riparian plant communities, and only one of the sites assessed (WAI1, Figure 3) has significant physical impacts from human activities. Riparian sites ranged from 1.1 to 7.1 hectares (2.7 to 17.3 acres) in size, with a total of 18.7 hectares (46.2 acres) assessed along 4.6 kilometres of streambank.

##### B) Vegetation Health

The majority of the Aura Cache Grazing Allotment, Waiparous Creek study area is very similar in nature to the Ghost River Grazing Allotment. The prevailing riparian plant community is comprised of white spruce with an understory of mid and low-statured shrubs, mainly silverberry, common bearberry, shrubby cinquefoil and a variety of willows (Table 7). WAI1 also has a small aspen (*Populus tremuloides*) community at the downstream end (Table 7). WAI3 (near the north end of the allotment, close to Highway 40) includes a small side channel along the outer edge of the site that is dominated by water sedge (Table 7).

**Table 7 Plant Community Types for the Waiparous Creek, Aura Cache Allotment Sites**

| <i>Plant Community*</i>           | <i>Classification*</i> | <i>Polygons Where Found</i>     | <i>Area Occupied</i> | <i>Area Occupied (%)</i> |
|-----------------------------------|------------------------|---------------------------------|----------------------|--------------------------|
| white spruce / low-bush cranberry | Habitat Type           | WAI1, WAI3, WAI11, WAI12, WAI14 | 17.5 ha (42.8 ac)    | 92.6                     |
| water sedge                       | Habitat Type           | WAI3                            | 0.7 ha (1.7 ac)      | 3.7                      |
| aspen / low-bush cranberry        | Community Type         | WAI1                            | 0.5 ha (1.3 ac)      | 2.8                      |

\*Based on Thompson and Hansen 2003

All five sites include a diversity and abundance of native plant species. In total, 145 plant species were identified within these areas along Waiparous Creek in the Aura Cache Allotment. Excluding a brome species whose identity could not be confirmed, this total includes 135 (93%) native species and 9 (6%) disturbance-caused introduced species. There is presently only a trace amount of disturbance plant cover, mainly tame forages such as smooth brome (*Bromus inermis*), quack grass (*Agropyron repens*), timothy (*Phleum pratense*), Kentucky bluegrass, clovers (*Trifolium* spp.) as well as common dandelion. No invasive species were observed. Again shallow gravelly soils in the Waiparous Creek floodplain helps limit the spread of weeds.



**Table 8 Riparian Health Score Sheet for the Waiparous Creek, Aura Cache Allotment Sites**

| Question                                          | Health Score – Waiparous Creek – Aura Cache Grazing Allotment |            |              |             |              |            |              |             |              |             |
|---------------------------------------------------|---------------------------------------------------------------|------------|--------------|-------------|--------------|------------|--------------|-------------|--------------|-------------|
|                                                   | WAI1                                                          |            | WAI3         |             | WAI11        |            | WAI12        |             | WAI14        |             |
| Cottonwood and Balsam Poplar Regeneration         | 6/6                                                           |            | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Regeneration of Other Native Trees                | 3/3                                                           |            | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Regeneration of Preferred Shrubs                  | 6/6                                                           |            | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Decadent and Dead Woody Material                  | 3/3                                                           |            | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Utilization of Preferred Trees and Shrubs         | 3/3                                                           |            | 3/3          |             | 1/3          |            | 2/3          |             | 1/3          |             |
| Live Woody Removal Other than Browsing            | 2/3                                                           |            | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Total Cover of Woody Species                      | 3/3                                                           |            | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Invasive Plant Species (Cover)                    | 6/6                                                           |            | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Invasive Plant Species (Density Distribution)     | 3/3                                                           |            | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| Disturbance-Caused Undesirable Herbaceous Species | 3/3                                                           |            | 3/3          |             | 3/3          |            | 3/3          |             | 3/3          |             |
| <b>Vegetation Rating</b>                          | <b>38/39</b>                                                  | <b>97%</b> | <b>39/39</b> | <b>100%</b> | <b>37/39</b> | <b>95%</b> | <b>38/39</b> | <b>97%</b>  | <b>37/39</b> | <b>95%</b>  |
| <b>Soil/Hydrology</b>                             |                                                               |            |              |             |              |            |              |             |              |             |
| Riverbank Root Mass Protection                    | 6/6                                                           |            | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Human-Caused Bare Ground                          | 4/6                                                           |            | 6/6          |             | 4/6          |            | 6/6          |             | 6/6          |             |
| Removal or Addition of Water                      | 9/9                                                           |            | 9/9          |             | 9/9          |            | 9/9          |             | 9/9          |             |
| Control of Flood Peak and Timing                  | 9/9                                                           |            | 9/9          |             | 9/9          |            | 9/9          |             | 9/9          |             |
| Riverbank Structurally Altered                    | 6/6                                                           |            | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Human Physical Alteration to the Site             | 2/6                                                           |            | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| Floodplain Accessibility                          | 6/6                                                           |            | 6/6          |             | 6/6          |            | 6/6          |             | 6/6          |             |
| <b>Soil/Hydrology Rating</b>                      | <b>42/48</b>                                                  | <b>88%</b> | <b>48/48</b> | <b>100%</b> | <b>46/48</b> | <b>96%</b> | <b>48/48</b> | <b>100%</b> | <b>48/48</b> | <b>100%</b> |
| <b>Overall Rating</b>                             | <b>80/87</b>                                                  | <b>92%</b> | <b>87/87</b> | <b>100%</b> | <b>83/87</b> | <b>95%</b> | <b>86/87</b> | <b>99%</b>  | <b>85/87</b> | <b>98%</b>  |

Trees and shrubs cover approximately 87% of the area assessed along Waiparous Creek in the Aura Cache Allotment. This includes 4 tree species and 26 shrub species, nearly all of which are preferred woody species (i.e. wildlife forages and / or species with good soil stabilizing ability). All five sites show signs of woody regeneration and establishment, with excellent age class structure. Three of the five sites have evidence of light (WAI12) to moderate (WAI11 and WAI14) browse by livestock and wildlife (Table 8). WAI14 (in a fairly remote area near the south end of the allotment) (Figure 3) is the only site where the growth forms of many preferred woody species appear flat-topped due to excessive browsing. WAI1 (near the north end of the allotment) is the only site with recent beaver activity. Beaver cuttings, combined with some minor vegetation clearing for recreational trails, etc., has removed more than 5% of the woody vegetation in this site.

### ***C) Soil and Hydrology Health***

Very few physical alterations to the riparian area were observed in most sites with the exception of WAI1. In total, less than 1% of the streambank and 7% of the floodplain have been structurally altered due to grazing and recreational activities. Exposed soil was found throughout 3% of the total area assessed, and 41% of this is due to human-causes (i.e. grazing and recreation). WAI1 has significant impacts to soil and hydrology health due to recreational use. This site is located in a higher use area on the north side of Waiparous Creek adjacent to the Waiparous Valley road, just downstream from Camp Howard and Camp Chamisall (Figure 3). Approximately 20% of this site is physically altered from quad trails that have caused soil compaction, bare ground and accelerated erosion in some places. Livestock grazing has contributed to some bare ground exposure and physical alterations to 3% of the riparian area in WAI11 (on the southern boundary of the Aura Cache Allotment) (Figure 3).

## **4.5 Waiparous Creek in the Waiparous Village**

### ***A) Overall Health and Riparian Area Discussion***

A single riparian health inventory was completed on the west side of Waiparous Creek within the Summer Village of Waiparous (WAI9). This site rated *healthy* (95%) (Table 9). The riparian area is extremely narrow here (one to twenty meters in width, with an average of width of seven meters) and is confined by a canyon-like creek valley. The upstream end of this site is located at a fenceline marking the village boundary. The site extended 0.3 kilometers downstream to the edge of a tall cutbank with exposed rock just upstream of the Highway 40 bridge. This site is very well vegetated with an abundance of woody vegetation. Human-caused physical alteration to the riparian area from recreational use is the main factor impacting the health of this site.





D. White, RHIP11WAI004.

A white spruce plant community with an understory of preferred shrub species is typical of all sites along Waiparous Creek in the Aura Cache allotment.



C. Ball, RHIP03WAI010.

This large water sedge meadow in the WAI3 polygon (near the north end of the allotment, close to Highway 40) is highly susceptible to physical alterations due to saturated, fine textured soils.



C. Ball, RHIP01WAI005.

Recreational activities, such as OHV use, are contributing to soil erosion and compaction in WAI1 (near Camp Howard) in particular. These activities can damage sensitive riparian plants.



C. Ball, RHIP03WAI007.

Creek fords such as this one in the WAI3 site, contribute to sediment delivery into Waiparous Creek and may harm fish habitat.

### WAIPAROUS CREEK – AURA CACHE ALLOTMENT REPRESENTATIVE PHOTOS



**Table 9 Riparian Health Score Sheet for Waiparous Creek in Waiparous Village**

| Question                                          | Health Score – Waiparous Creek |             |
|---------------------------------------------------|--------------------------------|-------------|
| <b>Vegetation</b>                                 | <b>WAI9</b>                    |             |
| Cottonwood and Balsam Poplar Regeneration         | 6/6                            |             |
| Regeneration of Other Native Trees                | 3/3                            |             |
| Regeneration of Preferred Shrubs                  | 6/6                            |             |
| Decadent and Dead Woody Material                  | 3/3                            |             |
| Utilization of Preferred Trees and Shrubs         | 3/3                            |             |
| Live Woody Removal Other than Browsing            | 3/3                            |             |
| Total Cover of Woody Species                      | 3/3                            |             |
| Invasive Plant Species (Cover)                    | 6/6                            |             |
| Invasive Plant Species (Density Distribution)     | 3/3                            |             |
| Disturbance-Caused Undesirable Herbaceous Species | 3/3                            |             |
| <b>Vegetation Rating</b>                          | <b>39/39</b>                   | <b>100%</b> |
| <b>Soil/Hydrology</b>                             |                                |             |
| Riverbank Root Mass Protection                    | 6/6                            |             |
| Human-Caused Bare Ground                          | 4/6                            |             |
| Removal or Addition of Water                      | 9/9                            |             |
| Control of Flood Peak and Timing                  | 9/9                            |             |
| Riverbank Structurally Altered                    | 6/6                            |             |
| Human Physical Alteration to the Site             | 4/6                            |             |
| Floodplain Accessibility                          | 6/6                            |             |
| <b>Soil/Hydrology Rating</b>                      | <b>44/48</b>                   | <b>92%</b>  |
| <b>Overall Rating</b>                             | <b>83/87</b>                   | <b>95%</b>  |

**B) Vegetation Health**

Typical of other sites along Waiparous Creek, this site is comprised of white spruce with an understory of silverberry and other low growing native shrubs. Unlike the previously described sites, however, WAI9 also has 10% cover from balsam poplar (*Populus balsamifera*) and a higher proportion of native willows (mainly smooth willow [*Salix glauca*]). This likely indicates better soil development in parts of the riparian area. A mix of 21 shrub species, 33 native forbs (mainly common horsetail [*Equisetum arvense*] and Canada goldenrod [*Solidago canadensis*]) and 10 grass / grass-like species (mainly hairy wild rye) are part of the plant community of this site. In total, 66 plant species were identified, 60 (91%) of these are native plant species and 6 (9%) are introduced, non-native species. Most of the introduced species are disturbance species, all of which occur in trace amounts except for slightly higher amounts of common dandelion. One of the introduced species, **yellow clematis** (*Clematis tangutica*) is an **invasive**, ornamental creeping vine with bright yellow flowers. Although not previously listed, since our assessment it has been designated as a “noxious weed” on the most recent version of the Alberta *Weed Control Act*. Only trace occurrence of this species was noted in this site. It has likely encroached from intentional plantings of this shrub in a residential property in Waiparous Village.

Native trees and shrubs show good age class structure and appear to be naturally regenerating and establishing in this site. There is no evidence of wildlife browse or removal of woody plants by beavers or human activities.

### ***C) Soil and Hydrology Health***

Very few physical alterations to the riparian area were observed. In total, 3% of the bank and 10% of the remainder of the riparian area have been structurally altered due to recreational activities. A walking trail runs through most of the site. Exposed soil was found throughout 3% of the total area assessed, mostly from recreational use, but also partially due natural sediment deposition, erosion and wildlife use.



C. Wood, RHIP09WA1002.

The riparian area is dominated by a white spruce plant community with a diversity of native shrubs, forbs and a few grasses in the understory.



C. Wood, RHIP09WA1004.

Both human-caused and natural bare ground is present within the riparian area from recreational trails and natural sediment deposition, as seen here.

## 4.6 Johnson Creek

### ***A) Overall Health and Riparian Area Discussion***

Four riparian health inventories were completed on Johnson Creek and one riparian health inventory was completed on an unnamed tributary to Johnson Creek (JOX1) (Figure 4). These sites in the Ghost River Allotment are all in the *healthy* category, with an average health score of 92% (Table 10). Area-weighted health is similar with a score of 91%. One site (JON1) rated *healthy with problems* and accounts for 16% of the area assessed. The other three sites assessed are within *healthy* category. The sites range from 2.1 to 13.1 hectares (5.1 to 32.0 acres) in size, with a total of 25.9 hectares (63.1 acres) assessed along 4.0 kilometres of channel length.

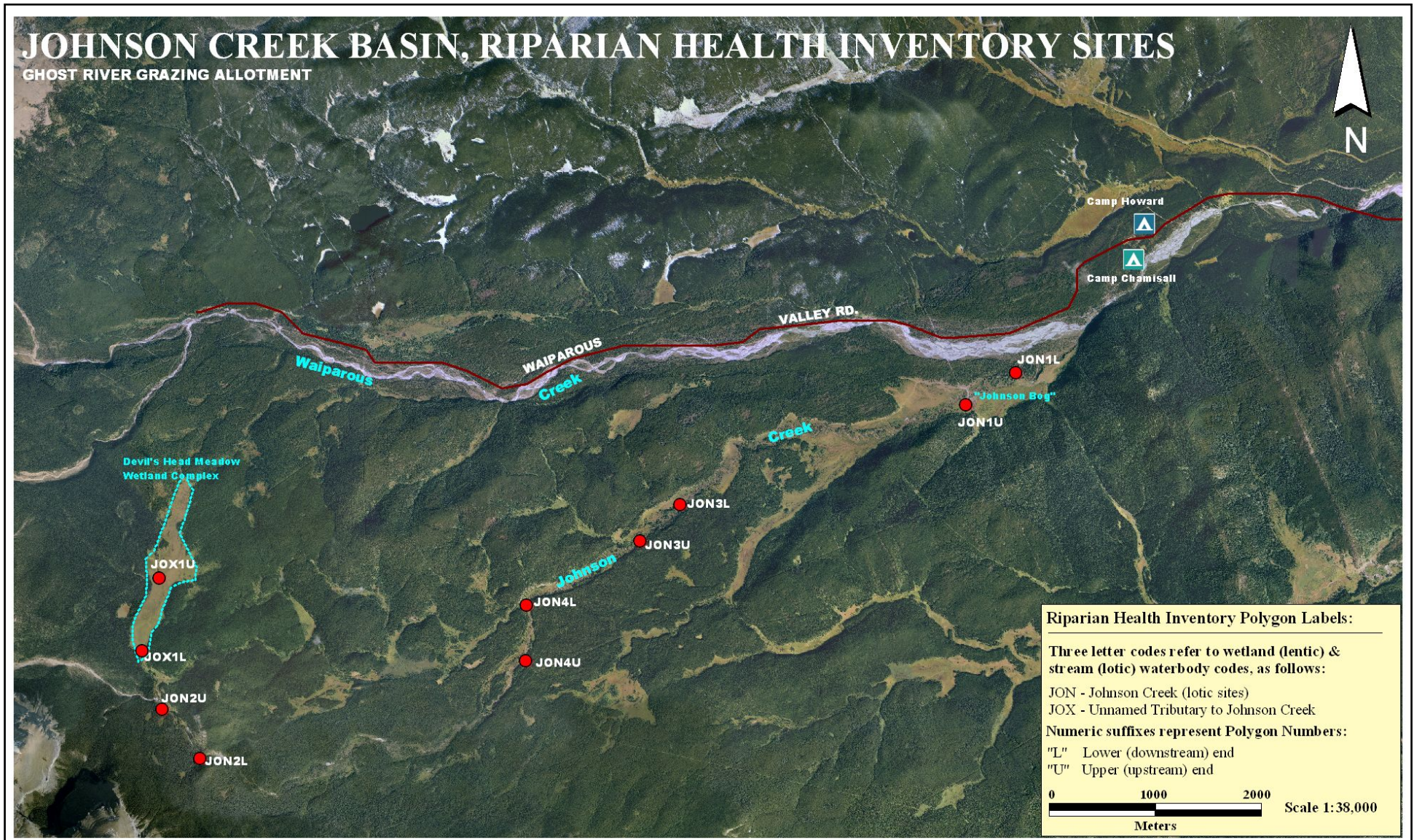
The unnamed tributary JOX1 represents an intermittent stream that runs through a portion of a wetland complex known as “Devil’s Head Meadow”. Since this intermittent stream has a defined channel (with defined bed and banks) for part of its length it was assessed as a lotic (flowing system) as opposed to a lentic (non-flowing wetland) system.

Narrower parts of the Johnson Creek valley have a dense spruce overstory with moss cover in the understory and shallow gravelly soils. Other portions of Johnson Creek, and similarly Meadow Creek, Four Mile Creek, Lost Knife Creek and other Waiparous Creek tributaries, are defined by wide riparian meadows with a rich build up of organic fine textured soils. Beavers have played a key role in influencing the hydrology of these systems and in creating lush, productive riparian meadows. Beaver ponds contribute to raising the water table and slowing the flow of streams, reducing erosive forces. Beaver ponds gradually accumulate sediment and lead to the formation of lush wet meadow habitats. The build-up of organic soils in beaver modified meadows supports lush riparian vegetation such as willow and sedge community types. Fine textured, moist soil in riparian meadows is particularly susceptible to soil compaction and erosion from recreational use and concentrated livestock use.

### ***B) Vegetation Health***

The four sites assessed along the main stem of Johnson Creek are dominated by a white spruce community (Table 11) with a dense shrubby understory comprised of species such as bog birch (*Betula glandulosa*), willows, shrubby cinquefoil, common bearberry and a variety of other shrubs. The unnamed tributary to Johnson Creek is dominated by a flat-leaved willow (*Salix planifolia*) / water sedge Habitat Type (Table 11). The associated Devil’s Head Meadow wetland complex is mainly comprised of water sedge, northern bog sedge (*Carex gynocrates*) and wire rush (*Juncus balticus*).





**Figure 4 Johnson Creek Watershed Riparian Health Inventory Sites**



**Table 10 Riparian Health Score Sheet for Sites within the Johnson Creek Watershed**

| Question                                                | Riparian Health Score – Johnson Creek (JON) & Tributary to Johnson Creek (JOX) |            |              |             |              |             |              |             |              |             |
|---------------------------------------------------------|--------------------------------------------------------------------------------|------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|
| Vegetation                                              | JON1                                                                           |            | JON2         |             | JON3         |             | JON4         |             | JOX1         |             |
| Vegetation Cover of Floodplain and Streambanks          | 4/6                                                                            |            | 6/6          |             | 6/6          |             | 6/6          |             | 6/6          |             |
| Invasive Plant Species (Cover)                          | 2/3                                                                            |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |             |
| Invasive Plant Species (Density Distribution)           | 1/3                                                                            |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |             |
| Disturbance-Caused Undesirable Herbaceous Species       | 2/3                                                                            |            | 3/3          |             | 3/3          |             | 2/3          |             | 3/3          |             |
| Preferred Tree and Shrub Establishment and Regeneration | 6/6                                                                            |            | 6/6          |             | 6/6          |             | 6/6          |             | 6/6          |             |
| Utilization of Preferred Trees and Shrubs               | 2/3                                                                            |            | 3/3          |             | 2/3          |             | 3/3          |             | 2/3          |             |
| Live Woody Removal Other than Browsing                  | 3/3                                                                            |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |             |
| Decadent and Dead Woody Material                        | 3/3                                                                            |            | 3/3          |             | 3/3          |             | 3/3          |             | 3/3          |             |
| <b>Vegetation Rating</b>                                | <b>23/30</b>                                                                   | <b>77%</b> | <b>30/30</b> | <b>100%</b> | <b>29/30</b> | <b>97%</b>  | <b>29/30</b> | <b>97%</b>  | <b>29/30</b> | <b>97%</b>  |
| <b>Soil/Hydrology</b>                                   |                                                                                |            |              |             |              |             |              |             |              |             |
| Streambank Root Mass Protection                         | 6/6                                                                            |            | 6/6          |             | 6/6          |             | 6/6          |             | 6/6          |             |
| Human-Caused Bare Ground                                | 2/6                                                                            |            | 4/6          |             | 6/6          |             | 6/6          |             | 6/6          |             |
| Streambank Structurally Altered                         | 6/6                                                                            |            | 6/6          |             | 6/6          |             | 6/6          |             | 6/6          |             |
| Human Physical Alteration to the Site                   | 1/3                                                                            |            | 2/3          |             | 3/3          |             | 3/3          |             | 3/3          |             |
| Stream Channel Incisement                               | 9/9                                                                            |            | 9/9          |             | 9/9          |             | 9/9          |             | 9/9          |             |
| <b>Soil/Hydrology Rating</b>                            | <b>24/30</b>                                                                   | <b>80%</b> | <b>27/30</b> | <b>90%</b>  | <b>30/30</b> | <b>100%</b> | <b>30/30</b> | <b>100%</b> | <b>30/30</b> | <b>100%</b> |
| <b>Overall Rating</b>                                   | <b>47/60</b>                                                                   | <b>78%</b> | <b>57/60</b> | <b>95%</b>  | <b>53/60</b> | <b>98%</b>  | <b>59/60</b> | <b>98%</b>  | <b>59/60</b> | <b>98%</b>  |



The unclassified wetland type in the JON1 site (Table 11, Figure 4) represents an altered area at the upstream end of the site (locally known as the “Johnson Bog”) that is dominated by disturbance species such as Kentucky bluegrass, quack grass and common dandelion. Livestock grazing and high intensity recreational use have contributed to alteration of this site located closest to the confluence with Waiparous Creek.

**Table 11 Plant Community Types within the Johnson Creek Watershed**

| Plant Community*                    | Classification* | Polygons Where Found   | Area Occupied     | Area Occupied (%) |
|-------------------------------------|-----------------|------------------------|-------------------|-------------------|
| white spruce / low-bush cranberry** | Habitat Type    | JON1, JON2, JON3, JON4 | 11.4 ha (27.7 ac) | 43.9              |
| flat-leaved willow / water sedge    | Habitat Type    | JOX1                   | 7.9 ha (19.2 ac)  | 30.4              |
| water sedge                         | Habitat Type    | JON4, JOX1             | 5.7 ha (13.8 ac)  | 21.9              |
| Unclassified wetland type           | NA              | JON1                   | 0.8 ha (2.0 ac)   | 3.1               |

\* Based on Thompson and Hansen 2003

\*\* Low-bush cranberry does not occur in the Johnson Creek valley; willows are the dominant understory shrub.

There is a tremendous diversity of native species in the Johnson Creek and Devil’s Head Meadow riparian sites. A total of 125 plant species were identified within these areas, including 114 (91%) native plants and 9 (7%) introduced species. Five of the native species are considered to be poisonous to livestock (white camas [*Zigadenus elegans*], common horsetail, death camas [*Zigadenus venenosus*], slender arrow-grass [*Triglochin palustris*] and seaside arrow-grass [*Triglochin maritima*]). Only trace amounts of these species were found, not signifying a management concern.

Of the nine introduced species, six are disturbance species such as common dandelion and Kentucky bluegrass and three are invasive weeds listed as “noxious” under the *Weed Control Act* (Canada thistle [*Cirsium arvense*], perennial sow-thistle [*Sonchus arvensis*] and tall buttercup [*Ranunculus acris*]). Disturbance and invasive species are most prevalent in the JON1 site in association with human-caused disturbance from recreational motorized vehicles (Table 12). Similar human-caused disturbances may also have contributed to the spread of tall buttercup in the Devil’s Head Meadow and associated stream (JOX1) (Table 12).

**Table 12 Invasive Plant Species Observed in the Johnson Creek Watershed**

| Species                                           | JON1      |                                                         | JOX1      |                                                          |
|---------------------------------------------------|-----------|---------------------------------------------------------|-----------|----------------------------------------------------------|
|                                                   | Cover (%) | Density Distribution                                    | Cover (%) | Density Distribution                                     |
| Canada thistle ( <i>Cirsium arvense</i> )         | 0.5       | A single patch plus a few sporadically occurring plants | NA        | NA                                                       |
| Perennial sow-thistle ( <i>Sonchus arvensis</i> ) | 0.5       | A single patch                                          | NA        | NA                                                       |
| Tall buttercup ( <i>Ranunculus acris</i> )        | 0.5       | A few sporadically occurring individual plants          | 3         | A few patches plus several sporadically occurring plants |

Five native tree species and 20 native shrub species collectively cover 87% of the area assessed along Johnson Creek and its tributary. Woody plant communities have excellent age class structure and exhibit healthy amounts of recruitment (new growth). Light browse from a combination of wildlife (moose, elk and deer) and livestock use is apparent in three (JON1, JON3, JOX1) of the five sites.

Except for a minor amount of tree removal associated with recreational use in JON1, there is presently no active commercial logging or other human-caused woody vegetation removal in any of the Johnson Creek riparian sites. Beaver removal of woody vegetation is also minimal at present, with most sites only having evidence of old beaver chewed stems and no freshly cut stems.

### ***C) Soil and Hydrology Health***

Few physical alterations to the riparian area were observed on three of the five sites (Table 10); however, recreational use is significantly impacting the health of the JON1 riparian site (close to the Waiparous Creek confluence) and to a lesser extent the JON2 site (near the headwaters of this creek) (Figure 4). Motorized recreational vehicles have caused extensive soil compaction, erosion and human-caused bare ground in these two sites. This is of concern since it contributes to sedimentation of Johnson Creek which feeds directly into Waiparous Creek. These types of alterations also damage sensitive riparian plants and contribute to the introduction and proliferation of non-native invasive and disturbance plant species. The JON1 site in particular has unhealthy levels of human-caused bare ground (10%) and floodplain alterations (20%). The JON2 site has 3% human-caused bare ground and 10% floodplain alterations from recreational use. Recreational use impacts appear to be concentrated away from the bank in both of these sites. Bank alterations are mainly limited to forded vehicle crossings (which account for approximately 3% of the total bank length assessed for both sites). Although isolated, these vehicle crossings do contribute to high sediment loading into Johnson Creek particularly during wet periods.

“Johnson Bog” at the upstream, southern portion of the JON1 site is an area that in the recent past has been heavily used by motorized vehicles to the point that deep ruts have been created resulting in water pooling or channelling of water. Attempts have been made to fence out and restrict OHV use at former crossing locations at the upstream end of the JON1 site. These fences seem to be ineffective since they are in disrepair and they do not form a good access barrier.



C. Wood, RHIP01JON008.

OHV use has caused significant physical alterations and human-caused bare ground in some areas along Johnson Creek, in particular to 'Johnson Bog' at the upstream end of the JON1 site (near to the confluence with Waiparous Creek).



C. Ball, RHIP03JON002.

Trees and shrubs are regenerating well throughout Johnson Creek and its tributary.



C. Ball, RHIP02JON004.

Healthy white spruce communities with an understory of native shrubs provide good streambank stability along Johnson Creek.



C. Wood, RHIP01JON004.

Sedges and other grass-like species are the dominant ground cover along the unnamed tributary to Johnson Creek and the associated Devil's Head Meadow wetland complex.

### JOHNSON CREEK WATERSHED REPRESENTATIVE PHOTOS



## 4.7 Meadow Creek

### ***A) Overall Health and Riparian Area Discussion***

Four riparian health inventories were completed along Meadow Creek (MDW) and one inventory was completed along a tributary to Meadow Creek (MDX) in the Ghost River Allotment (Figure 5). Three of these sites (MDW2, MDW3 and MDW4) rated *healthy*; two sites (MDW1 and MDX1) rated *healthy, but with problems* (Table 13). These riparian sites range from 1.6 to 16.2 hectares (3.8 to 39.5 acres) in size, with a total of 41.3 hectares (100.7 acres) assessed along 4.2 kilometres of streambank. Of the total riparian area assessed, 23% of the area is within the *healthy* category and 77% of the area is within the *healthy, but with problems* category.

The largest sites (both approximately 16 ha in size), MDW1 and MDX1, represent large beaver modified riparian meadows with several active beaver dams and a complex of old, stabilized and revegetated beaver ponds. Fertile beaver meadows have created prime forage for livestock in the Meadow Creek basin. Since adjacent upland conifer forests have limited herbaceous forage in the understory, livestock use is naturally concentrated in open grassland and riparian meadows in the basin. As confirmed by 2007 ASRD range health audits (ASRD 2008) this has resulted in overutilization of parts of the Meadow Creek Distribution Unit. This includes heavy use of riparian and upland meadows in and adjacent to MDW1 and MDX1, where riparian health is being negatively affected as a result.

### ***B) Vegetation Health***

A diversity of native plant communities occur within the Meadow Creek valley (Table 14). More than half of the valley is comprised of a flat-leaved willow / water sedge Habitat Type. Saturated beaver meadows are made up mainly of a water sedge Habitat Type. White spruce with an understory of native willows occurs along the drier outer fringe of the riparian zone. The tributary to Meadow Creek, MDX1, is the only site to include a disturbance riparian plant community dominated by Kentucky bluegrass. MDW4 includes an unclassified community comprised mainly of lodgepole pine (*Pinus contorta*) and Canada buffaloberry (*Shepherdia canadensis*). This community type occurs in drier, outer fringes of the riparian zone.



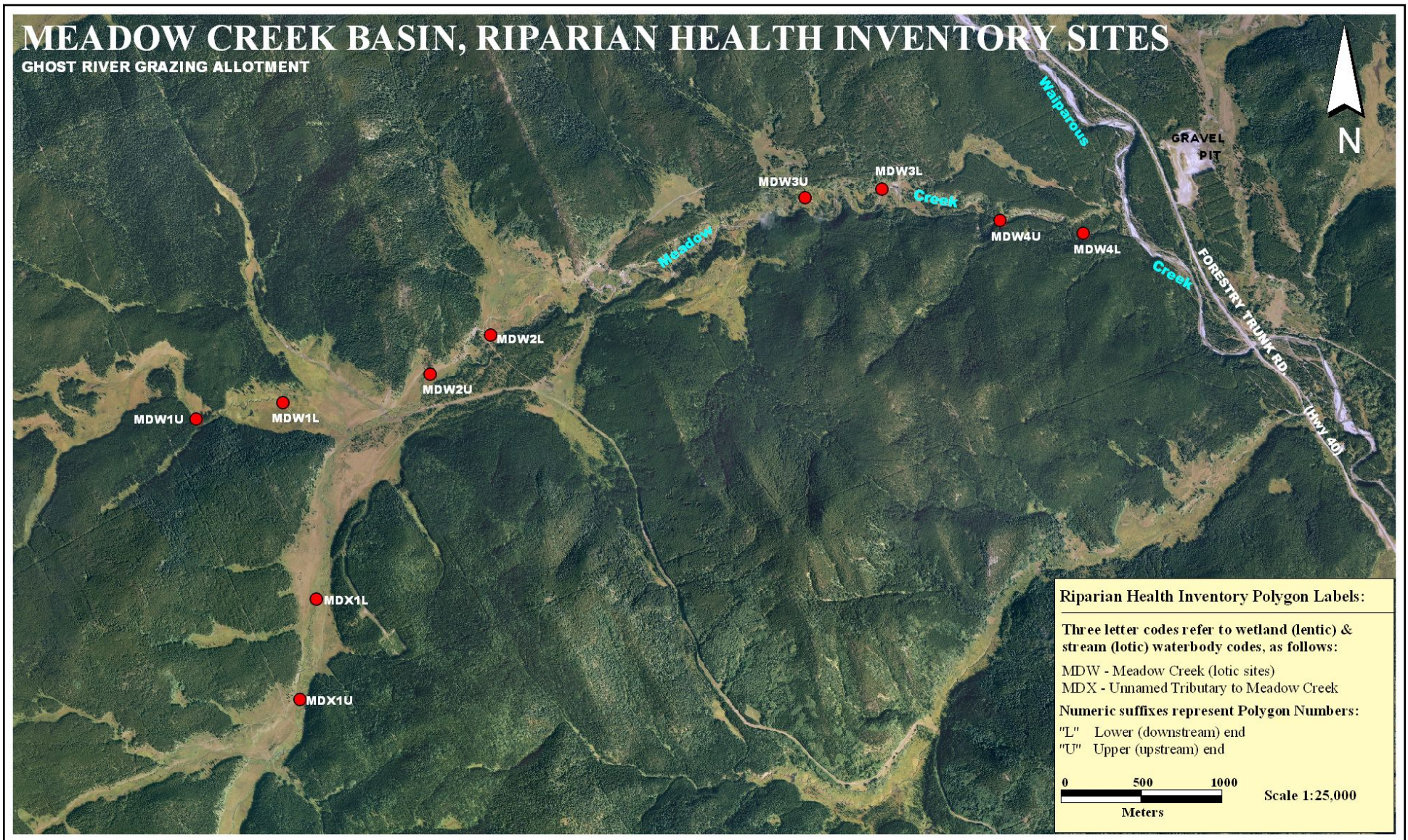


Figure 5 Meadow Creek Watershed Riparian Health Inventory Sites



**Table 13 Riparian Health Score Sheet for Sites within the Meadow Creek Watershed**

| Question                                                | Riparian Health Score – Meadow Creek (MDW)<br>& Meadow Creek Tributary (MDX) |            |              |            |              |             |              |             |              |            |
|---------------------------------------------------------|------------------------------------------------------------------------------|------------|--------------|------------|--------------|-------------|--------------|-------------|--------------|------------|
|                                                         | MDW1                                                                         |            | MDW2         |            | MDW3         |             | MDW4         |             | MDX1         |            |
| <b>Vegetation</b>                                       |                                                                              |            |              |            |              |             |              |             |              |            |
| Vegetation Cover of Floodplain and Streambanks          | 6/6                                                                          |            | 6/6          |            | 6/6          |             | 6/6          |             | 6/6          |            |
| Invasive Plant Species (Cover)                          | 2/3                                                                          |            | 2/3          |            | 2/3          |             | 2/3          |             | 2/3          |            |
| Invasive Plant Species (Density Distribution)           | 1/3                                                                          |            | 1/3          |            | 0/3          |             | 2/3          |             | 1/3          |            |
| Disturbance-Caused Undesirable Herbaceous Species       | 2/3                                                                          |            | 3/3          |            | 3/3          |             | 2/3          |             | 2/3          |            |
| Preferred Tree and Shrub Establishment and Regeneration | 6/6                                                                          |            | 6/6          |            | 6/6          |             | 6/6          |             | 6/6          |            |
| Utilization of Preferred Trees and Shrubs               | 2/3                                                                          |            | 2/3          |            | 2/3          |             | 3/3          |             | 0/3          |            |
| Live Woody Removal Other than Browsing                  | 2/3                                                                          |            | 3/3          |            | 3/3          |             | 3/3          |             | 3/3          |            |
| Decadent and Dead Woody Material                        | 3/3                                                                          |            | 3/3          |            | 3/3          |             | 2/3          |             | 3/3          |            |
| <b>Vegetation Rating</b>                                | <b>24/30</b>                                                                 | <b>80%</b> | <b>26/30</b> | <b>87%</b> | <b>25/30</b> | <b>83%</b>  | <b>26/30</b> | <b>87%</b>  | <b>23/30</b> | <b>77%</b> |
| <b>Soil/Hydrology</b>                                   |                                                                              |            |              |            |              |             |              |             |              |            |
| Streambank Root Mass Protection                         | 4/6                                                                          |            | 6/6          |            | 6/6          |             | 6/6          |             | 4/6          |            |
| Human-Caused Bare Ground                                | 6/6                                                                          |            | 4/6          |            | 6/6          |             | 6/6          |             | 4/6          |            |
| Streambank Structurally Altered                         | 6/6                                                                          |            | 6/6          |            | 6/6          |             | 6/6          |             | 6/6          |            |
| Human Physical Alteration to the Site                   | 3/3                                                                          |            | 3/3          |            | 3/3          |             | 3/3          |             | 0/3          |            |
| Stream Channel Incisement                               | 3/9                                                                          |            | 9/9          |            | 9/9          |             | 9/9          |             | 9/9          |            |
| <b>Soil/Hydrology Rating</b>                            | <b>22/30</b>                                                                 | <b>73%</b> | <b>28/30</b> | <b>93%</b> | <b>30/30</b> | <b>100%</b> | <b>30/30</b> | <b>100%</b> | <b>23/30</b> | <b>77%</b> |
| <b>Overall Rating</b>                                   | <b>46/60</b>                                                                 | <b>77%</b> | <b>54/60</b> | <b>90%</b> | <b>55/60</b> | <b>92%</b>  | <b>56/60</b> | <b>93%</b>  | <b>46/60</b> | <b>77%</b> |

**Table 14 Plant Community Types within the Meadow Creek Watershed**

| Plant Community*                    | Classification* | Polygons Where Found   | Area Occupied     | Area Occupied (%) |
|-------------------------------------|-----------------|------------------------|-------------------|-------------------|
| Flat-leaved willow / water sedge    | Habitat Type    | MDW1, MDW3, MDX1       | 23.7 ha (57.9 ac) | 57.5              |
| white spruce / low-bush cranberry** | Habitat Type    | MDW1, MDW2, MDW3, MDW4 | 8.5 ha (20.7 ac)  | 20.5              |
| water sedge                         | Habitat Type    | MDW1, MDW3, MDW4       | 5.6 ha (13.7 ac)  | 13.6              |
| Kentucky bluegrass                  | Community Type  | MDX1                   | 3.2 ha (7.9 ac)   | 7.8               |
| basket willow / awned sedge         | Habitat Type    | MDX1                   | 0.5 ha (1.2 ac)   | 1.2               |
| Unclassified                        | Wetland Type    | MDW4                   | 0.2 ha (0.4 ac)   | 0.4               |

\* Based on Thompson and Hansen 2003.

\*\* Low-bush cranberry does not occur in the Meadow Creek valley; willows are the dominant understory shrub.

Lush growing conditions in the Meadow Creek valley create suitable habitat for 142 plant species, 92% of which (i.e. 130 species) are native species. Of particular interest, **a provincially rare native species, Mountain mare's tail (*Hippuris montana*)**, was found in the MDX1 site. Positive identification of this species was confirmed by a professional botanist and a specimen was provided to the University of Calgary herbarium for their rare plant reference collection. This is the only incidental rare plant finding that was recorded during this project in the entire Waiparous Creek basin. Provincially this species is ranked as "S1" on the Alberta Conservation Information Management System's<sup>3</sup> Vascular Plant Tracking List (Kemper 2009). This indicates there are five or fewer known occurrences of this species in the province, or that it is especially vulnerable to extirpation due to other factors. Mountain mare's tail is a delicate, short-statured plant with narrow, whorled leaves and tiny, inconspicuous flowers. It grows to a height of 10 cm from slender, creeping rhizomes. This rare species occurs in Montane wet meadows, streams and mossy banks.

Trees and shrubs cover 69% of the riparian zone assessed within the Meadow Creek basin. Lodgepole pine, balsam poplar and aspen have less than 3% canopy cover, with white spruce providing the main tree cover. Of the 22 shrub species, the most wide spread species are flat-leaved willow, smooth willow and firm leaf willow (*Salix pseudomyrsinites*). Water sedge and to a lesser extent common tall manna grass (*Glyceria grandis*) and tufted hair grass (*Deschampsia cespitosa*) form the ground cover in the basin. A diverse mix of 85 forbs occur in sparse amounts throughout the basin, with species such as common fireweed (*Epilobium angustifolium*), tall lungwort (*Mertensia paniculata*), and purple avens (*Geum rivale*) having the greatest cover. Among the forbs are five poisonous species, tall larkspur (*Delphinium glaucum*), common horsetail, reflexed locoweed (*Oxytropis deflexa*), white camas and late yellow locoweed (*Oxytropis monticola*). These species are not a management concern since they occur in trace amounts.

<sup>3</sup> formerly the Alberta Natural Heritage Information Centre (ANHIC)

Of the 12 non-native species, 2 are invasive noxious weeds (Canada thistle and perennial sow-thistle), and 10 are disturbance species. Disturbance species, mainly Kentucky bluegrass and common dandelion have more than 5% cover in three sites (MDW1, MDW4 and MDX1) (Table 13). A combination of livestock grazing and recreational use has contributed to higher disturbance species abundance in the MDX1 site (the unnamed tributary in the south end of the basin) (Figure 5). Livestock grazing is the main disturbance in the MDW1 site (Figure 5). MDW4, closest to the Waiparous Creek confluence, has no sign of human-caused disturbance. Native disturbance species (e.g. wild strawberry [*Fragaria virginiana*]) are recolonizing portions of that site following natural disturbance factors such as beaver use.

Canada thistle occurs in trace amounts in all of the Meadow Creek sites (Table 15). It is most widely distributed in the MDW1, MDW2 and MDW3 sites (Table 15) (Figure 5). The only occurrence of perennial sow-thistle is a single patch of this weed in the MDX1 site (Table 15).

**Table 15 Invasive Plant Species Observed in the Meadow Creek Watershed**

| Species                                           | MDW1      |               | MDW2      |               | MDW3      |                                                          | MDW4      |                 | MDX1      |                                                         |
|---------------------------------------------------|-----------|---------------|-----------|---------------|-----------|----------------------------------------------------------|-----------|-----------------|-----------|---------------------------------------------------------|
|                                                   | Cover (%) | DD            | Cover (%) | DD            | Cover (%) | DD                                                       | Cover (%) | DD              | Cover (%) | DD                                                      |
| Canada thistle ( <i>Cirsium arvense</i> )         | 0.5       | A few patches | 0.5       | A few patches | 0.5       | A few patches plus several sporadically occurring plants | 0.5       | Rare occurrence | 0.5       | A single patch plus a few sporadically occurring plants |
| Perennial sow-thistle ( <i>Sonchus arvensis</i> ) | NA        | NA            | NA        | NA            | NA        | NA                                                       | NA        | NA              | 0.5       | A single patch                                          |

DD = Density Distribution

All five sites show signs of woody regeneration and establishment. Livestock appear to be using all of the sites with the exception of MDW4. MDW4, nearest to the Waiparous Creek confluence, is a narrower site, with steep rocky slopes and recent flooding from a beaver dam rupture. Flood debris and steeper rocky slopes limit cattle (and human) accessibility of this site. MDW1, MDW2 and MDW3 have low levels of livestock browse as well as some wildlife use (mainly from moose as indicated by moose scat and tracks). Heavy livestock browse is apparent in the MDX1 site as evidenced by flat-topped willow growth forms. Long-term livestock use of this site has contributed to a decline in woody cover in this site.

Beavers have modified and shaped the entire Meadow Creek basin and most sites have at least some sign of recent beaver activity. However, only the MDW1 site had more than 5% of the woody plant community removed due to recent beaver activity at the time of the survey. Although no recent beaver use was noted in the MDW4 site, standing dead lodgepole pine trees in saturated beaver meadows are evidence of past flooding from beaver dams. No commercial logging or other human removal of trees or shrubs is occurring in the riparian zone.





C. Ball, RHIP02MDW002.

Most of the Meadow Creek basin is dominated by this flat-leaved willow and water sedge plant community. White spruce occurs along the outer fringe of the riparian zone and extends into the uplands.



K. Hull, RHIP01MDW008

Increased cover from disturbance species such as Kentucky bluegrass in response to long-term livestock use can contribute to bank instability and slumping. Kentucky bluegrass is a shallow rooted grass which lacks bank binding ability.



D. White, RHIP01MDX009.

Heavy livestock use in the riparian zone is occurring in the MDX1 site. Flat-topped willow growth forms are a sign of long-term heavy use. Continued heavy use can eventually kill the plant and impede regeneration of woody species.



D. White, RHIP01MDX011.

OHV trails impact portions of the riparian zone in the MDW2, MDW3 and MDX1 sites, contributing to the spread of non-native disturbance and invasive species, soil compaction, erosion and sedimentation of Meadow Creek.

### MEADOWCREEK WATERSHED REPRESENTATIVE PHOTOS

### ***C) Soil and Hydrology Health***

In total, 1% of the Meadow Creek streambank and 13% of the floodplain have been structurally altered due to grazing and recreational activities. MDX1 has the greatest amount of physical alterations with 3% of the streambank and 30% of the remainder of the riparian area impacted. Half of these alterations are due to pugging and hummocking<sup>4</sup> from livestock trampling, and half are due to OHV trails. Exposed soil was found in 2% of the total area assessed, most of which is due to human-causes (i.e. grazing and recreational activities). MDW2 and MDX1 have the greatest amount of bare ground with approximately 3% of the riparian area lacking vegetative cover. Most of the bare ground within MDW2 is due to grazing and nearly all of the bare ground within MDX1 is from OHV trails. The MDW1 stream channel lacks deep binding roots that is usually provided by willows or sedges and is slightly incised due to flooding from beaver dam ruptures. The MDX1 stream channel also lacks deeply rooted plants from a combination of livestock impacts and flooding of riparian plants from beaver dams. Long-term livestock use contributes to an increase in shallow-rooted disturbance plants such as Kentucky bluegrass that have poor streambank binding ability.

## **4.8 Lost Knife Creek**

### ***A) Overall Health and Riparian Area Discussion***

Three riparian health inventories were completed along Lost Knife Creek in the Ghost River Allotment (Figure 6), all of which rated *healthy* with an average health score of 89% (Table 16). Area-weighted riparian health is 82%. Riparian sites assessed ranged from 0.5 to 10.0 hectares (1.2 to 24.3 acres) in size. A total of 11.7 hectares (28.5 acres) was assessed along 2.5 kilometres of streambank. The Lost Knife Creek beaver modified valley has similar plant community types to the Meadow Creek basin and it experiences similar human land use pressures.

### ***B) Vegetation Health***

The two dominant plant communities in the Lost Knife Creek basin are a flat-leaved willow / water sedge Habitat Type and a white spruce Habitat Type with a willow understory (Table 17). LOK3 (Figure 6) is the only site entirely composed of a white spruce Habitat Type. Although portions of this site are dominated by willows and sedges, white spruce seedlings and saplings are present throughout.

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<sup>4</sup> Pugging and hummocking refers to deep imprints ('pugs') and raised mounds ('hummocks') of soil caused by livestock / wildlife hoof prints.



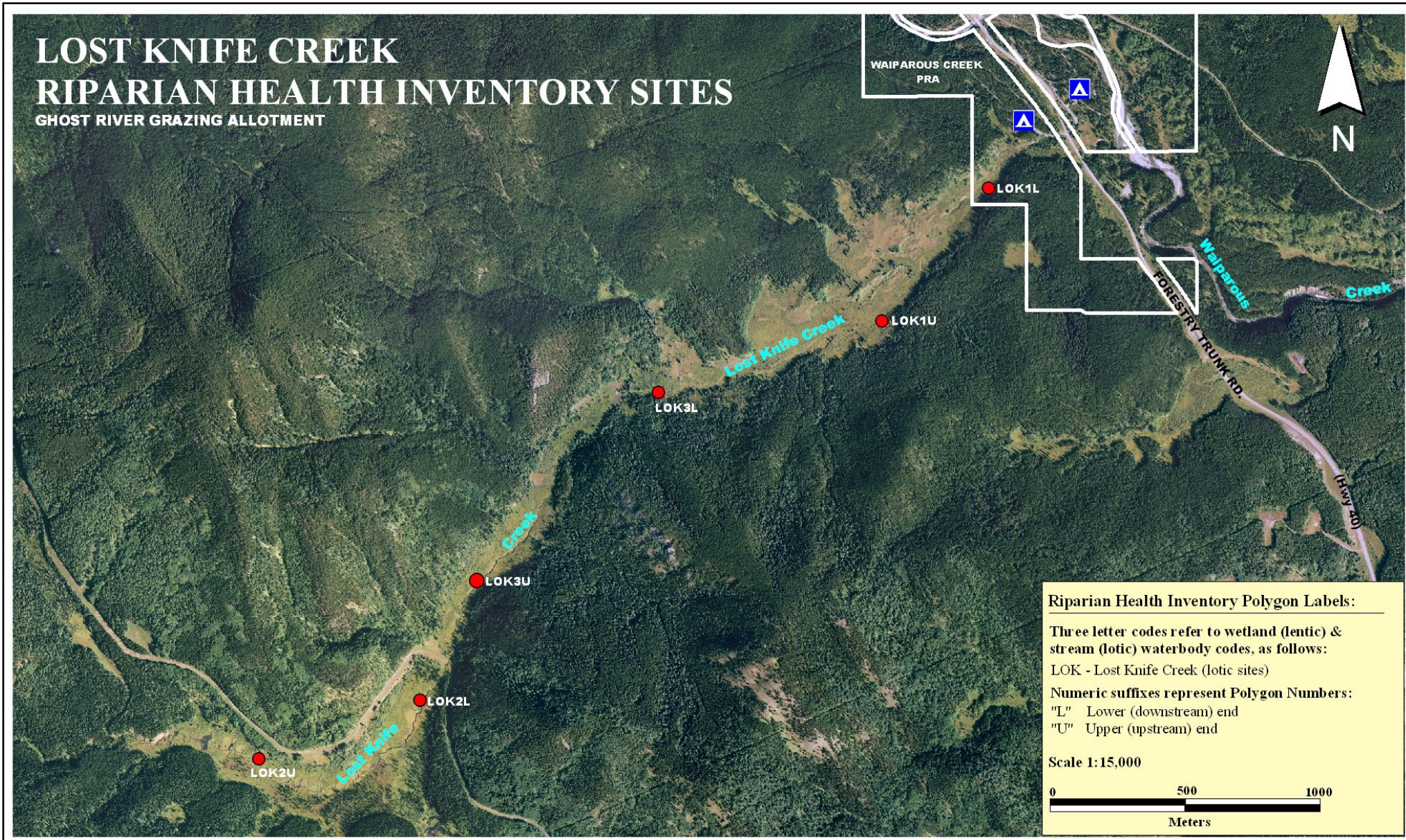


Figure 6 Lost Knife Creek Riparian Health Inventory Sites



**Table 16 Riparian Health Score Sheet for Lost Knife Creek Sites**

| Question                                                | Riparian Health Score –Lost Knife Creek |             |              |            |              |            |
|---------------------------------------------------------|-----------------------------------------|-------------|--------------|------------|--------------|------------|
| Vegetation                                              | LOK1                                    |             | LOK2         |            | LOK3         |            |
| Vegetation Cover of Floodplain and Streambanks          | 6/6                                     |             | 6/6          |            | 6/6          |            |
| Invasive Plant Species (Cover)                          | 3/3                                     |             | 2/3          |            | 2/3          |            |
| Invasive Plant Species (Density Distribution)           | 3/3                                     |             | 1/3          |            | 2/3          |            |
| Disturbance-Caused Undesirable Herbaceous Species       | 3/3                                     |             | 3/3          |            | 3/3          |            |
| Preferred Tree and Shrub Establishment and Regeneration | 6/6                                     |             | 6/6          |            | 6/6          |            |
| Utilization of Preferred Trees and Shrubs               | 2/3                                     |             | 2/3          |            | 2/3          |            |
| Live Woody Removal Other than Browsing                  | 3/3                                     |             | 3/3          |            | 3/3          |            |
| Decadent and Dead Woody Material                        | 3/3                                     |             | 3/3          |            | 3/3          |            |
| <b>Vegetation Rating</b>                                | <b>29/30</b>                            | <b>97%</b>  | <b>26/30</b> | <b>87%</b> | <b>27/30</b> | <b>90%</b> |
| Soil/Hydrology                                          |                                         |             |              |            |              |            |
| Streambank Root Mass Protection                         | 6/6                                     |             | 4/6          |            | 6/6          |            |
| Human-Caused Bare Ground                                | 6/6                                     |             | 6/6          |            | 4/6          |            |
| Streambank Structurally Altered                         | 6/6                                     |             | 6/6          |            | 6/6          |            |
| Human Physical Alteration to the Site                   | 3/3                                     |             | 3/3          |            | 2/3          |            |
| Stream Channel Incisement                               | 9/9                                     |             | 3/9          |            | 9/9          |            |
| <b>Soil/Hydrology Rating</b>                            | <b>30/30</b>                            | <b>100%</b> | <b>22/30</b> | <b>73%</b> | <b>27/30</b> | <b>90%</b> |
| <b>Overall Rating</b>                                   | <b>59/60</b>                            | <b>98%</b>  | <b>48/60</b> | <b>80%</b> | <b>54/60</b> | <b>90%</b> |

**Table 17 Plant Community Types along Lost Knife Creek**

| Plant Community*                  | Classification* | Polygons Where Found | Area Occupied    | Area Occupied (%) |
|-----------------------------------|-----------------|----------------------|------------------|-------------------|
| flat-leaved willow / water sedge  | Habitat Type    | LOK1, LOK2           | 7.1 ha (17.3 ac) | 60.7              |
| white spruce / low-bush cranberry | Habitat Type    | LOK1, LOK2, LOK3     | 4.6 ha (11.2 ac) | 39.2              |

\*Based on Thompson and Hansen 2003

An excellent diversity of 105 plant species were identified along Lost Knife Creek: 4 tree species, 20 shrubs, 20 grass and grass-like species and 61 forbs. Of these species, 95 (90%) are native plant species and 10 (10%) are introduced species. Dominant plant species include white spruce, flat-leaved willow, firm leaf willow, smooth willow, water birch (*Betula occidentalis*), water sedge, beaked sedge<sup>5</sup> (*Carex utriculata*) and common fireweed (*Epilobium angustifolium*).

<sup>5</sup> Beaked sedge is also referred to as “small bottle sedge”.

As with Meadow Creek, five poisonous plants occur in trace amounts in the riparian zone and do not present a management concern to livestock managers: common horsetail, tall larkspur, reflexed locoweed, late yellow locoweed and white camas.

Of the 10 introduced species, 7 are disturbance-caused plants and 1 is an invasive weed (Canada thistle). Disturbance species have less than 5% cover in all sites and are not impeding riparian health (Table 16). Trace amounts of Canada thistle were observed in LOK2 and LOK3 (Table 18). This noxious weed is more widely distributed in LOK2 (Figure 6).

**Table 18 Invasive Plant Species Observed in the Lost Knife Creek Watershed**

| Species                                      | LOK1      |                      | LOK2      |                      | LOK3      |                      |
|----------------------------------------------|-----------|----------------------|-----------|----------------------|-----------|----------------------|
|                                              | Cover (%) | Density Distribution | Cover (%) | Density Distribution | Cover (%) | Density Distribution |
| Canada thistle<br>( <i>Cirsium arvense</i> ) | NA        | NA                   | 0.5       | A few patches        | 0.5       | A single patch       |

Healthy tree and shrub communities with good age class diversity cover 80% of the riparian area assessed along Lost Knife Creek. All three sites exhibit light browsing by livestock and wildlife (mainly moose, as evidenced by tracks and scat). There is no recent evidence of tree or shrub clearing by beavers or human land uses (e.g. commercial logging) within LOK3 (Figure 6). Beaver use has removed a minor amount of woody cover (less than 5%) in the LOK1 and LOK2 sites (Figure 6).

### ***C) Soil and Hydrology Health***

There are very few physical alterations to the riparian area and minimal human-caused bare ground in the Lost Knife Creek basin overall. LOK3 (Figure 6) has the greatest amount of physical disturbance with 3% of the streambank and 10% of the remainder of the riparian area altered due to grazing. This site also has the greatest amount of bare ground (approximately 3%) from erosion caused by livestock use (i.e. livestock trails and hoof shear).

The creek channel in the LOK2 site (Figure 6) is moderately incised due to recent ruptures of multiple old beaver dams. Ongoing downward erosion of the stream channel is occurring below the ruptured dams. The force of large volumes of water released from the beaver dam ruptures has led to some bank instability in this site. Not even deeply rooted sedges and willows are capable of resisting these types of erosive intermittent floods. Fine textured sediment that builds up as a result of long-term beaver damming activities is easily susceptible to downward erosion.





K. Adair, RHIP01LOK004.

Most of the riparian zone in the Lost Knife Creek basin is characterized by a flat-leaved willow / water sedge Habitat Type.



D. White, RHIP03LOK002.

Dense willows growing along Lost Knife Creek provide abundant forage for wildlife such as moose, habitat for songbirds, and overhanging cover for fish.



C. Wood, RHIP02LOK004.

Lost Knife Creek is highly influenced by beaver activities. Beaver dams raise the water table and allow for accumulation of fine textured organic sediment that eventually forms wide lush and productive moist riparian meadows.



K. Adair, RHIP01LOK005.

Heavy trampling by livestock compacts soft, saturated riparian soils. This can lead to gradual drying out and less moisture retention in the riparian zone. It also promotes encroachment of invasive and disturbance-caused plant species.

### LOST KNIFE CREEK REPRESENTATIVE PHOTOS

## 4.9 Four Mile Creek

### A) Overall Health and Riparian Area Discussion

Three riparian health inventories were completed along Four Mile Creek in the Ghost River Allotment (Figure 7). The average health score for this system is 89% (*healthy*) with a similar score of 88% for area-weighted health. Two of the sites rated in the *healthy* category (91% of the area assessed) and one (FOU2, 9% of the area assessed) rated in the *healthy, but with problems* category (Table 19). Riparian sites assessed ranged from 0.1 to 7.8 hectares (0.3 to 19.0 acres) in size, with a total of 8.7 hectares (21.2 acres) assessed along 1.4 kilometres of streambank.

Natural disturbance factors, mainly beaver dam activities, are apparent in all sites. Impacts from human land uses (recreation and livestock grazing) are minimal and localized.

**Table 19 Riparian Health Score Sheet for Four Mile Creek Sites**

| Question                                                | Riparian Health Score – Four Mile Creek |             |              |            |              |             |
|---------------------------------------------------------|-----------------------------------------|-------------|--------------|------------|--------------|-------------|
| Vegetation                                              | FOU1                                    |             | FOU2         |            | FOU3         |             |
| Vegetation Cover of Floodplain and Streambanks          | 6/6                                     |             | 6/6          |            | 6/6          |             |
| Invasive Plant Species (Cover)                          | 3/3                                     |             | 2/3          |            | 2/3          |             |
| Invasive Plant Species (Density Distribution)           | 3/3                                     |             | 0/3          |            | 0/3          |             |
| Disturbance-Caused Undesirable Herbaceous Species       | 3/3                                     |             | 3/3          |            | 3/3          |             |
| Preferred Tree and Shrub Establishment and Regeneration | 6/6                                     |             | 6/6          |            | 6/6          |             |
| Utilization of Preferred Trees and Shrubs               | 3/3                                     |             | 2/3          |            | 1/3          |             |
| Live Woody Removal Other than Browsing                  | 3/3                                     |             | 3/3          |            | 2/3          |             |
| Decadent and Dead Woody Material                        | 3/3                                     |             | 3/3          |            | 3/3          |             |
| <b>Vegetation Rating</b>                                | <b>30/30</b>                            | <b>100%</b> | <b>25/30</b> | <b>83%</b> | <b>23/30</b> | <b>77%</b>  |
| Soil/Hydrology                                          |                                         |             |              |            |              |             |
| Streambank Root Mass Protection                         | 6/6                                     |             | 4/6          |            | 6/6          |             |
| Human-Caused Bare Ground                                | 6/6                                     |             | 6/6          |            | 6/6          |             |
| Streambank Structurally Altered                         | 6/6                                     |             | 6/6          |            | 6/6          |             |
| Human Physical Alteration to the Site                   | 3/3                                     |             | 3/3          |            | 3/3          |             |
| Stream Channel Incisement                               | 9/9                                     |             | 3/9          |            | 9/9          |             |
| <b>Soil/Hydrology Rating</b>                            | <b>30/30</b>                            | <b>100%</b> | <b>22/30</b> | <b>73%</b> | <b>30/30</b> | <b>100%</b> |
| <b>Overall Rating</b>                                   | <b>60/60</b>                            | <b>100%</b> | <b>47/60</b> | <b>78%</b> | <b>53/60</b> | <b>88%</b>  |







## B) Vegetation Health

Much of the Four Mile Creek valley is characterized by a flat-leaved willow / water sedge Habitat Type (Table 20). FOU1 begins as a wide floodplain but constricts into a narrow steep sided valley close to its confluence with Waiparous Creek. This site is entirely comprised of a white spruce plant community with a willow understory (Table 20). FOU2 and FOU3 by comparison are more typical of wide, lush beaver modified valleys with primarily sedge and willow plant communities (Table 20). FOU2 has a series of sedge dominated historic beaver ponds and one active beaver dam and pond complex.

**Table 20 Plant Community Types along Four Mile Creek**

| Plant Community*                    | Classification* | Polygons Where Found | Area Occupied    | Area Occupied (%) |
|-------------------------------------|-----------------|----------------------|------------------|-------------------|
| flat-leaved willow / water sedge    | Habitat Type    | FOU2, FOU3           | 6.1 ha (15.0 ac) | 70.6              |
| white spruce / low-bush cranberry** | Habitat Type    | FOU1, FOU3           | 2.5 ha (6.0 ac)  | 28.4              |
| Beaked willow / awned sedge         | Habitat Type    | FOU2                 | 0.1 ha (0.2 ac)  | 0.9               |

\* Based on Thompson and Hansen 2003

\*\* Low-bush cranberry does not occur in the Four Mile Creek valley. Native willows are dominant in the white spruce understory in this Habitat Type along Four Mile Creek.

Natural disturbance from beaver activity in combination with some livestock and recreational use has led to the introduction of several non-native species in the Four Mile Creek basin. Areas of exposed organic loamy soils are readily colonized by disturbance introduced species such as Kentucky bluegrass and clover (*Trifolium* spp.) species. Of the 113 plant species inventoried in the Four Mile Creek riparian sites, 14 (12%) are non-native species, with the remainder being native species. Likely in part due to minimal disturbance from livestock and recreational use in the riparian zone, disturbance introduced species only occur in trace amounts in all sites and are not presently impacting riparian health. Native plants are well established throughout the riparian zone. A total of 3 tree species, 21 shrub species, 27 grass and grass-like species, and low amounts of 62 forb species were inventoried in the three sites. Dominant species include flat-leaved willow, firm leaf willow, smooth willow, basket willow (*Salix petiolaris*), water sedge and beaked sedge. These species are well adapted to saturated soil conditions in beaver meadows. By comparison most non-native species are not adapted to prolonged flood conditions which also helps to limit their spread in the Four Mile Creek basin.

Four poisonous plants were observed, occurring in low levels (not a management concern) in the Four Mile Creek basin: common horsetail, tall larkspur, reflexed locoweed and seaside arrow-grass.

Bare ground exposed along beaver dams in the FOU2 and FOU3 sites (Figure 7) has created microsites for the establishment of two noxious weeds (Canada thistle and perennial sow-thistle) (Table 21). A few thistle patches and several sporadically occurring thistle plants were observed in these sites, although the overall cover of these species is minimal. Again, minimal livestock and recreational disturbance in the riparian zone combined with prolonged flooded conditions in beaver meadows has likely helped limit the spread of these weeds.

**Table 21 Invasive Plant Species Observed in the Four Mile Creek Watershed**

| Species                                              | FOU1      |                      | FOU2      |                                                                 | FOU3      |                                                                 |
|------------------------------------------------------|-----------|----------------------|-----------|-----------------------------------------------------------------|-----------|-----------------------------------------------------------------|
|                                                      | Cover (%) | Density Distribution | Cover (%) | Density Distribution                                            | Cover (%) | Density Distribution                                            |
| Canada thistle<br>( <i>Cirsium arvense</i> )         | NA        | NA                   | 0.5       | <i>A few patches plus several sporadically occurring plants</i> | 0.5       | <i>A few patches plus several sporadically occurring plants</i> |
| Perennial sow-thistle<br>( <i>Sonchus arvensis</i> ) | NA        | NA                   | 0.5       | <i>A few patches plus several sporadically occurring plants</i> | 0.5       | <i>A single patch plus a few sporadically occurring plants</i>  |

Trees and shrubs cover 82% of the riparian zone we assessed along Four Mile Creek. Most of the light and moderate woody utilization in the FOU2 and FOU3 sites, respectively, is attributed to moose browse (evidence of livestock use is minimal). Steep slopes limit wildlife and livestock access to the FOU1 site. Since all three sites have excellent woody recruitment (young growth), current browse utilization is not a management concern.

There is no evidence of woody removal from commercial logging or other human uses. Recent beaver activity is occurring in the FOU3 site, where more than 5% of woody vegetation has been recently removed by beavers. Given the high density of willows in the basin this level of beaver use is not impacting riparian health. No recent beaver activity was observed in FOU1 or FOU2.

### ***C) Soil and Hydrology Health***

Very few physical alterations to the riparian area were observed. Less than 1% of both the streambank and the remainder of the riparian area have been structurally altered from human land uses. Bare ground exposure from these human causes is also minimal. There are no signs of livestock use in FOU1 due to steep slope access restrictions. Other than a high use livestock crossing at the upstream end of FOU2 and a single watering access point midway along FOU3, there is otherwise minimal sign of livestock use in the riparian zone. Recreational use is also limited to a single quad trail crossing near the upstream end of FOU1 and to a bridge crossing in FOU3. Horse trails were apparent in some sites which may be from recreational riding, feral horse use or a combination of the two. Recent rupture of a beaver dam has led to moderate incisement of the FOU2 stream channel and ongoing bank erosion and bank slumping in places.





C. Ball, RHIP03FOU007.

Beavers continue to shape and influence the hydrology and riparian plant communities in the Four Mile Creek basin. Active beaver ponds provide excellent habitat for amphibians, waterfowl and other fish and wildlife species.



C. Ball, RHIP03FOU004.

The riparian zone along Four Mile Creek has dense and diverse willow stands and an understory of native sedges. White spruce is encroaching along the drier outer fringes of the valley bottom from adjacent upland forests.



C. Ball, RHIP02FOU007.

When old beaver dams eventually give way, the sudden rush of water can wash away even well vegetated streambanks. However, this allows for new floodplains to develop with new plant communities, continuing the natural succession of riparian areas.



C. Ball, RHIP02FOU003.

Although few in number, localized watering points, like this one in FOU2, may need to be temporarily fenced off to prevent ongoing erosion and sedimentation of the creek. With sufficient rest, this compacted area of bare ground will recover naturally.

#### FOUR MILE CREEK REPRESENTATIVE PHOTOS

#### 4.10 Unnamed Tributary to Waiparous Creek

##### A) Overall Health and Riparian Area Discussion

A single riparian health inventory (WAZ1) was completed on both sides of an unnamed tributary of Waiparous Creek in the Ghost River Allotment (Figure 3). This tributary enters Waiparous Creek near Camp Howard. This site is approximately 0.3 hectares (0.7 acres) in size and ranges in width from 3 to 8 meters, with an average width of 5 meters. The site rated *healthy* with a score of 90% (Table 22).

**Table 22 Riparian Health Score Sheet for the Unnamed Tributary to Waiparous Creek**

| Question                                                | Riparian Health Score – Unnamed Tributary to Waiparous Creek |            |
|---------------------------------------------------------|--------------------------------------------------------------|------------|
| <b>Vegetation</b>                                       | <b>WAZ1</b>                                                  |            |
| Vegetation Cover of Floodplain and Streambanks          | 6/6                                                          |            |
| Invasive Plant Species (Cover)                          | 3/3                                                          |            |
| Invasive Plant Species (Density Distribution)           | 3/3                                                          |            |
| Disturbance-Caused Undesirable Herbaceous Species       | 3/3                                                          |            |
| Preferred Tree and Shrub Establishment and Regeneration | 6/6                                                          |            |
| Utilization of Preferred Trees and Shrubs               | 2/3                                                          |            |
| Live Woody Removal Other than Browsing                  | 3/3                                                          |            |
| Decadent and Dead Woody Material                        | 3/3                                                          |            |
| <b>Vegetation Rating</b>                                | <b>29/30</b>                                                 | <b>97%</b> |
| <b>Soil/Hydrology</b>                                   |                                                              |            |
| Streambank Root Mass Protection                         | 4/6                                                          |            |
| Human-Caused Bare Ground                                | 6/6                                                          |            |
| Streambank Structurally Altered                         | 6/6                                                          |            |
| Human Physical Alteration to the Site                   | 3/3                                                          |            |
| Stream Channel Incisement                               | 6/9                                                          |            |
| <b>Soil/Hydrology Rating</b>                            | <b>25/30</b>                                                 | <b>83%</b> |
| <b>Overall Rating</b>                                   | <b>54/60</b>                                                 | <b>90%</b> |

##### B) Vegetation Health

Much of this tributary to Waiparous Creek is dominated by a flat-leaved willow community with an understory of riparian grasses and sedges, such as water sedge, tufted hair grass and beaked sedge (Table 23). White spruce occurs along the outer edge of the riparian zone in the upstream portion of this site, where it is encroaching from the surrounding upland forests.



In total, 62 plant species were identified, 58 (94%) of which are native species and 4 (6%) are introduced, mainly disturbance-caused species. This species count includes 3 tree, 9 shrub, 15 grass / grass-like and 35 forb species. Trace occurrence of one poisonous plant, tall larkspur was found in the riparian zone. More abundant forbs are wild flowers such as alpine hedsarum, tall lungwort, wild strawberry and yellow avens. No invasive species were observed.

**Table 23 Plant Community Types along the Unnamed Tributary to Waiparous Creek**

| Plant Community*                    | Classification* | Area Occupied     | Area Occupied (%) |
|-------------------------------------|-----------------|-------------------|-------------------|
| flat-leaved willow / water sedge    | Habitat Type    | 0.25 ha (0.62 ac) | 90.0              |
| white spruce / low-bush cranberry** | Habitat Type    | 0.03 ha (0.07 ac) | 10.0              |

\*Based on Thompson and Hansen 2003

\*\* Low-bush cranberry does not occur in this site. Native willows are dominant in the white spruce understory in this Habitat Type.

Trees and shrubs cover 50% of the riparian zone, mainly firm leaf willow, flat-leaved willow, smooth willow, bog birch and white spruce (mostly along the outer periphery). Woody utilization (browse) by wildlife is light overall and is not impeding recruitment (new growth). There are no obvious signs of livestock use in the site or human caused vegetation removal. This site is an old beaver meadow, but there is no recent sign of beaver activity.

### ***C) Soil and Hydrology Health***

No human-caused bare ground or structural alterations to the riparian area were observed. Approximately 3% of the site has exposed soil due to natural erosion, sediment deposition and wildlife trails. More than 25% of the streambank is unstable due to a lack of deep binding roots in the downstream portion of the site, which is likely due to historical beaver activity. The stream channel is slightly incised, which is natural for many systems within such close proximity to their confluence with a larger stream system.



C. Ball, RHIP01WAZ001.

White spruce occurs along the southern periphery of the riparian zone near the upstream end of this site.



C. Ball, RHIP01WAZ002.

Most of the upstream portion of the riparian zone has dense cover from a variety of willows and some bog birch. These shrubs and native sedges in the understory help to stabilize the streambank and slow erosion.



C. Ball, RHIP01WAZ003.

The stream channel of the unnamed tributary is slightly incised as it enters the lower elevation Waiparous Creek valley. Incisement here is also due to natural processes from historic beaver activity and down-cutting following rupture of beaver dams.



C. Ball, RHIP01WAZ004.

Wide sedge meadows along this tributary are indicative of beaver modified watersheds.

### UNNAMED TRIBUTARY TO WAIPAROUS CREEK REPRESENTATIVE PHOTOS



## 4.11 Aura Creek

### A) Overall Health and Riparian Area Discussion

Two riparian health inventories were completed on Aura Creek and one riparian health inventory was completed on an unnamed tributary to Aura Creek (Figure 8). These riparian sites all rated *healthy*, with an average health score of 94% (Table 24). Area-weighted health is 89%. Riparian sites range from 0.5 to 2.8 hectares (1.2 to 6.8 acres) in size, with a total of 3.9 hectares (9.6 acres) assessed along 1.4 kilometres of channel length. Present land uses (i.e. livestock grazing and recreational activities) are currently having minimal impact on the health of these sites.

**Table 24 Riparian Health Score Sheet for Aura Creek Sites**

| Question                                                | Health Score |             |              |             |                                 |            |
|---------------------------------------------------------|--------------|-------------|--------------|-------------|---------------------------------|------------|
|                                                         | Aura Creek   |             |              |             | Unnamed Tributary to Aura Creek |            |
| Vegetation                                              | AUR1         |             | AUR2         |             | AUY1                            |            |
| Vegetation Cover of Floodplain and Streambanks          | 6/6          |             | 6/6          |             | 6/6                             |            |
| Invasive Plant Species (Cover)                          | 2/3          |             | 3/3          |             | 2/3                             |            |
| Invasive Plant Species (Density Distribution)           | 2/3          |             | 3/3          |             | 0/3                             |            |
| Disturbance-Caused Undesirable Herbaceous Species       | 3/3          |             | 3/3          |             | 2/3                             |            |
| Preferred Tree and Shrub Establishment and Regeneration | 6/6          |             | 6/6          |             | 6/6                             |            |
| Utilization of Preferred Trees and Shrubs               | 3/3          |             | 3/3          |             | 2/3                             |            |
| Live Woody Removal Other than Browsing                  | 3/3          |             | 3/3          |             | 3/3                             |            |
| Decadent and Dead Woody Material                        | 3/3          |             | 3/3          |             | 3/3                             |            |
| <b>Vegetation Rating</b>                                | <b>28/30</b> | <b>93%</b>  | <b>30/30</b> | <b>100%</b> | <b>24/30</b>                    | <b>80%</b> |
| Soil/Hydrology                                          |              |             |              |             |                                 |            |
| Streambank Root Mass Protection                         | 6/6          |             | 6/6          |             | 6/6                             |            |
| Human-Caused Bare Ground                                | 6/6          |             | 6/6          |             | 6/6                             |            |
| Streambank Structurally Altered                         | 6/6          |             | 6/6          |             | 6/6                             |            |
| Human Physical Alteration to the Site                   | 3/3          |             | 3/3          |             | 3/3                             |            |
| Stream Channel Incisement                               | 9/9          |             | 9/9          |             | 6/9                             |            |
| <b>Soil/Hydrology Rating</b>                            | <b>30/30</b> | <b>100%</b> | <b>30/30</b> | <b>100%</b> | <b>27/30</b>                    | <b>90%</b> |
| <b>Overall Rating</b>                                   | <b>58/60</b> | <b>97%</b>  | <b>60/60</b> | <b>100%</b> | <b>51/60</b>                    | <b>85%</b> |



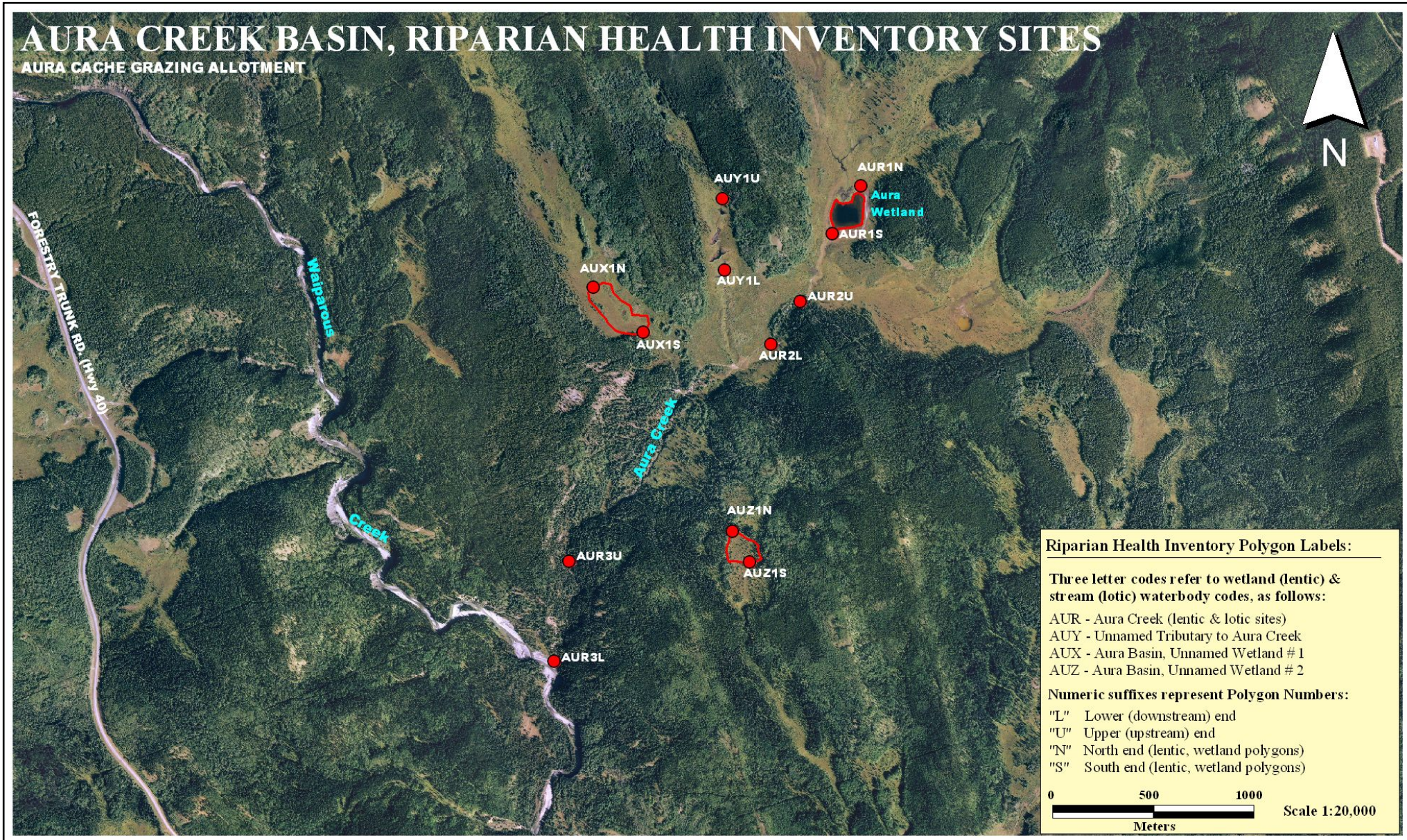


Figure 8 Aura Creek Watershed Riparian Health Inventory Sites



## B) Vegetation Health

The two sites on the main stem of Aura Creek (AUR1 and AUR2) are dominated by a white spruce community with an understory of willows, bog birch, common bearberry and a variety of other shrub species. Moss is the main ground cover in some portions of AUR1 where there is a dense spruce overstory and ground shading. Saturated beaver meadows along the unnamed tributary to Aura Creek (AUY1) are comprised of water sedge and flat-leaved willow / water sedge Habitat Types (Table 25).

**Table 25 Plant Community Types within the Aura Creek Watershed**

| <i>Plant Community*</i>             | <i>Classification*</i> | <i>Polygons Where Found</i> | <i>Area Occupied</i> | <i>Area Occupied (%)</i> |
|-------------------------------------|------------------------|-----------------------------|----------------------|--------------------------|
| water sedge                         | Habitat Type           | AUY1                        | 1.7 ha (4.1 ac)      | 42.7                     |
| flat-leaved willow / water sedge    | Habitat Type           | AUY1                        | 1.1 ha (2.7 ac)      | 28.5                     |
| white spruce / low-bush cranberry** | Habitat Type           | AUR1, AUR2                  | 1.1 ha (2.7 ac)      | 28.1                     |

\* Based on Thompson and Hansen 2003

\*\* Low-bush cranberry does not occur in the Aura Creek basin. Native willows are dominant in the white spruce understory in this Habitat Type along Aura Creek.

All three sites include a diversity and abundance of native plant species. Of the 97 plant species recorded during our inventories, 87 (90%) are native plant species, with the remainder being introduced species that have established in response to natural or human-caused disturbances. Disturbance species (mainly Kentucky bluegrass) are either absent or occur in trace amounts along Aura Creek, but have high cover along the unnamed tributary where beaver activity has caused ground disturbance and soil exposure. Three tree species (mainly white spruce with some aspen and balsam poplar), 18 shrub species (mainly willows), 21 grass and grass/like species (mainly sedges) and 55 forbs provide good ground cover throughout the riparian zone. Most forb species occur in trace amounts except for dense patches of common horsetail in some parts of the AUR1 site. Common horsetail can be poisonous to livestock if large quantities are ingested. Other poisonous plants including white camas, tall larkspur, reflexed locoweed and seaside arrow-grass occur in trace amounts and are not a management concern.

Two noxious weeds, Canada thistle and perennial sow-thistle, were recorded in the Aura Creek basin (Table 26). Beaver related ground disturbance and exposed soil on beaver dams has resulted in establishment of a few patches and several sporadically occurring individuals of these invasive species in the AUY1 unnamed tributary site. Rare occurrence of Canada thistle was noted in the AUR1 Aura Creek site.

**Table 26 Invasive Plant Species Observed in the Aura Creek Watershed**

| Species                                              | AUR1             |                      | AUR2             |                      | AUY1             |                                                                     |
|------------------------------------------------------|------------------|----------------------|------------------|----------------------|------------------|---------------------------------------------------------------------|
|                                                      | Canopy Cover (%) | Density Distribution | Canopy Cover (%) | Density Distribution | Canopy Cover (%) | Density Distribution                                                |
| Canada thistle<br>( <i>Cirsium arvense</i> )         | 0.5              | Rare occurrence      | NA               | NA                   | 0.5              | A few patches plus several sporadically occurring individual plants |
| Perennial sow-thistle<br>( <i>Sonchus arvensis</i> ) | NA               | NA                   | NA               | NA                   | 0.5              | A single patch plus a few sporadically occurring plants             |

Trees and shrubs cover approximately 70% of the riparian zone along Aura Creek and its tributary. There is minimal sign of woody browse along the narrow floodplain of the Aura Creek main stem. Light browse is occurring along the unnamed tributary (AUY1). This appears to be mainly from use by feral horses and other wildlife rather than from domestic livestock use based on tracks and scat sign.

There are signs of past beaver activity, such as old chewed stems and dams, in all sites. Recent removal of woody vegetation by beavers is not impacting riparian health since there is an abundance of new recruitment of willows. Aside from a few cut stems in the AUR1 site, no other signs of human removal of woody vegetation were observed.

#### ***D) Soil and Hydrology Health***

Aside from minor evidence of horse use (trailing) along the unnamed tributary, no other physical alterations from human land uses were observed in the AUY1 site. Horse use may be from feral horses, or a combination of feral and domestic horse use. There is minor sign of livestock use along Aura Creek in AUR1 and AUR2, with less than 1% of the streambank and floodplain having evidence of physical alterations from trampling or trails. An OHV trail crosses Aura Creek at the downstream end of the AUR2 site (Figure 8). This is the only recreational use impact observed. Recreational use and livestock have caused a minimal amount of exposed bare ground, but most of the soil exposure in the sites is from natural sediment deposition and beaver related disturbance.

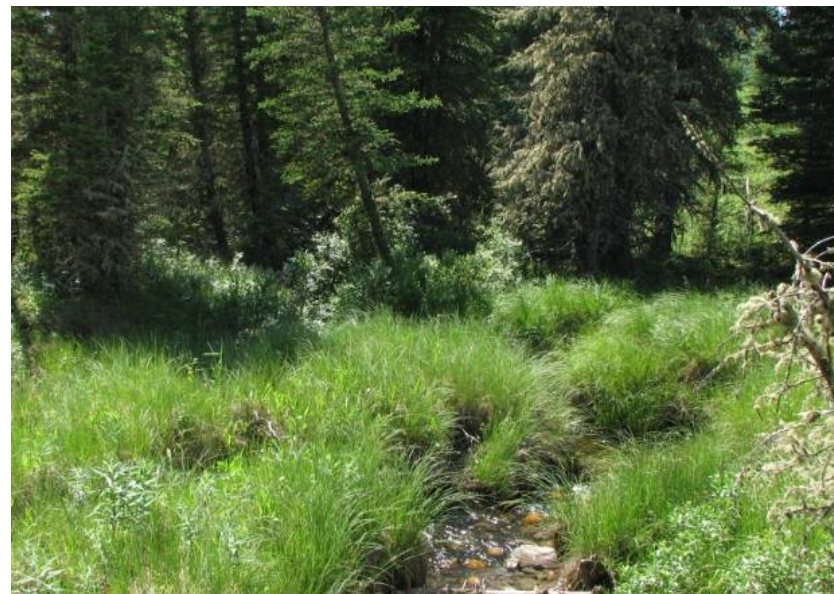
All three sites have excellent deep binding rootmass provided by healthy riparian plant communities along the banks. There is no evidence of channel incisement along AUR1 or AUR2. The unnamed tributary to Aura Creek is slightly incised in places, limiting floodwater access to the floodplain. This incisement appears to be related to the breach of beaver dams throughout this reach of the creek. This incisement is a natural occurrence and it is not impacting the health of the site.





C. Wood, RHIP01AUR002.

The relatively narrow riparian valley along Aura Creek is comprised of white spruce with an understory of willows and other native shrubs.



C. Wood, RHIP02AUR002.

Sedges, in addition to trees and shrubs, stabilize the banks of Aura Creek and its tributary with their deep binding roots.



D. White, RHIP01AUY006.

The unnamed tributary to Aura Creek (AUY1) has less woody cover overall due to flooding and historic clearing by beavers. The riparian zone along this tributary is characterized by beaver modified willow – sedge meadows as shown here.



C. Wood, RHIP02AUR003.

This OHV crossing is located at the downstream end of the AUR2 site. Although recreational impacts are few in this site, forded crossings like this can have a significant impact on water quality from erosion and sediment inputs.

#### AURA CREEK WATERSHED REPRESENTATIVE PHOTOS

## 4.12 Aura Wetlands

### A) Overall Health and Riparian Area Discussion

Three riparian health inventories were completed in wetland complexes in the Aura Creek basin, including two unnamed wetlands north (AUX1) and south (AUZ1) of Aura Creek, and the “Aura Wetland” at the headwaters of Aura Creek (AUR3) (Figure 8). These wetlands are all situated in the Aura Cache Grazing Allotment.

These wetlands rated *healthy*, with an average health score of 86% (Table 27). Area-weighted riparian health is 87% with 31% of the area in the *healthy, but with problems* category and 69% of the area assessed in the *healthy* category. Riparian sites ranged from 1.2 to 3.6 hectares (3.0 to 8.8 acres) in size, with a total of 7.0 hectares (17.1 acres) assessed along 1.1 kilometres of shoreline.

Livestock grazing is currently impacting AUR3, but there is minimal impact on the unnamed wetlands (AUX1 and AUZ1) from livestock or recreational use.

**Table 27 Riparian Health Score Sheet for the Aura Wetlands**

| Question                                                | Health Score – Aura Wetlands |            |              |             |              |             |
|---------------------------------------------------------|------------------------------|------------|--------------|-------------|--------------|-------------|
| Vegetation                                              | AUR3                         |            | AUX1         |             | AUZ1         |             |
| Vegetation Cover of Site                                | 2/6                          |            | 6/6          |             | 6/6          |             |
| Invasive Plant Species (Cover)                          | 3/3                          |            | 3/3          |             | 3/3          |             |
| Invasive Plant Species (Density Distribution)           | 3/3                          |            | 3/3          |             | 3/3          |             |
| Disturbance-Caused Undesirable Herbaceous Species       | 3/3                          |            | 3/3          |             | 3/3          |             |
| Preferred Tree and Shrub Establishment and Regeneration | 6/6                          |            | 6/6          |             | 6/6          |             |
| Utilization of Preferred Trees and Shrubs               | 3/3                          |            | 2/3          |             | 3/3          |             |
| Live Woody Removal Other than Browsing                  | 3/3                          |            | 3/3          |             | 3/3          |             |
| Human Alteration of Site Vegetation                     | 2/6                          |            | 6/6          |             | 6/6          |             |
| <b>Vegetation Rating</b>                                | <b>25/33</b>                 | <b>76%</b> | <b>32/33</b> | <b>97%</b>  | <b>33/33</b> | <b>100%</b> |
| Soil/Hydrology                                          |                              |            |              |             |              |             |
| Human Alteration of Site Physical Structure             | 4/12                         |            | 12/12        |             | 12/12        |             |
| Severity of Human-Caused Alterations to Physical Site   | 1/3                          |            | 3/3          |             | 2/3          |             |
| Human-Caused Bare Ground                                | 0/6                          |            | 6/6          |             | 6/6          |             |
| Degree of Artificial Removal/Addition of Water          | 9/9                          |            | 9/9          |             | 9/9          |             |
| <b>Soil/Hydrology Rating</b>                            | <b>14/30</b>                 | <b>47%</b> | <b>30/30</b> | <b>100%</b> | <b>29/30</b> | <b>97%</b>  |
| <b>Overall Rating</b>                                   | <b>39/63</b>                 | <b>62%</b> | <b>62/63</b> | <b>98%</b>  | <b>62/63</b> | <b>98%</b>  |



## B) Vegetation Health

The two unnamed wetlands are dominated by tree and shrub communities (Table 28). Trees and shrubs have a combined canopy cover of approximately 70% in the AUZ1 and AUX1 sites. A white spruce Habitat Type with a willow and bog birch understory is found on each of these sites, but comprises less of the AUX1 site. AUX1 is mainly dominated by a flat-leaved willow / water sedge Habitat Type. The wetland at the headwaters of Aura Creek (AUR3) is dominated by sedge communities (water sedge and beaked sedge Habitat Types), with limited willow cover in portions of the site (Table 28). This site only has a trace amount of tree cover (balsam poplar and aspen).

**Table 28 Plant Community Types for the Aura Wetlands**

| <i>Plant Community*</i>           | <i>Classification*</i> | <i>Polygons Where Found</i> | <i>Area Occupied</i> |            |
|-----------------------------------|------------------------|-----------------------------|----------------------|------------|
|                                   |                        |                             | <i>Area Occupied</i> | <i>(%)</i> |
| flat-leaved willow / water sedge  | Habitat Type           | AUX1, AUR3                  | 3.3 ha (8.1 ac)      | 47.5       |
| white spruce / low-bush cranberry | Habitat Type           | AUX1, AUZ1                  | 1.9 ha (4.7 ac)      | 27.3       |
| water sedge                       | Habitat Type           | AUR3                        | 1.1 ha (2.7 ac)      | 15.5       |
| Unclassified wetland type         | NA                     | AUR3                        | 0.4 ha (1.1 ac)      | 6.2        |
| beaked sedge                      | Habitat Type           | AUR3                        | 0.2 ha (0.5 ac)      | 3.1        |

\* Based on Thompson and Hansen 2003

\*\* Low-bush cranberry does not occur in the Aura Creek basin. Native willows and bog birch are dominant in the white spruce understory in this Habitat Type along Aura Creek.

All three sites are dominated by native plant species. Of the 63 plant species recorded in these wetlands, 60 (95%) are native plant species. This includes 3 tree species (mainly white spruce with some balsam poplar and aspen), 14 shrub species (primarily bog birch, firm-leaf willow and flat-leaved willow), 18 grass and grass-like species (water sedge being dominant in all sites, but wire rush, tufted hair grass and hairy wild rye having high cover in AUZ1), and 28 forbs. Forbs are sparse in the wetlands except for higher cover (10% combined cover) of alpine bistort (*Polygonum viviparum*) and vine-leaved coltsfoot (*Petasites vitifolius*) in the AUZ1 site. Trace amounts of tall larkspur (AUX1 and AUZ1) and white camas (AUZ1) were observed in the unnamed wetlands. These poisonous plants do not pose a management concern.

Invasive plant species were not observed on any of the three sites. In addition, only trace amounts of two introduced species (common dandelion and curled dock [*Rumex crispus*]) were observed. Ground disturbance from recreational use (AUZ1 only) and livestock and wildlife use (all sites) has not yet resulted in an influx of disturbance species. Only four disturbance species (mainly native plants) occur in trace amounts in the wetlands. Thus, existing land uses have not altered the native vegetation composition of these lentic riparian sites.

All wetland sites are providing valuable habitat to wildlife. Moose, deer and bear sign (tracks and scat) and minor browse use was observed in all sites. Browse use was highest in the AUX1 site, but this appears to be mainly from feral horse use. Cattle browse appears minimal in all sites (based on scat and track observations). Present levels of combined browse pressure from feral horses, wildlife and domestic livestock is not affecting recruitment of woody plants (i.e. there is good cover from seedling and sapling aged trees and shrubs).

Recent beaver sign (e.g. cut stems) was not observed in any of the wetlands. Woody vegetation removal from human activities was also not observed. However, **a combination of horse use (possibly feral horses) and livestock grazing pressure has contributed to significantly reducing herbaceous vegetation cover in 20% of the Aura Wetland (AUR3).** This loss of vegetation cover and consequent alteration of site vegetation reduced the vegetation health score of this site to *healthy, but with problems* (Table 27).

### ***C) Soil and Hydrology Health***

The two unnamed wetlands received *healthy* scores for all of the soil / hydrology health parameters evaluated, except for one slight deduction to the AUZ1 site (Table 27). These sites have no human-caused bare ground or physical structure alterations (e.g. soil compaction) from livestock use. In addition, no sign of recreational use was observed in the AUX1 site. A non-designated, all-terrain vehicle (quad) trail runs from the north end of the AUZ1 site through the center of the wetland. **This trail may pose a serious risk to the health of this site if it receives continued use or higher levels of use.** At present, slight soil compaction has resulted from the trail, but other than that, it does not appear to have caused rutting or bare ground exposure or influenced the vegetation composition of the site (e.g. through introduction of non-native species).

Aura wetland (AUR3) at the headwaters of Aura Creek is approximately 30% altered due to livestock grazing and horse use (possibly feral horses, or a combination of domestic horses and feral horses). Soil compaction along the east portion of the site and pugging and hummocking (deep imprints and raised mounds of soil caused by livestock and wildlife) on the south and west portions of the site have impaired some riparian functions of AUR3. Of particular concern is that 20% of this site has human-caused bare ground from livestock and horse use. Areas of bare ground are prone to weed infestations, erosion and increased run-off rates. High levels of bare ground also diminish wildlife habitat values such as important waterfowl nesting or brood rearing shelter and cover.

None of the wetlands have been subject to artificial water withdrawals or additions that would affect water levels.



C. Wood, RHIP03AUR003.

Sedge communities dominate the Aura wetland (AUR3) at the headwaters of Aura Creek. This portion of the wetland has not been altered by human activities.



C. Ball, RHIP01AUX004.

Part of the AUR3 wetland and 80% of the AUX1 wetland is comprised of a flat-leaved willow/water sedge Habitat Type as shown here.



C. Wood, RHIP01AUZ003.

A white spruce community with an understory of willows and bog birch is the dominant community type in the AUZ1 wetland and in 20% of the AUX1 wetland.



C. Wood, RHIP03AUR002.

Feral and / or domestic horse and livestock use is negatively impacting the health of the Aura wetland (AUR3). Trampling and grazing pressure has caused large areas of bare ground, as shown here, that are susceptible to weed infestation and erosion.

#### AURA CREEK WATERSHED – WETLANDS - REPRESENTATIVE PHOTOS

## 5 THE NEXT STEPS

This riparian health inventory project is intended to establish a necessary baseline for monitoring riparian areas in the Ghost River watershed and for focusing attention on riparian health issues. Follow-up monitoring of riparian health is recommended approximately five years after the first evaluation is completed. More frequent monitoring of ‘hotspot’ sites of concern may be warranted at the discretion of the GWAS and resource managers for the area.

Riparian health monitoring allows the GWAS to:

- **create awareness** and build a common understanding of riparian management issues in the Ghost River watershed;
- **take action** by assisting local decision-makers develop strategies to address riparian land use issues;
- **monitor progress** in improving, maintaining and protecting riparian health in the Ghost River watershed;
- **identify environmental risk** and integrate into watershed management planning;
- **develop and maintain riparian management plans** for improved long-term ecological health; and
- **establish benchmarks** of riparian health from which change over time can be measured.

This riparian health inventory project represents Phase One of an initiative to inventory riparian health within the entire Ghost River watershed. As discussed, additional riparian health inventories are planned in 2011 as part of Phase Two that will encompass the Ghost River and major tributaries to this river and associated wetlands.

Riparian health inventory of the Ghost River watershed (Phase 1 and 2) will aid the GWAS in watershed management planning. It is intended to compliment and inform con-current research and management planning initiatives in the watershed spearheaded by the GWAS. Two such initiatives are 1) the 2010 *Cumulative Effects Study of the Ghost Watershed* led by Cornel Yarmoloy and Dr. Brad Stelfox of the ALCES<sup>6</sup> Group; and 2) the *Ecosystem-Based Conservation Plan* project led by Herb Hammond of Silva Ecosystem Consultants. The intent of these studies is to better understand the cumulative impacts of multiple land uses on the structure, composition and function of the Ghost Watershed’s ecosystem. An ecosystem-based management plan for the Ghost River watershed is intended to identify thresholds and planning models that will allow multiple land uses to occur without jeopardizing sensitive ecosystem types or compromising vital ecosystem functions such as the protection of water quality within the headwaters region of the Bow River.

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<sup>6</sup> A Landscape Cumulative Effects Simulator



A major impetus for these projects and our study are the concerning findings of a 2006 water quality study of Waiparous Creek, Fallentimber Creek and the Ghost River commissioned by Alberta Environment (Andrews 2006). This study found that sediment loading coefficients in the lower regions of Waiparous Creek and the Ghost River were much greater than expected for rivers draining a forested environment in the Upper Foothills Natural Subregion. Sediment loads were considered abnormally high even in comparison to streams draining agricultural lands at lower elevations where sediment erosion is a common problem (Andrews 2006). High sediment loads are often associated with increases in nutrients, bacteria and certain metals that can have negative ecological effects downstream. Motorized recreational use is thought to be one of the main contributors to high sediment loads in the Waiparous basin (Andrews 2006). Streambank erosion from OHV tracks and at stream fording locations is of particular concern (Andrews 2006).

Riparian health is usually an indicator of water quality within a watershed. Our study findings show a high level of riparian health for the Waiparous Creek basin as a whole. Given degraded water quality and high sediment loads in Waiparous Creek (Andrews 2006), this suggests that although few in number, isolated areas of degraded riparian health, may have a significant impact on water quality. Degraded water quality may also indicate that land uses in the Waiparous Basin may be overtaxing the buffering ability of riparian areas, even those in a healthy condition. If the health and condition of adjacent uplands is degraded, erosion and loss of upland vegetation cover (e.g. logging) can overburden the ability of riparian areas to absorb and filter sediment from overland runoff. A Range Health Assessment Audit conducted by ASRD in 2007 (ASRD 2008) found a high number of upland sites in an *unhealthy* or *healthy, with problems* condition in the Ghost River Grazing Allotment. Degraded range health was attributed to a combination of factors including OHV use, overgrazing by livestock, feral horse use, and encroachment of non-native plant species. **Upland range health monitoring is therefore important to consider in conjunction with the findings of our study.**

Going forward, careful land use management in the Waiparous Creek basin is a priority, particularly within sensitive riparian ecosystems. Collaboration in the watershed management planning process between the GWAS, ASRD, industry and user groups in the area will be important to create a successful plan that is implemented at all levels.

***Suggested next steps:***

- **Monitor recreational/human activities and restrict OHV use in the riparian area**

The Ghost-Waiparous Operational Access Management Plan (GWOAMP) was developed and approved in 2005 in response to the increased use of OHVs and random camping in the area and conflicts with other users. Support, monitoring and enforcement of the GWOAMP should be provided by all jurisdictions and levels of government, industry and the public with

an interest in this area. Designated trails should be monitored periodically to ensure they are properly located and maintained. Trails should be relocated or closed where ecological impact is significant, such as on soft, eroding banks or steep slopes.

Seasonal closures / trail restrictions should be considered for tributary systems with fine textured organic soils. These types of trails and creek crossings should be closed during wet spring and summer months.

- **Riparian restoration and conservation projects:**

- **Collaboration.** Involve as many user groups as possible in riparian improvement projects. This encourages a sense of ownership of and responsibility for restoration projects and increases their likelihood of success. Other groups may have resources and volunteers that may not be available with a single group.
- **Restoration projects.** Allowing natural plant succession to occur on a site generally provides the most effective results. If conducting riparian planting or bioengineering projects, native and locally harvested species should be used that are best suited to the local soil type, moisture and micro-climate conditions of the restoration site (Cows and Fish no date, a and b). Approval from ASRD is needed to harvest native plant material in the Waiparous Creek watershed. Care should be taken not to damage donor plant sites and to limit harvest of an individual plant to less than one third of the total live stems emerging from one root system. Most plant materials are best collected during the dormant period (between September and March). Pioneering woody species such as willows that can propagate from branch cuttings are typically used in restoration projects (Polster 2003). Silverberry plantings and yellow mountain avens seed dispersion may be appropriate to use for restoration of shallow gravelly soils in the Waiparous Creek floodplain. The nitrogen fixing and rhizomatous / mat forming properties of these pioneering species will help to stabilize disturbed sites. Planting later successional species such as white spruce can be expensive and may not be successful at establishing initial vegetative cover. The desired end land use should be compatible with the type of plant communities being restored. Restoration sites must be adequately signed to inform users of temporary closures and the rationale for these closures.
- **Stream crossings.** Mapping and monitoring of existing stream crossings is recommended. Restrict OHV use within riparian areas to a few select crossing points to limit structural disturbances to streambanks and soil exposure. Stream crossing areas should be designated according to their suitability to stream system dynamics and ability to minimize ecological impact, especially in the highly beaver-modified tributaries to Waiparous Creek. They should not be designated based on where current crossings already exist. Appropriate, safe and approved bridge crossings should be installed at

forded crossings that are presently endangering aquatic life and causing sediment loading, riparian degradation and bank instability. **Before starting any bridge construction project that will occur within the high water mark of a stream, appropriate approvals and design guidelines need to be obtained from Alberta Environment and Fisheries and Oceans Canada (DFO).** Work with your local DFO representative to help determine the best structures to use for any bridges or stream crossings.

- **Monitor encroachment of disturbance-caused species**

One of the best techniques for limiting the expansion or encroachment of disturbance-caused species is to limit disturbance to riparian soils. Areas (other than appropriately designated trails) that have been subject to repeated disturbance often require complete rest from disturbance (a temporary or permanent closure of the area as outlined in GWOAMP 2005) in order to recover. As mentioned below in the stocking rate discussion, areas that have been disturbed repeatedly for long periods of time are unlikely to fully recover to native plants and non-native species such as Kentucky bluegrass may persist.

Many non-native disturbance-caused species are not tolerant of heavy shading. Therefore, encouraging thick tree and shrub cover will limit their expansion or establishment.

- **Maintain appropriate stocking rates**

Balance the number of animal units permitted on the allotment with the available forage (as directed by ASRD's Lands Division). ASRD uses information from range health inventories and audits, ecological classification of plant communities found in each allotment and mapping of ecological units to calculate grazing capacities for those communities and the overall allotment.

Within the Upper Foothills and Montane Natural Subregions, one of the best suited plant communities for grazing by livestock is the rough fescue (*Festuca campestris*) dominated grassland type. Historically, these grassland communities in the foothills of south-western Alberta have been burned and grazed by wild and domestic ungulates. Willoughby (2000) found that if left undisturbed, a rough fescue – hairy wildrye grassland in the Upper Foothills will eventually become dominated by coniferous forest. Protection from grazing and lack of fire allows these rough fescue dominated grasslands to be invaded by willow on the moister sites, and eventually conifer forests. This is also true of montane regions where the lack of fire also appears to allow trees to encroach onto the rough fescue dominated ecological site to form Douglas fir, lodgepole pine and aspen dominated community types (Willoughby and Alexander 2005). However, continued heavy grazing pressure leads to the decline in native species and there is an increase in Kentucky bluegrass. In southern Alberta Willoughby and



Alexander (2000) have found that rough fescue cover can recover in these Kentucky bluegrass dominated communities. It is likely that protection from grazing on the Kentucky bluegrass-Sedge dominated community type may eventually lead to a Rough fescue-Kentucky bluegrass dominated community. A balance of disturbance to the ecosystem, either through grazing, fire or both, and a sufficient amount of rest from these disturbances is necessary to maintain the ecological integrity and biodiversity of these natural landscapes. The area within each allotment that contains plant communities suitable for grazing by livestock should be periodically evaluated to factor in loss of forage productivity due to shrub and tree encroachment in to grasslands.

- **Improve livestock distribution.**

Improve livestock distribution by using strategic salt and mineral placement and low-stress livestock herding techniques. This will help provide riparian areas with adequate rest during the growing season. Efforts to change livestock use patterns would likely be most beneficial in the Meadow Creek basin, as evidenced by lower riparian health scores attributed to heavy livestock use, but pertain to improving livestock distribution in all areas. There are also several *unhealthy* and *healthy with problems* upland range health sites in the Meadow Creek Distribution Unit (ASRD 2008).

Low-stress herding in combination with mineral / supplement placement has been shown to be particularly successful in changing livestock behaviour patterns and reducing use of lowland riparian areas (Bailey *et al.* 2008). Salt and supplements should be placed a minimum of 400 m away from a stream, but preferably at least 800 m away (Kinch 1989). Salt generally works best early in the season when the moisture content of forage is high and lush forage stimulates a greater craving for salt (Smith 2007). Protein supplement is a more effective tool in late summer, fall and winter, when forage is mature and dry (Smith 2007).

Sensory cues such as wind chimes, flags, posts or pylons can be used to help animals find and remember locations with supplement or to lure them to underutilized rangeland areas (Launchbaugh and Howery 2005). But a more effective tool is to use herding to show cattle where supplements are located. Cattle can usually find subsequent supplement sites, so long as these sites are within 600 m of the previous site (Smith 2007). For herding to be most successful, low stress livestock handling techniques should be used. Some of the ways to reduce stress when moving cattle is to make sure cows and calves are paired up and to keep social groups together (BEHAVE n.d.). Another strategy is to time moves to coincide with the animal's regular routine. For example, it is best to move cattle to a new foraging site before they have fed; similarly, it is best to move them to new loafing areas soon after they have fed and watered. Persistent herding over a number of years may be needed to behaviourally bond animals to new parts of the rangeland. Case studies in Montana show that

it can take at least three years for “bottom-dweller” cows to adapt to using uplands (Cote 1999). Herding and supplementation programs can be more efficient if animals are preselected that are known to use upland sites more readily (e.g., younger animals). Another consideration is breed. Livestock breeds such as Tarentaise cattle, developed in rugged terrain in the French Alps, are better at more evenly grazing rugged rangelands than flatland Hereford breeds (Bailey 1999).

- **Monitor and control invasive plant species.**

Our study shows that the Waiparous basin is remarkably free of invasive species in riparian areas along Waiparous Creek and the Aura Wetlands. Only three noxious weeds (Canada thistle, perennial sow-thistle and tall buttercup) were found along tributaries to Waiparous Creek. It is important to keep the watershed weed free!

|                                                                                     |                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | <p>Most of the biomass of Canada thistle plants is below ground; therefore killing the roots is the only effective control method. An integrated management plan that uses a variety control options (pulling, mowing, chemical) is the only real chance of reducing infestations.</p> |
|  | <p>Mowing can prevent seed production, but the plant’s long flowering period would necessitate many cuts. Seedlings can be easily hand-pulled.</p>                                                                                                                                     |
|  | <p>Good pasture management will help prevent spread. Hand pulling can be effective on small infestations. Be sure to wear gloves and long sleeves as the plant’s juices can cause blistering and redness.</p>                                                                          |

Prevent weed introductions through education and awareness; conduct weed monitoring; and quickly respond to new weed occurrences. Residents in the Waiparous Village should be encouraged to control and avoid planting invasive ornamental species such as yellow clematis and ox-eye daisy (refer to the Alberta Invasive Plant Council website for more information). Community weed pull events are an effective way to bring the community together and tackle an environmental issue.

- **Monitor riparian health.**

To assess riparian health trend, we generally recommend that extensive riparian health inventories be repeated at least every five years by qualified professionals. Ongoing, yearly community-based monitoring of riparian health is also encouraged at ‘hotspot’ sites of concern. The field workbook *Riparian Health Assessment for Streams and Small Rivers* (Fitch *et al.* 2001) is available from Cows and Fish. This workbook explains how to conduct a rapid survey to quickly check the health status of your riparian area. Cows and Fish provides outdoor field workshops to community groups interested in learning how to apply this tool.

Photography monitoring is another way that community groups can participate in tracking changes in riparian health. Benchmark photographs were taken as part of our study at the upstream and downstream end points of each riparian health inventory site, and at other locations of interest within riparian health polygons. These benchmark photographs can be repeated yearly by community volunteers to track changes in riparian health especially at sites where impacts have occurred. The GWAS will be provided with digital copies of all of the monitoring photographs that were taken during this riparian health inventory project and UTM locations for these photographs. Other locations of concern not encompassed by our study can also be photographed for monitoring purposes, as warranted.

Consider community-based data collection of other watershed health parameters including aquatic invertebrates and water quality through programs such as DFO’s *Stream Keepers Program*.

## 6 CLOSING

To inquire about additional references for riparian health monitoring and management and for further information on any aspect of this report, please contact:

Amanda Halawell or Kathryn Hull, *Range/Riparian Specialists*  
Alberta Riparian Habitat Management Society – Cows and Fish  
Tel: (403) 275-4400 Fax: 274-0007  
Email: [abogen@cowsandfish.org](mailto:abogen@cowsandfish.org); [khull@cowsandfish.org](mailto:khull@cowsandfish.org)  
Website: [www.cowsandfish.org](http://www.cowsandfish.org)



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## APPENDIX A

### Glossary

**Canopy cover** – the ground area covered by vegetative growth. Different plant species can provide varying degrees of cover depending on their overall size and abundance. Total canopy cover can be greater than the area being studied due to overlap in plant structural layers.

**Community type** – an aggregation of all plant communities distinguished by floristic and structural similarities in both overstory and undergrowth layers. *“Community Types” defined by Thompson and Hansen (2003) represent interim or ‘seral’ plant communities that are replaced by another plant community or species as succession progresses.*

**Disturbance-caused undesirable herbaceous species** – native or introduced non-woody plant species that are well adapted to disturbance or an environment of continual stress. This term *does not* include invasive plant species.

**Floodplain** – the land base alongside a stream that has the potential to be flooded during high water events.

**Habitat Type** – as defined by Thompson and Hansen (2003) - the land area that supports, or has the potential to support, the same primary climax, or final state, plant communities that are self-perpetuating and in dynamic equilibrium with their environment.

**Human-caused bare ground** – areas devoid of vegetation as a result of human activity. This can include vehicle roads, recreational trails and livestock trampling.

**Invasive plant species** – plant species that are designated by the *Weed Control Act* of Alberta as *prohibited noxious* or *noxious* weeds, as well as some additional species (e.g. common caragana [*Caragana arborescens*]) identified by Cows and Fish and / or Public Lands (Alberta Sustainable Resource Development) to be invasive within riparian areas.

**Lotic** – this term means *flowing water* (i.e., streams and rivers).

**Lentic** – this term means *standing or still water* (i.e., lakes, ponds and sloughs).

**Pointbar** – areas along the stream edge where sediment has been naturally deposited by moving water. These typically occur on the inside portion of a channel bend. Also known as a *sandbar*.

**Polygon** – term used to describe a riparian inventory site. On lotic systems, a polygon has an upstream and downstream end along a reach of a stream and an associated riparian width. The lateral extent (width) of



the riparian area is subjectively determined in the field based on vegetation and terrain clues indicating the flood prone area.

**Reach** – section of a stream or river with similar physical and vegetative features and similar management influences.

**Stream channel incisement** – the degree of downward erosion within the channel bed.

**Structural alteration** – physical changes to the shape or contour of the streambank caused by human influences. Some examples are livestock crossings, culverts and ‘riprap’

**Tree and shrub regeneration** – the presence of seedlings and saplings, or the ‘new growth’.

**Watershed** - An area of land that catches precipitation and drains it to a specific point such as a marsh, lake, stream or river. A watershed, also called a basin, can be made up of a number of sub-watersheds that contribute to the overall drainage of the watershed.

**Woody plant species** – simply refers to trees and shrubs. These plants serve different riparian functions than grasses and broad-leaf plants.

## APPENDIX B

### Location Coordinates for the Upstream and Downstream Ends of the 2010 Riparian Health Inventory Sites

| Polygon (Site)<br>ID                                           | UTM<br>Zone | Upstream End |         | Downstream End |         |
|----------------------------------------------------------------|-------------|--------------|---------|----------------|---------|
|                                                                |             | Northing     | Easting | Northing       | Easting |
| Waiparous Creek (WAI)                                          |             |              |         |                |         |
| WAI1                                                           | 11U         | 636125       | 5696442 | 636828         | 5696448 |
| WAI2                                                           | 11U         | 633483       | 5695625 | 634247         | 5696325 |
| WAI3                                                           | 11U         | 637819       | 5695809 | 637838         | 5695125 |
| WAI4                                                           | 11U         | 638430       | 5694399 | 638975         | 5693578 |
| WAI5                                                           | 11U         | 630899       | 5695239 | 631626         | 5695051 |
| WAI6                                                           | 11U         | 623853       | 5694634 | 624481         | 5695014 |
| WAI7                                                           | 11U         | 627605       | 5694354 | 628160         | 5694708 |
| WAI8                                                           | 11U         | 639941       | 5692740 | 640336         | 5692247 |
| WAI9                                                           | 11U         | 650635       | 5683838 | 650625         | 5683508 |
| WAI10                                                          | 11U         | 646908       | 5685522 | 647901         | 5685532 |
| WAI11                                                          | 11U         | 648570       | 5685347 | 649048         | 5684818 |
| WAI12                                                          | 11U         | 643874       | 5688440 | 644263         | 5687874 |
| WAI13                                                          | 11U         | 642346       | 5691121 | 642612         | 5690396 |
| WAI14                                                          | 11U         | 644807       | 5687242 | 645385         | 5686934 |
| Unnamed Tributary to Waiparous Creek (WAZ)                     |             |              |         |                |         |
| WAZ1                                                           | 11U         | 633031       | 5696082 | 633294         | 5696572 |
| Johnson Creek (JON) and Unnamed Johnson Creek Tributary (JOX1) |             |              |         |                |         |
| JON1                                                           | 11U         | 631900       | 5694451 | 632363         | 5694767 |
| JON2                                                           | 11U         | 624437       | 5691383 | 624804         | 5690930 |
| JON3                                                           | 11U         | 628880       | 5693088 | 629247         | 5693437 |
| JON4                                                           | 11U         | 627841       | 5691931 | 627827         | 5692451 |
| JOX1                                                           | 11U         | 624378       | 5692614 | 624236         | 5691927 |
| Meadow Creek (MDW) and Unnamed Meadow Creek Tributary (MDX)    |             |              |         |                |         |
| MDW1                                                           | 11U         | 633275       | 5692060 | 633809         | 5692174 |
| MDW2                                                           | 11U         | 634718       | 5692377 | 635085         | 5692630 |
| MDW3                                                           | 11U         | 637011       | 5693537 | 637484         | 5693602 |
| MDW4                                                           | 11U         | 638223       | 5693426 | 638744         | 5693361 |
| MDX1                                                           | 11U         | 633966       | 5690338 | 634049         | 5690962 |

| Polygon (Site)<br>ID                                              | UTM<br>Zone | Upstream End |         | Downstream End |         |
|-------------------------------------------------------------------|-------------|--------------|---------|----------------|---------|
|                                                                   |             | Northing     | Easting | Northing       | Easting |
| Lost Knife Creek (LOK)                                            |             |              |         |                |         |
| LOK1                                                              | 11U         | 639492       | 5691571 | 639873         | 5692074 |
| LOK2                                                              | 11U         | 637232       | 5689885 | 637822         | 5690120 |
| LOK3                                                              | 11U         | 637769       | 5690813 | 638672         | 5691285 |
| Four Mile Creek (FOU)                                             |             |              |         |                |         |
| FOU1                                                              | 11U         | 641656       | 5690218 | 641972         | 5690478 |
| FOU2                                                              | 11U         | 640078       | 5689253 | 640458         | 5689452 |
| FOU3                                                              | 11U         | 639292       | 5688745 | 639596         | 5688954 |
| Aura Creek (AUR) and Unnamed Aura Creek Tributary (AUY)           |             |              |         |                |         |
| AUR1                                                              | 11U         | 643888       | 5689493 | 643828         | 5688997 |
| AUR2                                                              | 11U         | 644999       | 5690809 | 644860         | 5690594 |
| AUY1                                                              | 11U         | 644600       | 5691307 | 644618         | 5690953 |
| Aura Wetland (AUR3) and Unnamed Aura Watershed Wetlands (AUX,AUZ) |             |              |         |                |         |
| AUX1                                                              | 11U         | 643973       | 5690853 | 644224         | 5690635 |
| AUZ1                                                              | 11U         | 644693       | 5689663 | 644781         | 5689514 |
| AUR3                                                              | 11U         | 645283       | 5691387 | 645147         | 5691147 |



## **APPENDIX C**

### **Riparian Plant Species Inventory Tables (Waiparous Creek, Waiparous Creek Tributaries and Aura Basin Wetlands)**

## WAIPAROUS CREEK (n = 14)

| Life Form                                              | Plant Status <sup>1,2</sup> | Area<br>by<br>Species<br>(acres) | Area by<br>Species<br>(hectares) | Average<br>Canopy<br>Cover <sup>3</sup> | Constancy <sup>4</sup> |
|--------------------------------------------------------|-----------------------------|----------------------------------|----------------------------------|-----------------------------------------|------------------------|
| <b>TREES</b>                                           |                             |                                  |                                  |                                         |                        |
| aspen ( <i>Populus tremuloides</i> )                   | native                      | 1.67                             | 0.69                             | 1.94%                                   | 64.29%                 |
| balsam poplar ( <i>Populus balsamifera</i> )           | native                      | 3.59                             | 1.47                             | 2.78%                                   | 100.00%                |
| black spruce ( <i>Picea mariana</i> )                  | native                      | 0.10                             | 0.04                             | 0.50%                                   | 7.14%                  |
| lodgepole pine ( <i>Pinus contorta</i> )               | native                      | 0.61                             | 0.25                             | 0.71%                                   | 57.14%                 |
| white spruce ( <i>Picea glauca</i> )                   | Native                      | 71.55                            | 29.33                            | 55.44%                                  | 100.00%                |
| <b>SHRUBS</b>                                          |                             |                                  |                                  |                                         |                        |
| balsam willow ( <i>Salix pyrifolia</i> )               | native                      | 0.33                             | 0.14                             | 2.89%                                   | 14.29%                 |
| basket willow ( <i>Salix petiolaris</i> )              | native                      | 0.48                             | 0.20                             | 0.78%                                   | 50.00%                 |
| beaked willow ( <i>Salix bebbiana</i> )                | native                      | 1.97                             | 0.81                             | 2.16%                                   | 64.29%                 |
| bog birch ( <i>Betula glandulosa</i> )                 | native                      | 0.63                             | 0.26                             | 0.50%                                   | 85.71%                 |
| bunchberry ( <i>Cornus canadensis</i> )                | native                      | 0.03                             | 0.01                             | 0.50%                                   | 7.14%                  |
| Canada buffaloberry ( <i>Shepherdia canadensis</i> )   | native                      | 2.23                             | 0.92                             | 2.19%                                   | 85.71%                 |
| common bearberry ( <i>Arctostaphylos uva-ursi</i> )    | native                      | 9.86                             | 4.04                             | 7.64%                                   | 100.00%                |
| common wild rose ( <i>Rosa woodsii</i> )               | native                      | 0.56                             | 0.23                             | 1.20%                                   | 21.43%                 |
| creeping juniper ( <i>Juniperus horizontalis</i> )     | native                      | 4.96                             | 2.03                             | 4.10%                                   | 92.86%                 |
| Drummond's willow ( <i>Salix drummondiana</i> )        | native                      | 9.03                             | 3.70                             | 6.99%                                   | 100.00%                |
| dusky willow ( <i>Salix melanopsis</i> )               | native                      | 0.16                             | 0.07                             | 0.50%                                   | 35.71%                 |
| false mountain willow ( <i>Salix pseudomonticola</i> ) | native                      | 0.32                             | 0.13                             | 0.52%                                   | 64.29%                 |
| firm leaf willow ( <i>Salix pseudomyrsinites</i> )     | native                      | 2.31                             | 0.95                             | 2.06%                                   | 85.71%                 |
| flat-leaved willow ( <i>Salix planifolia</i> )         | native                      | 0.32                             | 0.13                             | 1.29%                                   | 35.71%                 |
| ground juniper ( <i>Juniperus communis</i> )           | native                      | 3.51                             | 1.44                             | 2.72%                                   | 100.00%                |
| hoary willow ( <i>Salix candida</i> )                  | native                      | 0.03                             | 0.01                             | 0.50%                                   | 7.14%                  |
| northern gooseberry ( <i>Ribes oxycanthoides</i> )     | native                      | 0.15                             | 0.06                             | 0.50%                                   | 21.43%                 |
| prickly rose ( <i>Rosa acicularis</i> )                | native                      | 1.37                             | 0.56                             | 1.92%                                   | 71.43%                 |
| red-osier dogwood ( <i>Cornus stolonifera</i> )        | native                      | 0.02                             | 0.01                             | 3.00%                                   | 7.14%                  |
| sandbar willow ( <i>Salix exigua</i> )                 | native                      | 0.06                             | 0.02                             | 0.50%                                   | 7.14%                  |
| Saskatoon ( <i>Amelanchier alnifolia</i> )             | native                      | 0.02                             | 0.01                             | 0.50%                                   | 14.29%                 |
| Scouler's willow ( <i>Salix scouleriana</i> )          | native                      | 0.33                             | 0.13                             | 3.00%                                   | 7.14%                  |
| short-capsuled willow ( <i>Salix brachycarpa</i> )     | native                      | 0.07                             | 0.03                             | 0.50%                                   | 7.14%                  |
| shrubby cinquefoil ( <i>Potentilla fruticosa</i> )     | native                      | 14.32                            | 5.87                             | 11.09%                                  | 100.00%                |
| Silverberry ( <i>Elaeagnus commutata</i> )             | native                      | 14.52                            | 5.95                             | 11.25%                                  | 100.00%                |
| smooth willow ( <i>Salix glauca</i> )                  | native                      | 3.94                             | 1.61                             | 3.33%                                   | 92.86%                 |
| Snowberry ( <i>Symphoricarpos albus</i> )              | native                      | 0.18                             | 0.07                             | 1.16%                                   | 28.57%                 |
| thorny buffaloberry ( <i>Shepherdia argentea</i> )     | native                      | 0.04                             | 0.02                             | 0.50%                                   | 7.14%                  |
| twinflor ( <i>Linnaea borealis</i> )                   | native                      | 0.04                             | 0.02                             | 0.50%                                   | 7.14%                  |

|                                                     |                              |       |      |        |        |
|-----------------------------------------------------|------------------------------|-------|------|--------|--------|
| twining honeysuckle ( <i>Lonicera dioica</i> )      | native                       | 0.06  | 0.03 | 0.50%  | 21.43% |
| velvet-fruited willow ( <i>Salix maccalliana</i> )  | native                       | 0.03  | 0.01 | 0.50%  | 7.14%  |
| water birch ( <i>Betula occidentalis</i> )          | native                       | 0.03  | 0.01 | 0.50%  | 7.14%  |
| wild red raspberry ( <i>Rubus idaeus</i> )          | native                       | 0.03  | 0.01 | 0.50%  | 14.29% |
| willow ( <i>Salix spp.</i> )                        | native                       | 0.00  | 0.00 | 0.00%  | 7.14%  |
| <b>yellow clematis (<i>Clematis tangutica</i>)*</b> | <b>introduced (invasive)</b> | 0.00  | 0.00 | 0.50%  | 7.14%  |
| yellow mountain avens ( <i>Dryas drummondii</i> )   | native                       | 21.50 | 8.82 | 17.27% | 85.71% |
| yellow willow ( <i>Salix lutea</i> )                | native                       | 0.11  | 0.04 | 0.50%  | 28.57% |

| GRASSES AND GRASS-LIKES                                           |                         |      |      |       |        |
|-------------------------------------------------------------------|-------------------------|------|------|-------|--------|
| alpine bluegrass ( <i>Poa alpina</i> )                            | native                  | 0.84 | 0.34 | 0.82% | 78.57% |
| alpine rush ( <i>Juncus alpinoarticulatus</i> )                   | native                  | 0.14 | 0.06 | 0.50% | 28.57% |
| beaked sedge / small bottle sedge ( <i>Carex utriculata</i> )     | native                  | 0.04 | 0.02 | 0.50% | 7.14%  |
| beautiful sedge ( <i>Carex concinna</i> )                         | native                  | 0.09 | 0.04 | 0.50% | 14.29% |
| Bluebunch wheat grass ( <i>Agropyron spicatum</i> )               | native                  | 0.15 | 0.06 | 0.50% | 14.29% |
| bluejoint ( <i>Calamagrostis canadensis</i> )                     | native                  | 1.06 | 0.43 | 1.02% | 78.57% |
| bristle-leaved sedge ( <i>Carex eburnea</i> )                     | native                  | 0.09 | 0.04 | 0.50% | 14.29% |
| brome grass ( <i>Bromus spp.</i> )                                | unknown                 | 0.04 | 0.02 | 0.50% | 7.14%  |
| brownish sedge ( <i>Carex brunnescens</i> )                       | native                  | 0.39 | 0.16 | 3.00% | 7.14%  |
| creeping spike-rush ( <i>Eleocharis palustris</i> )               | native                  | 0.34 | 0.14 | 3.00% | 7.14%  |
| few-flowered spike-rush ( <i>Eleocharis quinqueflora</i> )        | native                  | 0.04 | 0.02 | 0.50% | 7.14%  |
| field wood-rush ( <i>Luzula multiflora</i> )                      | native                  | 0.03 | 0.01 | 0.50% | 7.14%  |
| foothills rough fescue ( <i>Festuca campestris</i> )              | native                  | 0.03 | 0.01 | 0.50% | 7.14%  |
| fowl bluegrass ( <i>Poa palustris</i> )                           | native                  | 0.30 | 0.12 | 1.53% | 21.43% |
| golden sedge ( <i>Carex aurea</i> )                               | native                  | 0.41 | 0.17 | 0.50% | 64.29% |
| graminoid ( <i>Graminoid</i> )                                    | unknown                 | 0.04 | 0.01 | 0.50% | 7.14%  |
| hair-like sedge ( <i>Carex capillaris</i> )                       | native                  | 0.46 | 0.19 | 0.82% | 50.00% |
| hairy wild rye ( <i>Elymus innovatus</i> )                        | native                  | 6.50 | 2.66 | 5.95% | 92.86% |
| hay sedge ( <i>Carex siccata</i> )                                | native                  | 0.03 | 0.01 | 0.50% | 7.14%  |
| inland sedge ( <i>Carex interior</i> )                            | native                  | 0.03 | 0.01 | 0.50% | 7.14%  |
| Kentucky bluegrass ( <i>Poa pratensis</i> )                       | disturbance, introduced | 1.65 | 0.68 | 2.25% | 57.14% |
| mud rush ( <i>Juncus tracyi</i> )                                 | native                  | 0.02 | 0.01 | 0.50% | 7.14%  |
| narrow reed grass ( <i>Calamagrostis stricta</i> )                | native                  | 0.03 | 0.01 | 0.50% | 7.14%  |
| northern awnless brome ( <i>Bromus inermis ssp pumpellianus</i> ) | native                  | 0.27 | 0.11 | 2.03% | 21.43% |
| northern wheat grass ( <i>Agropyron dasystachyum</i> )            | native                  | 0.14 | 0.06 | 0.50% | 21.43% |
| Norway sedge ( <i>Carex norvegica</i> )                           | native                  | 0.06 | 0.02 | 0.50% | 7.14%  |
| purple oat grass ( <i>Schizachne purpurascens</i> )               | native                  | 1.33 | 0.55 | 7.31% | 14.29% |
| quack grass ( <i>Agropyron repens</i> )                           | disturbance, introduced | 0.23 | 0.09 | 0.90% | 21.43% |
| Raymond's sedge ( <i>Carex raymondii</i> )                        | native                  | 0.05 | 0.02 | 0.50% | 14.29% |
| red fescue ( <i>Festuca rubra</i> )**                             | native, introduced      | 0.47 | 0.19 | 0.78% | 57.14% |
| Richardson needle grass ( <i>Stipa richardsonii</i> )             | native                  | 0.03 | 0.01 | 0.50% | 7.14%  |
| Richardson's sedge ( <i>Carex richardsonii</i> )                  | native                  | 0.09 | 0.04 | 0.50% | 14.29% |
| Rocky Mountain fescue ( <i>Festuca saximontana</i> )              | native                  | 0.10 | 0.04 | 0.50% | 7.14%  |



|                                                                    |                         |      |      |       |         |
|--------------------------------------------------------------------|-------------------------|------|------|-------|---------|
| rush-like sedge ( <i>Carex scirpoidea</i> )                        | native                  | 6.84 | 2.80 | 5.08% | 107.14% |
| Sartwell's sedge ( <i>Carex sartwellii</i> )                       | native                  | 0.65 | 0.27 | 2.11% | 14.29%  |
| sedge ( <i>Carex spp.</i> )                                        | native                  | 0.31 | 0.13 | 1.21% | 21.43%  |
| slender wheat grass ( <i>Agropyron trachycaulum</i> )              | native                  | 0.03 | 0.01 | 0.50% | 14.29%  |
| small-winged sedge ( <i>Carex microptera</i> )                     | native                  | 0.07 | 0.03 | 0.50% | 14.29%  |
| smooth brome ( <i>Bromus inermis</i> )                             | disturbance, introduced | 1.79 | 0.73 | 1.39% | 100.00% |
| spike trisetum ( <i>Trisetum spicatum</i> )                        | native                  | 0.07 | 0.03 | 0.50% | 14.29%  |
| sweet grass ( <i>Hierochloe odorata</i> )                          | native                  | 0.04 | 0.02 | 0.50% | 14.29%  |
| tall cotton grass ( <i>Eriophorum polystachion</i> )               | native                  | 0.09 | 0.04 | 0.50% | 7.14%   |
| thread-leaved sedge ( <i>Carex filifolia</i> )                     | native                  | 0.03 | 0.01 | 0.50% | 7.14%   |
| timothy ( <i>Phleum pratense</i> )                                 | disturbance, introduced | 0.05 | 0.02 | 0.50% | 21.43%  |
| tufted hair grass ( <i>Deschampsia cespitosa</i> )                 | native                  | 4.09 | 1.68 | 3.17% | 100.00% |
| water sedge ( <i>Carex aquatilis</i> )                             | native                  | 3.49 | 1.43 | 5.63% | 50.00%  |
| wheat grass ( <i>Agropyron spp.</i> )                              | unknown                 | 0.02 | 0.01 | 0.50% | 7.14%   |
| white-grained mountain rice grass ( <i>Oryzopsis asperifolia</i> ) | native                  | 0.54 | 0.22 | 1.25% | 28.57%  |
| wire rush ( <i>Juncus balticus</i> )                               | native                  | 1.09 | 0.45 | 1.51% | 71.43%  |
| wood-rush ( <i>Luzula spp.</i> )                                   | native                  | 0.09 | 0.04 | 0.50% | 7.14%   |

|                                                         |                         |      |      |       |         |
|---------------------------------------------------------|-------------------------|------|------|-------|---------|
| <b>FORBS</b>                                            |                         |      |      |       |         |
| alfalfa ( <i>Medicago sativa</i> )                      | introduced              | 0.02 | 0.01 | 0.50% | 7.14%   |
| alpine aster ( <i>Aster alpinus</i> )                   | native                  | 0.03 | 0.01 | 0.50% | 7.14%   |
| alpine bistort ( <i>Polygonum viviparum</i> )           | native                  | 0.40 | 0.17 | 0.50% | 64.29%  |
| alpine hedysarum ( <i>Hedysarum alpinum</i> )           | native                  | 1.84 | 0.75 | 5.64% | 42.86%  |
| alpine locoweed ( <i>Oxytropis cusickii</i> )           | native, poisonous       | 1.36 | 0.56 | 2.29% | 35.71%  |
| alpine milk vetch ( <i>Astragalus alpinus</i> )         | native                  | 0.00 | 0.00 | 0.50% | 7.14%   |
| alsike clover ( <i>Trifolium hybridum</i> )             | disturbance, introduced | 0.10 | 0.04 | 0.50% | 14.29%  |
| anemone ( <i>Anemone spp.</i> )                         | native                  | 0.04 | 0.01 | 0.50% | 7.14%   |
| Arctic aster ( <i>Aster sibiricus</i> )                 | native                  | 0.03 | 0.01 | 0.50% | 7.14%   |
| aster ( <i>Aster spp.</i> )                             | native                  | 0.02 | 0.01 | 0.50% | 7.14%   |
| balsam groundsel ( <i>Senecio pauperculus</i> )         | native                  | 0.04 | 0.02 | 0.50% | 14.29%  |
| biennial sagewort ( <i>Artemisia biennis</i> )          | native                  | 0.06 | 0.02 | 0.50% | 7.14%   |
| broad-leaved fireweed ( <i>Epilobium latifolium</i> )   | native                  | 0.64 | 0.26 | 0.50% | 92.86%  |
| Canada goldenrod ( <i>Solidago canadensis</i> )         | native                  | 0.11 | 0.05 | 0.90% | 21.43%  |
| columbine ( <i>Aquilegia spp.</i> )                     | native                  | 0.00 | 0.00 | 0.50% | 7.14%   |
| common blue-eyed grass ( <i>Sisyrinchium montanum</i> ) | native                  | 0.15 | 0.06 | 0.50% | 21.43%  |
| common butterwort ( <i>Pinguicula vulgaris</i> )        | native                  | 0.45 | 0.18 | 0.50% | 64.29%  |
| common dandelion ( <i>Taraxacum officinale</i> )        | disturbance, introduced | 0.99 | 0.40 | 0.76% | 100.00% |
| common fireweed ( <i>Epilobium angustifolium</i> )      | native                  | 0.26 | 0.10 | 0.50% | 50.00%  |
| common horsetail ( <i>Equisetum arvense</i> )           | native, poisonous       | 0.33 | 0.13 | 0.59% | 64.29%  |
| common pink wintergreen ( <i>Pyrola asarifolia</i> )    | native                  | 0.13 | 0.05 | 0.50% | 35.71%  |
| common plantain ( <i>Plantago major</i> )               | disturbance, introduced | 0.05 | 0.02 | 0.50% | 7.14%   |
| common red paintbrush ( <i>Castilleja miniata</i> )     | native                  | 0.09 | 0.04 | 0.50% | 21.43%  |

|                                                             |                     |      |      |       |        |
|-------------------------------------------------------------|---------------------|------|------|-------|--------|
| common scouring-rush ( <i>Equisetum hyemale</i> )           | native              | 0.16 | 0.07 | 0.54% | 35.71% |
| common yarrow ( <i>Achillea millefolium</i> )               | native              | 0.59 | 0.24 | 0.50% | 92.86% |
| cow parsnip ( <i>Heracleum lanatum</i> )                    | native              | 0.06 | 0.02 | 0.50% | 7.14%  |
| cream-colored vetchling ( <i>Lathyrus ochroleucus</i> )     | native              | 0.07 | 0.03 | 0.50% | 21.43% |
| cut-leaved anemone ( <i>Anemone multifida</i> )             | native              | 0.31 | 0.13 | 0.50% | 50.00% |
| cut-leaved ragwort ( <i>Senecio eremophilus</i> )           | native              | 0.05 | 0.02 | 0.50% | 7.14%  |
| draba ( <i>Draba spp.</i> )                                 | native              | 0.18 | 0.07 | 0.50% | 14.29% |
| dwarf Canadian primrose ( <i>Primula mistassinica</i> )     | native              | 0.10 | 0.04 | 0.50% | 7.14%  |
| elephant's-head ( <i>Pedicularis groenlandica</i> )         | native              | 0.54 | 0.22 | 0.50% | 71.43% |
| entire-leaved groundsel ( <i>Senecio integerrimus</i> )     | native              | 0.07 | 0.03 | 0.50% | 14.29% |
| few-flowered milk vetch ( <i>Astragalus vexilliflexus</i> ) | native              | 0.15 | 0.06 | 0.50% | 28.57% |
| few-flowered ragwort ( <i>Senecio pauciflorus</i> )         | native              | 0.11 | 0.04 | 0.50% | 14.29% |
| field mouse-ear chickweed ( <i>Cerastium arvense</i> )      | disturbance, native | 0.05 | 0.02 | 0.50% | 7.14%  |
| golden fleabane ( <i>Erigeron aureus</i> )                  | native              | 0.03 | 0.01 | 0.50% | 7.14%  |
| golden whitlow-grass ( <i>Draba aurea</i> )                 | native              | 0.08 | 0.03 | 0.50% | 7.14%  |
| graceful cinquefoil ( <i>Potentilla gracilis</i> )          | native              | 0.07 | 0.03 | 0.50% | 14.29% |
| green alpine sandwort ( <i>Minuartia austromontana</i> )    | native              | 0.05 | 0.02 | 0.50% | 7.14%  |
| greenish-flowered wintergreen ( <i>Pyrola chlorantha</i> )  | native              | 0.04 | 0.02 | 0.50% | 7.14%  |
| hairy rock cress ( <i>Arabis hirsuta</i> )                  | native              | 0.01 | 0.01 | 0.50% | 7.14%  |
| harebell ( <i>Campanula rotundifolia</i> )                  | native              | 0.07 | 0.03 | 0.50% | 14.29% |
| heart-leaved Alexanders ( <i>Zizia aptera</i> )             | native              | 0.39 | 0.16 | 0.50% | 71.43% |
| horsetail ( <i>Equisetum spp.</i> )                         | native              | 0.06 | 0.02 | 0.50% | 7.14%  |
| Indian milk vetch ( <i>Astragalus aboriginum</i> )          | native              | 0.02 | 0.01 | 0.50% | 7.14%  |
| inflated oxytrope ( <i>Oxytropis podocarpa</i> )            | native              | 0.03 | 0.01 | 0.50% | 7.14%  |
| lance-leaved paintbrush ( <i>Castilleja occidentalis</i> )  | native              | 0.52 | 0.21 | 0.50% | 57.14% |
| late yellow locoweed ( <i>Oxytropis monticola</i> )         | native, poisonous   | 0.84 | 0.34 | 1.69% | 57.14% |
| leafy-bracted aster ( <i>Aster subspicatus</i> )            | native              | 0.00 | 0.00 | 0.50% | 7.14%  |
| locoweed ( <i>Oxytropis spp.</i> )                          | native, poisonous   | 0.05 | 0.02 | 0.50% | 7.14%  |
| long-fruited anemone ( <i>Anemone cylindrica</i> )          | native              | 0.26 | 0.10 | 0.50% | 42.86% |
| long-leaved chickweed ( <i>Stellaria longifolia</i> )       | native              | 0.08 | 0.03 | 0.50% | 7.14%  |
| loose-flowered milk vetch ( <i>Astragalus tenellus</i> )    | native              | 0.03 | 0.01 | 0.50% | 7.14%  |
| low goldenrod ( <i>Solidago missouriensis</i> )             | native              | 0.36 | 0.15 | 0.50% | 42.86% |
| lyre-leaved rock cress ( <i>Arabis lyrata</i> )             | native              | 0.00 | 0.00 | 0.50% | 7.14%  |
| marsh horsetail ( <i>Equisetum palustre</i> )               | native              | 0.04 | 0.02 | 0.50% | 7.14%  |
| marsh yellow cress ( <i>Rorippa palustris</i> )             | native              | 0.00 | 0.00 | 0.50% | 7.14%  |
| meadow horsetail ( <i>Equisetum pratense</i> )              | native              | 0.07 | 0.03 | 0.50% | 7.14%  |
| mealy primrose ( <i>Primula incana</i> )                    | native              | 0.10 | 0.04 | 0.50% | 7.14%  |

|                                                                |                         |      |      |       |        |
|----------------------------------------------------------------|-------------------------|------|------|-------|--------|
| Michaux's sagewort ( <i>Artemisia michauxiana</i> )            | native                  | 0.07 | 0.03 | 0.50% | 7.14%  |
| milk vetch ( <i>Astragalus spp.</i> )                          | native                  | 0.12 | 0.05 | 0.50% | 21.43% |
| mountain goldenrod ( <i>Solidago spathulata</i> )              | native                  | 0.07 | 0.03 | 0.50% | 14.29% |
| mountain shooting star ( <i>Dodecatheon conjugens</i> )        | native                  | 0.07 | 0.03 | 0.50% | 14.29% |
| narrow-leaved dock ( <i>Rumex triangulivalvis</i> )            | native                  | 0.02 | 0.01 | 0.50% | 7.14%  |
| narrow-leaved hawkweed ( <i>Hieracium umbellatum</i> )         | native                  | 0.09 | 0.04 | 0.50% | 21.43% |
| narrow-leaved milk vetch ( <i>Astragalus pectinatus</i> )      | native                  | 0.02 | 0.01 | 0.50% | 7.14%  |
| northern bedstraw ( <i>Galium boreale</i> )                    | native                  | 0.36 | 0.15 | 0.50% | 71.43% |
| northern grass-of-parnassus ( <i>Parnassia palustris</i> )     | native                  | 0.07 | 0.03 | 0.50% | 21.43% |
| northern green bog orchid ( <i>Habenaria hyperborea</i> )      | native                  | 0.49 | 0.20 | 0.50% | 78.57% |
| northern hedysarum ( <i>Hedysarum boreale</i> )                | native                  | 1.48 | 0.61 | 1.29% | 78.57% |
| one-sided wintergreen ( <i>Orthilia secunda</i> )              | native                  | 0.07 | 0.03 | 0.50% | 14.29% |
| pale coralroot ( <i>Corallorhiza trifida</i> )                 | native                  | 0.04 | 0.02 | 0.50% | 14.29% |
| palmate-leaved coltsfoot ( <i>Petasites palmatus</i> )         | native                  | 0.11 | 0.05 | 0.50% | 21.43% |
| plains wormwood ( <i>Artemisia campestris</i> )                | native                  | 0.08 | 0.03 | 0.50% | 14.29% |
| prairie groundsel ( <i>Senecio canus</i> )                     | native                  | 0.08 | 0.03 | 0.50% | 7.14%  |
| purple avens ( <i>Geum rivale</i> )                            | native                  | 0.04 | 0.02 | 0.50% | 7.14%  |
| purple milk vetch ( <i>Astragalus dasyglottis</i> )            | native                  | 0.36 | 0.15 | 0.50% | 42.86% |
| purple peavine ( <i>Lathyrus venosus</i> )                     | native                  | 0.02 | 0.01 | 0.50% | 7.14%  |
| purple-stemmed aster ( <i>Aster puniceus</i> )                 | native                  | 0.04 | 0.01 | 0.50% | 21.43% |
| red clover ( <i>Trifolium pratense</i> )                       | disturbance, introduced | 0.07 | 0.03 | 0.50% | 21.43% |
| reflexed locoweed ( <i>Oxytropis deflexa</i> )                 | native, poisonous       | 0.11 | 0.04 | 0.50% | 28.57% |
| rough cinquefoil ( <i>Potentilla norvegica</i> )               | disturbance, native     | 0.00 | 0.00 | 0.50% | 7.14%  |
| round-leaved orchid ( <i>Orchis rotundifolia</i> )             | native                  | 0.19 | 0.08 | 0.50% | 28.57% |
| saline shooting star ( <i>Dodecatheon pulchellum</i> )         | native                  | 0.45 | 0.19 | 0.50% | 57.14% |
| senecio ( <i>Senecio spp.</i> )                                | native                  | 0.08 | 0.03 | 0.50% | 14.29% |
| shining arnica ( <i>Arnica fulgens</i> )                       | native                  | 0.02 | 0.01 | 0.50% | 14.29% |
| showy everlasting ( <i>Antennaria pulcherrima</i> )            | disturbance, native     | 1.86 | 0.76 | 1.67% | 78.57% |
| showy locoweed ( <i>Oxytropis splendens</i> )                  | native, poisonous       | 0.18 | 0.07 | 0.50% | 28.57% |
| slender arrow-grass ( <i>Triglochin palustris</i> )            | native, poisonous       | 0.09 | 0.04 | 0.50% | 7.14%  |
| small wood anemone ( <i>Anemone parviflora</i> )               | native                  | 0.61 | 0.25 | 0.50% | 92.86% |
| small-leaved everlasting ( <i>Antennaria parvifolia</i> )      | disturbance, native     | 0.21 | 0.08 | 0.50% | 28.57% |
| smooth aster ( <i>Aster laevis</i> )                           | native                  | 0.67 | 0.27 | 0.71% | 78.57% |
| smooth fleabane ( <i>Erigeron glabellus</i> )                  | native                  | 0.04 | 0.02 | 0.50% | 14.29% |
| sparrow's-egg lady's-slipper ( <i>Cypripedium passerinum</i> ) | native                  | 0.19 | 0.08 | 0.50% | 35.71% |
| spear-leaved arnica ( <i>Arnica lonchophylla</i> )             | native                  | 0.03 | 0.01 | 0.50% | 7.14%  |
| star-flowered Solomon's-seal ( <i>Smilacina stellata</i> )     | native                  | 0.91 | 0.37 | 0.96% | 78.57% |

|                                                           |                                |      |      |       |         |
|-----------------------------------------------------------|--------------------------------|------|------|-------|---------|
| sticky false asphodel ( <i>Tofieldia glutinosa</i> )      | native                         | 1.03 | 0.42 | 0.94% | 78.57%  |
| sweet-flowered androsace ( <i>Androsace chamaejasme</i> ) | native                         | 0.62 | 0.26 | 0.50% | 85.71%  |
| tall lungwort ( <i>Mertensia paniculata</i> )             | native                         | 0.28 | 0.11 | 0.52% | 50.00%  |
| tufted fleabane ( <i>Erigeron caespitosus</i> )           | native                         | 0.02 | 0.01 | 0.50% | 7.14%   |
| variegated horsetail ( <i>Equisetum variegatum</i> )      | native                         | 1.61 | 0.66 | 2.00% | 71.43%  |
| veiny meadow rue ( <i>Thalictrum venulosum</i> )          | native                         | 0.05 | 0.02 | 0.50% | 14.29%  |
| vine-leaved coltsfoot ( <i>Petasites vitifolius</i> )     | native                         | 0.04 | 0.02 | 0.50% | 7.14%   |
| viscid locoweed ( <i>Oxytropis viscida</i> )              | native                         | 0.02 | 0.01 | 3.00% | 7.14%   |
| wandering daisy ( <i>Erigeron peregrinus</i> )            | native                         | 0.07 | 0.03 | 0.50% | 7.14%   |
| water smartweed ( <i>Polygonum amphibium</i> )            | native                         | 0.07 | 0.03 | 0.50% | 7.14%   |
| western sea-blite ( <i>Suaeda calceoliformis</i> )        | native                         | 0.04 | 0.02 | 0.50% | 7.14%   |
| western wood lily ( <i>Lilium philadelphicum</i> )        | native                         | 0.03 | 0.01 | 0.50% | 7.14%   |
| white camas ( <i>Zigadenus elegans</i> )                  | native, <i>poisonous</i>       | 1.32 | 0.54 | 1.18% | 85.71%  |
| white clover ( <i>Trifolium repens</i> )                  | <i>disturbance, introduced</i> | 0.07 | 0.03 | 0.50% | 21.43%  |
| wild blue flax ( <i>Linum lewisii</i> )                   | native                         | 0.02 | 0.01 | 0.50% | 7.14%   |
| wild chives ( <i>Allium schoenoprasum</i> )               | native                         | 0.12 | 0.05 | 0.50% | 14.29%  |
| wild licorice ( <i>Glycyrrhiza lepidota</i> )             | native                         | 0.08 | 0.03 | 0.50% | 21.43%  |
| wild strawberry ( <i>Fragaria virginiana</i> )            | <i>disturbance, native</i>     | 2.13 | 0.87 | 1.65% | 100.00% |
| wild vetch ( <i>Vicia americana</i> )                     | native                         | 0.09 | 0.04 | 0.50% | 35.71%  |
| woolly fleabane ( <i>Erigeron lanatus</i> )               | native                         | 0.08 | 0.03 | 0.50% | 7.14%   |
| wormseed mustard ( <i>Erysimum cheiranthoides</i> )       | <i>disturbance, introduced</i> | 0.01 | 0.01 | 0.50% | 7.14%   |
| yellow false dandelion ( <i>Agoseris glauca</i> )         | native                         | 0.11 | 0.04 | 0.50% | 28.57%  |
| yellow hedysarum ( <i>Hedysarum sulphurescens</i> )       | native                         | 2.65 | 1.09 | 2.27% | 71.43%  |
| yellow lady's-slipper ( <i>Cypripedium calceolus</i> )    | native                         | 0.13 | 0.05 | 0.50% | 35.71%  |

\* **Yellow clematis has been uplisted to a “noxious weed” on the 2010 revised *Weed Control Act*.**

\*\* Introduced and native strains of red fescue (*Festuca rubra*) occur in the project area.

<sup>1</sup> Our primary resource for plant species naming is Flora of Alberta by E.H. Moss (1994); for species not listed in Moss (1994), taxonomy follows the Integrated Taxonomic Information System (<http://www.itis.gov/>).

<sup>2</sup> Plant status is designated by Cows and Fish in association with Alberta Sustainable Resource Development (Public Lands), Alberta Agriculture, Food and Rural Development and the Alberta *Weed Control Act*. 'unknown' = plant not identified to species; plant status unknown.

<sup>3</sup> Based on visual estimates of the amount of ground the canopy of the plant covers. The percent cover values presented are the mid-values for the following ranges: 0.5=less than 1%; 3.0=1%-5%; 10.0=5%-15%; 20.0=15%-25%; 30.0=25%-35%; 40.0=35%-45%; 50.0=45%-55%; 60.0=55%-65%; 70.0=65%-75%; 80.0=75%-85%; 90.0=85%-95%; 97.5=greater than 95%; — = not observed.

<sup>4</sup> Constancy is the number of times the species occurs divided by the total number of Riparian Health Inventory Sites.



## WAIPAROUS CREEK TRIBUTARIES

(Johnson Creek [n=4], Johnson Creek tributary [n=1], Meadow Creek [n=4], Meadow Creek tributary [n=1], Lost Knife Creek [n=3], Four Mile Creek [n=3], Aura Creek [n=3], unnamed tributary to Waiparous Creek [n=1])

| Life Form                                              | Plant Status <sup>1,2</sup> | Area by Species (acres) | Area by Species (hectares) | Average Canopy Cover <sup>3</sup> | Constancy <sup>4</sup> |
|--------------------------------------------------------|-----------------------------|-------------------------|----------------------------|-----------------------------------|------------------------|
| <b>TREES</b>                                           |                             |                         |                            |                                   |                        |
| aspen ( <i>Populus tremuloides</i> )                   | native                      | 0.42                    | 0.17                       | 0.64%                             | 50.00%                 |
| balsam fir ( <i>Abies balsamea</i> )                   | native                      | 0.05                    | 0.02                       | 0.50%                             | 5.00%                  |
| balsam poplar ( <i>Populus balsamifera</i> )           | native                      | 1.13                    | 0.46                       | 0.84%                             | 65.00%                 |
| black spruce ( <i>Picea mariana</i> )                  | native                      | 0.30                    | 0.12                       | 3.00%                             | 5.00%                  |
| lodgepole pine ( <i>Pinus contorta</i> )               | native                      | 1.92                    | 0.79                       | 1.41%                             | 60.00%                 |
| white spruce ( <i>Picea glauca</i> )                   | native                      | 28.03                   | 11.49                      | 15.80%                            | 90.00%                 |
| <b>SHRUBS</b>                                          |                             |                         |                            |                                   |                        |
| autumn willow ( <i>Salix serissima</i> )               | native                      | 0.09                    | 0.04                       | 0.50%                             | 5.00%                  |
| balsam willow ( <i>Salix pyrifolia</i> )               | native                      | 1.02                    | 0.42                       | 1.23%                             | 30.00%                 |
| basket willow ( <i>Salix petiolaris</i> )              | native                      | 5.02                    | 2.06                       | 2.70%                             | 85.00%                 |
| beaked willow ( <i>Salix bebbiana</i> )                | native                      | 4.07                    | 1.67                       | 2.68%                             | 60.00%                 |
| bog birch ( <i>Betula glandulosa</i> )                 | native                      | 15.77                   | 6.46                       | 7.97%                             | 90.00%                 |
| Canada buffaloberry ( <i>Shepherdia canadensis</i> )   | native                      | 0.65                    | 0.27                       | 1.30%                             | 55.00%                 |
| choke cherry ( <i>Prunus virginiana</i> )              | native                      | 0.01                    | 0.00                       | 0.50%                             | 5.00%                  |
| common bearberry ( <i>Arctostaphylos uva-ursi</i> )    | native                      | 2.52                    | 1.03                       | 3.77%                             | 60.00%                 |
| creeping juniper ( <i>Juniperus horizontalis</i> )     | native                      | 1.41                    | 0.58                       | 2.20%                             | 35.00%                 |
| Drummond's willow ( <i>Salix drummondiana</i> )        | native                      | 3.94                    | 1.61                       | 2.56%                             | 60.00%                 |
| dusky willow ( <i>Salix melanopsis</i> )               | native                      | 0.17                    | 0.07                       | 0.50%                             | 15.00%                 |
| dwarf raspberry ( <i>Rubus arcticus</i> )              | native                      | 1.72                    | 0.71                       | 0.89%                             | 65.00%                 |
| false mountain willow ( <i>Salix pseudomonticola</i> ) | native                      | 2.27                    | 0.93                       | 1.34%                             | 60.00%                 |
| firm leaf willow ( <i>Salix pseudomyrsinites</i> )     | native                      | 26.32                   | 10.79                      | 11.77%                            | 100.00%                |
| flat-leaved willow ( <i>Salix planifolia</i> )         | native                      | 53.63                   | 21.99                      | 23.98%                            | 100.00%                |
| ground juniper ( <i>Juniperus communis</i> )           | native                      | 0.19                    | 0.08                       | 0.50%                             | 35.00%                 |
| myrtle-leaved willow ( <i>Salix myrtillofolia</i> )    | native                      | 0.09                    | 0.04                       | 0.50%                             | 5.00%                  |
| northern gooseberry ( <i>Ribes oxycanthoides</i> )     | native                      | 0.68                    | 0.28                       | 0.50%                             | 45.00%                 |
| prickly rose ( <i>Rosa acicularis</i> )                | native                      | 0.70                    | 0.29                       | 0.77%                             | 55.00%                 |
| sandbar willow ( <i>Salix exigua</i> )                 | native                      | 0.12                    | 0.05                       | 0.50%                             | 5.00%                  |
| Scouler's willow ( <i>Salix scouleriana</i> )          | native                      | 0.05                    | 0.02                       | 0.50%                             | 5.00%                  |
| shrubby cinquefoil ( <i>Potentilla fruticosa</i> )     | native                      | 13.44                   | 5.51                       | 6.04%                             | 95.00%                 |
| Silverberry ( <i>Elaeagnus commutata</i> )             | native                      | 0.12                    | 0.05                       | 0.75%                             | 20.00%                 |
| skunk currant ( <i>Ribes glandulosum</i> )             | native                      | 0.05                    | 0.02                       | 0.50%                             | 10.00%                 |
| smooth willow ( <i>Salix glauca</i> )                  | native                      | 22.88                   | 9.38                       | 12.58%                            | 90.00%                 |
| snowberry ( <i>Symphoricarpos albus</i> )              | native                      | 0.02                    | 0.01                       | 0.50%                             | 15.00%                 |

|                                                    |        |      |      |        |        |
|----------------------------------------------------|--------|------|------|--------|--------|
| velvet-fruited willow ( <i>Salix maccalliana</i> ) | native | 0.06 | 0.02 | 0.50%  | 10.00% |
| water birch ( <i>Betula occidentalis</i> )         | native | 2.43 | 1.00 | 10.00% | 5.00%  |
| white mountain avens ( <i>Dryas octopetala</i> )   | native | 0.31 | 0.13 | 3.00%  | 5.00%  |
| wild red raspberry ( <i>Rubus idaeus</i> )         | native | 0.10 | 0.04 | 0.50%  | 10.00% |
| yellow mountain avens ( <i>Dryas drummondii</i> )  | native | 0.08 | 0.03 | 0.50%  | 10.00% |

| GRASSES AND GRASS-LIKES                                           |                         |       |      |        |        |
|-------------------------------------------------------------------|-------------------------|-------|------|--------|--------|
| alpine bluegrass ( <i>Poa alpina</i> )                            | native                  | 0.27  | 0.11 | 0.50%  | 25.00% |
| alpine rush ( <i>Juncus alpinoarticulatus</i> )                   | native                  | 0.01  | 0.00 | 0.50%  | 5.00%  |
| Altai wild rye ( <i>Leymus angustus</i> )                         |                         | 0.00  | 0.00 | 0.50%  | 5.00%  |
| annual bluegrass ( <i>Poa annua</i> )                             | introduced              | 0.09  | 0.04 | 0.50%  | 5.00%  |
| awned sedge ( <i>Carex atherodes</i> )                            | native                  | 0.00  | 0.00 | 0.50%  | 5.00%  |
| beaked sedge / small bottle sedge ( <i>Carex utriculata</i> )     | native                  | 17.28 | 7.09 | 9.12%  | 65.00% |
| beautiful sedge ( <i>Carex concinna</i> )                         | native                  | 0.05  | 0.02 | 0.50%  | 5.00%  |
| bluejoint ( <i>Calamagrostis canadensis</i> )                     | native                  | 2.42  | 0.99 | 1.45%  | 65.00% |
| bristle-leaved sedge ( <i>Carex eburnea</i> )                     | native                  | 0.01  | 0.00 | 0.50%  | 5.00%  |
| common tall manna grass ( <i>Glyceria grandis</i> )               | native                  | 11.84 | 4.86 | 30.00% | 5.00%  |
| creeping spike-rush ( <i>Eleocharis palustris</i> )               | native                  | 0.29  | 0.12 | 0.50%  | 15.00% |
| fescue ( <i>Festuca spp.</i> )                                    | unknown                 | 0.03  | 0.01 | 0.50%  | 5.00%  |
| field wood-rush ( <i>Luzula multiflora</i> )                      | native                  | 0.07  | 0.03 | 0.50%  | 15.00% |
| foothills rough fescue ( <i>Festuca campestris</i> )              | native                  | 0.09  | 0.04 | 0.50%  | 5.00%  |
| fowl bluegrass ( <i>Poa palustris</i> )                           | native                  | 1.01  | 0.41 | 1.19%  | 30.00% |
| fowl manna grass ( <i>Glyceria striata</i> )                      | native                  | 1.02  | 0.42 | 2.08%  | 35.00% |
| golden sedge ( <i>Carex aurea</i> )                               | native                  | 0.56  | 0.23 | 0.50%  | 35.00% |
| graceful sedge ( <i>Carex praegracilis</i> )                      | native                  | 0.14  | 0.06 | 0.50%  | 15.00% |
| hair-like sedge ( <i>Carex capillaris</i> )                       | native                  | 0.24  | 0.10 | 0.50%  | 30.00% |
| hairy wild rye ( <i>Elymus innovatus</i> )                        | native                  | 0.71  | 0.29 | 1.17%  | 40.00% |
| hay sedge ( <i>Carex siccata</i> )                                | native                  | 0.36  | 0.15 | 0.50%  | 20.00% |
| Holn's Rocky Mountain sedge ( <i>Carex scopulorum</i> )           | native                  | 0.20  | 0.08 | 0.50%  | 5.00%  |
| Hood's sedge ( <i>Carex hoodii</i> )                              | native                  | 0.00  | 0.00 | 0.50%  | 5.00%  |
| inland sedge ( <i>Carex interior</i> )                            | native                  | 0.03  | 0.01 | 0.50%  | 5.00%  |
| June grass ( <i>Koeleria macrantha</i> )                          | native                  | 0.02  | 0.01 | 0.50%  | 5.00%  |
| Kentucky bluegrass ( <i>Poa pratensis</i> )                       | disturbance, introduced | 15.83 | 6.49 | 8.83%  | 80.00% |
| manna grass ( <i>Glyceria spp.</i> )                              | native                  | 0.09  | 0.04 | 0.50%  | 5.00%  |
| meadow foxtail ( <i>Alopecurus pratensis</i> )                    | introduced              | 0.05  | 0.02 | 0.50%  | 10.00% |
| meadow sedge ( <i>Carex praticola</i> )                           | native                  | 0.03  | 0.01 | 0.50%  | 5.00%  |
| northern awnless brome ( <i>Bromus inermis ssp pumpellianus</i> ) | native                  | 0.10  | 0.04 | 0.50%  | 10.00% |
| northern bog sedge ( <i>Carex gynocrates</i> )                    | native                  | 6.39  | 2.62 | 20.00% | 5.00%  |
| northern reed grass ( <i>Calamagrostis inexpansa</i> )            | native                  | 0.05  | 0.02 | 0.50%  | 10.00% |
| northern wheat grass ( <i>Agropyron dasystachyum</i> )            | native                  | 0.23  | 0.09 | 0.50%  | 15.00% |
| Norway sedge ( <i>Carex norvegica</i> )                           | native                  | 0.05  | 0.02 | 0.50%  | 15.00% |
| quack grass ( <i>Agropyron repens</i> )                           | disturbance, introduced | 0.19  | 0.08 | 0.50%  | 15.00% |
| Raymond's sedge ( <i>Carex raymondii</i> )                        | native                  | 0.87  | 0.35 | 0.67%  | 45.00% |

|                                                                  |                         |       |       |        |         |
|------------------------------------------------------------------|-------------------------|-------|-------|--------|---------|
| red fescue ( <i>Festuca rubra</i> )*                             | native, introduced      | 0.46  | 0.19  | 0.50%  | 50.00%  |
| Richardson's fescue ( <i>Festuca rubra</i> ssp. <i>arctica</i> ) | native                  | 0.06  | 0.03  | 0.50%  | 10.00%  |
| Rocky Mountain fescue ( <i>Festuca saximontana</i> )             | native                  | 0.05  | 0.02  | 0.50%  | 5.00%   |
| rush-like sedge ( <i>Carex scirpoidea</i> )                      | native                  | 3.24  | 1.33  | 2.33%  | 55.00%  |
| Sartwell's sedge ( <i>Carex sartwellii</i> )                     | native                  | 0.63  | 0.26  | 0.82%  | 25.00%  |
| sedge ( <i>Carex</i> spp.)                                       | native                  | 1.10  | 0.45  | 1.83%  | 15.00%  |
| sheathed sedge ( <i>Carex vaginata</i> )                         | native                  | 0.13  | 0.05  | 0.50%  | 15.00%  |
| short sedge ( <i>Carex curta</i> )                               | native                  | 0.00  | 0.00  | 0.50%  | 5.00%   |
| short-awn meadow-foxtail ( <i>Alopecurus aequalis</i> )          | native                  | 0.41  | 0.17  | 0.50%  | 15.00%  |
| silvery-flowered sedge ( <i>Carex aenea</i> )                    | native                  | 0.01  | 0.01  | 0.50%  | 5.00%   |
| slender rush ( <i>Juncus tenuis</i> )                            | native                  | 0.05  | 0.02  | 0.50%  | 5.00%   |
| slender wheat grass ( <i>Agropyron trachycaulum</i> )            | native                  | 0.60  | 0.25  | 0.53%  | 30.00%  |
| small-flowered wood-rush ( <i>Luzula parviflora</i> )            | native                  | 0.25  | 0.10  | 0.50%  | 15.00%  |
| small-winged sedge ( <i>Carex microptera</i> )                   | native                  | 0.84  | 0.35  | 0.50%  | 70.00%  |
| smooth brome ( <i>Bromus inermis</i> )                           | disturbance, introduced | 0.68  | 0.28  | 0.58%  | 55.00%  |
| sweet grass ( <i>Hierochloe odorata</i> )                        | native                  | 0.42  | 0.17  | 0.50%  | 20.00%  |
| thin-leaved cotton grass ( <i>Eriophorum viridi-carinatum</i> )  | native                  | 0.03  | 0.01  | 0.50%  | 5.00%   |
| tufted hair grass ( <i>Deschampsia cespitosa</i> )               | native                  | 9.31  | 3.82  | 5.05%  | 95.00%  |
| water sedge ( <i>Carex aquatilis</i> )                           | native                  | 43.28 | 17.74 | 19.35% | 100.00% |
| white rush ( <i>Juncus albens</i> )                              | native                  | 0.03  | 0.01  | 0.50%  | 5.00%   |
| wire rush ( <i>Juncus balticus</i> )                             | native                  | 7.83  | 3.21  | 3.50%  | 100.00% |

| FORBS                                                   |                         |      |      |       |        |
|---------------------------------------------------------|-------------------------|------|------|-------|--------|
| alpine bistort ( <i>Polygonum viviparum</i> )           | native                  | 0.74 | 0.30 | 0.50% | 70.00% |
| alpine hedysarum ( <i>Hedysarum alpinum</i> )           | native                  | 0.95 | 0.39 | 1.11% | 65.00% |
| alpine milk vetch ( <i>Astragalus alpinus</i> )         | native                  | 0.06 | 0.03 | 0.50% | 10.00% |
| alpine willowherb ( <i>Epilobium anagallidifolium</i> ) | native                  | 0.12 | 0.05 | 0.50% | 5.00%  |
| alsike clover ( <i>Trifolium hybridum</i> )             | disturbance, introduced | 0.01 | 0.00 | 0.50% | 5.00%  |
| American milk vetch ( <i>Astragalus americanus</i> )    | native                  | 0.19 | 0.08 | 0.50% | 5.00%  |
| American winter cress ( <i>Barbarea orthoceras</i> )    | native                  | 0.21 | 0.09 | 0.50% | 15.00% |
| annual hawk's-beard ( <i>Crepis tectorum</i> )          | disturbance, introduced | 0.01 | 0.00 | 0.50% | 5.00%  |
| annual whitlow-grass ( <i>Draba nemorosa</i> )          | native                  | 0.05 | 0.02 | 0.50% | 5.00%  |
| arrow-leaved coltsfoot ( <i>Petasites sagittatus</i> )  | native                  | 0.92 | 0.38 | 0.53% | 50.00% |
| balsam groundsel ( <i>Senecio pauperculus</i> )         | native                  | 0.09 | 0.04 | 0.50% | 25.00% |
| Bicknell's geranium ( <i>Geranium bicknellii</i> )      | native                  | 0.21 | 0.09 | 0.50% | 10.00% |
| bitter cress ( <i>Cardamine pensylvanica</i> )          | native                  | 0.04 | 0.02 | 0.50% | 10.00% |
| blue columbine ( <i>Aquilegia brevistyla</i> )          | native                  | 0.05 | 0.02 | 0.50% | 5.00%  |
| blunt-leaved sandwort ( <i>Moehringia lateriflora</i> ) | native                  | 0.00 | 0.00 | 0.50% | 5.00%  |

|                                                             |                                |      |      |       |         |
|-------------------------------------------------------------|--------------------------------|------|------|-------|---------|
| broad-leaved fireweed ( <i>Epilobium latifolium</i> )       | native                         | 0.27 | 0.11 | 0.50% | 45.00%  |
| Canada goldenrod ( <i>Solidago canadensis</i> )             | native                         | 0.17 | 0.07 | 0.50% | 10.00%  |
| Canada thistle ( <i>Cirsium arvense</i> )                   | <i>invasive, introduced</i>    | 0.83 | 0.34 | 0.50% | 60.00%  |
| celery-leaved buttercup ( <i>Ranunculus sceleratus</i> )    | native                         | 0.29 | 0.12 | 0.50% | 10.00%  |
| common blue-eyed grass ( <i>Sisyrinchium montanum</i> )     | native                         | 0.29 | 0.12 | 0.50% | 15.00%  |
| common butterwort ( <i>Pinguicula vulgaris</i> )            | native                         | 0.19 | 0.08 | 0.50% | 35.00%  |
| common dandelion ( <i>Taraxacum officinale</i> )            | <i>disturbance, introduced</i> | 4.76 | 1.95 | 2.35% | 85.00%  |
| common fireweed ( <i>Epilobium angustifolium</i> )          | native                         | 4.47 | 1.83 | 2.41% | 90.00%  |
| common horsetail ( <i>Equisetum arvense</i> )               | native, <i>poisonous</i>       | 1.30 | 0.53 | 0.73% | 80.00%  |
| common mouse-ear chickweed ( <i>Cerastium vulgatum</i> )    | <i>disturbance, introduced</i> | 0.00 | 0.00 | 0.50% | 5.00%   |
| common nettle ( <i>Urtica dioica</i> )                      | native                         | 0.13 | 0.05 | 0.50% | 10.00%  |
| common pink wintergreen ( <i>Pyrola asarifolia</i> )        | native                         | 0.09 | 0.04 | 0.50% | 5.00%   |
| common plantain ( <i>Plantago major</i> )                   | <i>disturbance, introduced</i> | 0.69 | 0.28 | 0.78% | 30.00%  |
| common red paintbrush ( <i>Castilleja miniata</i> )         | native                         | 0.03 | 0.01 | 0.50% | 15.00%  |
| common scouring-rush ( <i>Equisetum hyemale</i> )           | native                         | 0.05 | 0.02 | 0.50% | 5.00%   |
| common yarrow ( <i>Achillea millefolium</i> )               | native                         | 1.12 | 0.46 | 0.50% | 100.00% |
| cow parsnip ( <i>Heracleum lanatum</i> )                    | native                         | 0.10 | 0.04 | 0.50% | 10.00%  |
| cream-colored vetchling ( <i>Lathyrus ochroleucus</i> )     | native                         | 0.26 | 0.11 | 0.50% | 20.00%  |
| curled dock ( <i>Rumex crispus</i> )                        | <i>introduced</i>              | 0.05 | 0.02 | 0.50% | 10.00%  |
| death camas ( <i>Zigadenus venenosus</i> )                  | native, <i>poisonous</i>       | 0.05 | 0.02 | 0.50% | 5.00%   |
| early blue violet ( <i>Viola adunca</i> )                   | native                         | 0.45 | 0.18 | 0.50% | 45.00%  |
| elephant's-head ( <i>Pedicularis groenlandica</i> )         | native                         | 0.87 | 0.36 | 0.50% | 90.00%  |
| entire-leaved groundsel ( <i>Senecio integerrimus</i> )     | native                         | 0.31 | 0.13 | 0.50% | 20.00%  |
| fern ( <i>Fern spp. PTERIDOPHYTA</i> )                      | native                         | 0.05 | 0.02 | 0.50% | 5.00%   |
| few-flowered milk vetch ( <i>Astragalus vexilliflexus</i> ) | native                         | 0.01 | 0.00 | 0.50% | 5.00%   |
| few-flowered ragwort ( <i>Senecio pauciflorus</i> )         | native                         | 0.22 | 0.09 | 0.50% | 15.00%  |
| field mouse-ear chickweed ( <i>Cerastium arvense</i> )      | <i>disturbance, native</i>     | 0.68 | 0.28 | 0.50% | 50.00%  |
| flixweed; tansy mustard ( <i>Descurainia sophia</i> )       | <i>disturbance, introduced</i> | 0.03 | 0.01 | 0.50% | 5.00%   |
| forb ( <i>Forb</i> )                                        | unknown                        | 0.03 | 0.01 | 0.50% | 5.00%   |
| geranium ( <i>Geranium spp.</i> )                           | native                         | 0.05 | 0.02 | 0.50% | 5.00%   |
| graceful cinquefoil ( <i>Potentilla gracilis</i> )          | native                         | 1.84 | 0.75 | 1.08% | 65.00%  |
| green alpine sandwort ( <i>Minuartia austromontana</i> )    | native                         | 0.05 | 0.02 | 0.50% | 5.00%   |
| green sorrel ( <i>Rumex acetosa</i> )                       | <i>introduced</i>              | 0.21 | 0.09 | 0.50% | 15.00%  |
| hairy rock cress ( <i>Arabis hirsuta</i> )                  | native                         | 0.39 | 0.16 | 0.50% | 35.00%  |
| harebell ( <i>Campanula rotundifolia</i> )                  | native                         | 0.03 | 0.01 | 0.50% | 5.00%   |
| heart-leaved Alexanders ( <i>Zizia aptera</i> )             | native                         | 0.65 | 0.27 | 0.50% | 75.00%  |
| horseweed ( <i>Erigeron canadensis</i> )                    | native                         | 0.19 | 0.08 | 0.50% | 5.00%   |
| lance-leaved paintbrush ( <i>Castilleja occidentalis</i> )  | native                         | 0.34 | 0.14 | 0.50% | 35.00%  |



|                                                            |                                |      |      |       |        |
|------------------------------------------------------------|--------------------------------|------|------|-------|--------|
| lance-leaved stonecrop ( <i>Sedum lanceolatum</i> )        | native                         | 0.03 | 0.01 | 0.50% | 5.00%  |
| large-leaved yellow avens ( <i>Geum macrophyllum</i> )     | native                         | 0.19 | 0.08 | 0.50% | 15.00% |
| late yellow locoweed ( <i>Oxytropis monticola</i> )        | native, <i>poisonous</i>       | 0.24 | 0.10 | 0.50% | 20.00% |
| leafy arnica ( <i>Arnica chamissonis</i> )                 | native                         | 0.21 | 0.08 | 0.50% | 10.00% |
| long-fruited anemone ( <i>Anemone cylindrica</i> )         | native                         | 0.10 | 0.04 | 0.50% | 15.00% |
| long-leaved chickweed ( <i>Stellaria longifolia</i> )      | native                         | 0.19 | 0.08 | 0.50% | 25.00% |
| long-stalked chickweed ( <i>Stellaria longipes</i> )       | native                         | 0.52 | 0.21 | 0.50% | 20.00% |
| low goldenrod ( <i>Solidago missouriensis</i> )            | native                         | 0.17 | 0.07 | 0.50% | 15.00% |
| Macoun's buttercup ( <i>Ranunculus macounii</i> )          | native                         | 0.02 | 0.01 | 0.50% | 5.00%  |
| marsh yellow cress ( <i>Rorippa palustris</i> )            | native                         | 0.20 | 0.08 | 0.50% | 10.00% |
| meadow horsetail ( <i>Equisetum pratense</i> )             | native                         | 0.00 | 0.00 | 0.50% | 5.00%  |
| milk vetch ( <i>Astragalus eucosmus</i> )                  | native                         | 0.19 | 0.08 | 0.50% | 5.00%  |
| milk vetch ( <i>Astragalus spp.</i> )                      | native                         | 0.05 | 0.02 | 0.50% | 5.00%  |
| mountain mare's-tail ( <i>Hippuris montana</i> )           | native, <i>rare†</i>           | 0.20 | 0.08 | 0.50% | 5.00%  |
| mountain pearlwort ( <i>Sagina saginoides</i> )            | native                         | 0.03 | 0.01 | 0.50% | 5.00%  |
| mountain shooting star ( <i>Dodecatheon conjugens</i> )    | native                         | 0.10 | 0.04 | 0.50% | 10.00% |
| mountain valerian ( <i>Valeriana sitchensis</i> )          | native                         | 0.45 | 0.18 | 0.50% | 35.00% |
| narrow-leaved dock ( <i>Rumex triangulivalvis</i> )        | native                         | 0.05 | 0.02 | 0.50% | 5.00%  |
| northern bedstraw ( <i>Galium boreale</i> )                | native                         | 0.76 | 0.31 | 0.50% | 80.00% |
| northern grass-of-parnassus ( <i>Parnassia palustris</i> ) | native                         | 0.27 | 0.11 | 0.50% | 30.00% |
| northern green bog orchid ( <i>Habenaria hyperborea</i> )  | native                         | 0.33 | 0.13 | 0.50% | 55.00% |
| northern hedysarum ( <i>Hedysarum boreale</i> )            | native                         | 0.57 | 0.23 | 0.50% | 25.00% |
| northern ragwort ( <i>Senecio streptanthifolius</i> )      | native                         | 0.03 | 0.01 | 0.50% | 5.00%  |
| northern valerian ( <i>Valeriana dioica</i> )              | native                         | 0.49 | 0.20 | 0.50% | 20.00% |
| northern willowherb ( <i>Epilobium ciliatum</i> )          | native                         | 0.09 | 0.04 | 0.50% | 5.00%  |
| pale coralroot ( <i>Corallorhiza trifida</i> )             | native                         | 0.00 | 0.00 | 0.50% | 5.00%  |
| palmate-leaved coltsfoot ( <i>Petasites palmatus</i> )     | native                         | 0.24 | 0.10 | 0.50% | 35.00% |
| perennial sow-thistle ( <i>Sonchus arvensis</i> )          | <i>invasive, introduced</i>    | 0.39 | 0.16 | 0.50% | 25.00% |
| prairie groundsel ( <i>Senecio canus</i> )                 | native                         | 0.17 | 0.07 | 0.50% | 10.00% |
| purple avens ( <i>Geum rivale</i> )                        | native                         | 2.04 | 0.84 | 1.92% | 40.00% |
| purple rock cress ( <i>Arabis divaricarpa</i> )            | native                         | 0.12 | 0.05 | 0.50% | 5.00%  |
| purple-stemmed aster ( <i>Aster puniceus</i> )             | native                         | 0.01 | 0.00 | 0.50% | 5.00%  |
| red clover ( <i>Trifolium pratense</i> )                   | <i>disturbance, introduced</i> | 0.09 | 0.04 | 0.50% | 5.00%  |
| reflexed locoweed ( <i>Oxytropis deflexa</i> )             | native, <i>poisonous</i>       | 0.45 | 0.18 | 0.50% | 40.00% |
| Robbins' milk vetch ( <i>Astragalus robbinsii</i> )        | native                         | 0.00 | 0.00 | 0.50% | 5.00%  |
| rough cinquefoil ( <i>Potentilla norvegica</i> )           | <i>disturbance, native</i>     | 0.98 | 0.40 | 0.50% | 55.00% |
| saline shooting star ( <i>Dodecatheon pulchellum</i> )     | native                         | 0.73 | 0.30 | 0.50% | 75.00% |

|                                                                |                                        |      |      |       |        |
|----------------------------------------------------------------|----------------------------------------|------|------|-------|--------|
| seaside arrow-grass ( <i>Triglochin maritima</i> )             | native, <i>poisonous</i>               | 0.04 | 0.02 | 0.50% | 15.00% |
| seaside buttercup ( <i>Ranunculus cymbalaria</i> )             | native                                 | 0.36 | 0.15 | 0.50% | 30.00% |
| seneca snakeroot ( <i>Polygala senega</i> )                    | native                                 | 0.09 | 0.04 | 0.50% | 5.00%  |
| senecio ( <i>Senecio spp.</i> )                                | native                                 | 0.05 | 0.02 | 0.50% | 5.00%  |
| showy everlasting ( <i>Antennaria pulcherrima</i> )            | <i>disturbance</i> , native            | 1.65 | 0.67 | 0.85% | 80.00% |
| skunkweed ( <i>Polemonium viscosum</i> )                       | native                                 | 0.03 | 0.01 | 0.50% | 5.00%  |
| slender arrow-grass ( <i>Triglochin palustris</i> )            | native, <i>poisonous</i>               | 0.05 | 0.02 | 0.50% | 5.00%  |
| slender blue beardtongue ( <i>Penstemon procerus</i> )         | native                                 | 0.41 | 0.17 | 0.50% | 20.00% |
| small wood anemone ( <i>Anemone parviflora</i> )               | native                                 | 0.39 | 0.16 | 0.95% | 40.00% |
| small-flowered buttercup ( <i>Ranunculus abortivus</i> )       | native                                 | 0.39 | 0.16 | 0.50% | 10.00% |
| small-leaved everlasting ( <i>Antennaria parvifolia</i> )      | <i>disturbance</i> , native            | 0.07 | 0.03 | 0.50% | 20.00% |
| smooth aster ( <i>Aster laevis</i> )                           | native                                 | 1.77 | 0.73 | 1.20% | 60.00% |
| sparrow's-egg lady's-slipper ( <i>Cypripedium passerinum</i> ) | native                                 | 0.01 | 0.00 | 0.50% | 5.00%  |
| spear-leaved arnica ( <i>Arnica lonchophylla</i> )             | native                                 | 0.01 | 0.00 | 0.50% | 5.00%  |
| star-flowered Solomon's-seal ( <i>Smilacina stellata</i> )     | native                                 | 0.81 | 0.33 | 0.55% | 65.00% |
| sticky false asphodel ( <i>Tofieldia glutinosa</i> )           | native                                 | 0.27 | 0.11 | 1.08% | 25.00% |
| stiff yellow paintbrush ( <i>Castilleja lutescens</i> )        | native                                 | 0.39 | 0.16 | 0.50% | 10.00% |
| stinkweed ( <i>Thlaspi arvense</i> )                           | <i>disturbance</i> , <i>introduced</i> | 0.09 | 0.04 | 0.50% | 5.00%  |
| swamp horsetail ( <i>Equisetum fluviatile</i> )                | native                                 | 0.01 | 0.00 | 0.50% | 5.00%  |
| sweet-flowered androsace ( <i>Androsace chamaejasme</i> )      | native                                 | 0.39 | 0.16 | 0.50% | 45.00% |
| tall buttercup ( <i>Ranunculus acris</i> )                     | <i>invasive</i> , <i>introduced</i>    | 1.01 | 0.41 | 2.41% | 10.00% |
| tall larkspur ( <i>Delphinium glaucum</i> )                    | native, <i>poisonous</i>               | 1.68 | 0.69 | 1.16% | 50.00% |
| tall lungwort ( <i>Mertensia paniculata</i> )                  | native                                 | 3.41 | 1.40 | 1.83% | 90.00% |
| three-flowered avens ( <i>Geum triflorum</i> )                 | native                                 | 0.21 | 0.09 | 0.50% | 20.00% |
| sandwort ( <i>Minuartia spp.</i> )                             | native                                 | 0.05 | 0.02 | 0.50% | 10.00% |
| umbrella plant ( <i>Eriogonum spp.</i> )                       | native                                 | 0.03 | 0.01 | 0.50% | 5.00%  |
| variegated horsetail ( <i>Equisetum variegatum</i> )           | native                                 | 0.22 | 0.09 | 0.61% | 45.00% |
| veiny meadow rue ( <i>Thalictrum venulosum</i> )               | native                                 | 0.73 | 0.30 | 0.50% | 65.00% |
| Venus'-slipper ( <i>Calypso bulbosa</i> )                      | native                                 | 0.01 | 0.01 | 0.50% | 10.00% |
| vine-leaved coltsfoot ( <i>Petasites vitifolius</i> )          | native                                 | 0.55 | 0.22 | 0.50% | 55.00% |
| violet ( <i>Viola spp.</i> )                                   | native                                 | 0.24 | 0.10 | 0.50% | 10.00% |
| viscid locoweed ( <i>Oxytropis viscida</i> )                   | native                                 | 0.00 | 0.00 | 0.50% | 5.00%  |
| water parsnip ( <i>Sium suave</i> )                            | native                                 | 0.03 | 0.01 | 0.50% | 5.00%  |
| water smartweed ( <i>Polygonum amphibium</i> )                 | native                                 | 0.21 | 0.09 | 0.50% | 10.00% |
| western dock ( <i>Rumex occidentalis</i> )                     | native                                 | 0.69 | 0.28 | 0.50% | 45.00% |
| western willow aster ( <i>Aster hesperius</i> )                | native                                 | 0.03 | 0.01 | 0.50% | 5.00%  |
| white camas ( <i>Zigadenus elegans</i> )                       | native, <i>poisonous</i>               | 0.47 | 0.19 | 0.50% | 50.00% |
| white clover ( <i>Trifolium repens</i> )                       | <i>disturbance</i> , <i>introduced</i> | 1.59 | 0.65 | 1.32% | 40.00% |
| whitflow-grass ( <i>Draba lonchocarpa</i> )                    | native                                 | 0.01 | 0.01 | 0.50% | 5.00%  |

|                                                      |                         |      |      |       |        |
|------------------------------------------------------|-------------------------|------|------|-------|--------|
| wild chives ( <i>Allium schoenoprasum</i> )          | native                  | 0.38 | 0.16 | 0.50% | 15.00% |
| wild licorice ( <i>Glycyrrhiza lepidota</i> )        | native                  | 0.17 | 0.07 | 0.50% | 20.00% |
| wild strawberry ( <i>Fragaria virginiana</i> )       | disturbance, native     | 7.14 | 2.93 | 3.28% | 95.00% |
| wild vetch ( <i>Vicia americana</i> )                | native                  | 0.80 | 0.33 | 0.50% | 75.00% |
| wild white geranium ( <i>Geranium richardsonii</i> ) | native                  | 0.01 | 0.01 | 0.50% | 5.00%  |
| wormseed mustard ( <i>Erysimum cheiranthoides</i> )  | disturbance, introduced | 0.22 | 0.09 | 0.50% | 15.00% |
| yellow avens ( <i>Geum aleppicum</i> )               | native                  | 2.40 | 0.98 | 1.54% | 70.00% |
| yellow false dandelion ( <i>Agoseris glauca</i> )    | native                  | 0.15 | 0.06 | 0.50% | 15.00% |
| yellow hedysarum ( <i>Hedysarum sulphurescens</i> )  | native                  | 0.26 | 0.11 | 0.50% | 30.00% |
| yellow monkeyflower ( <i>Mimulus guttatus</i> )      | native                  | 0.05 | 0.02 | 0.50% | 5.00%  |
| yellow paintbrush ( <i>Castilleja cusickii</i> )     | native                  | 0.21 | 0.09 | 0.50% | 10.00% |
| yellow rattle ( <i>Rhinanthus minor</i> )            | native                  | 0.03 | 0.01 | 0.50% | 5.00%  |

\* Introduced and native strains of red fescue (*Festuca rubra*) occur in the project area.

<sup>1</sup> Our primary resource for plant species naming is Flora of Alberta by E.H. Moss (1994); for species not listed in Moss (1994), taxonomy follows the Integrated Taxonomic Information System (<http://www.itis.gov/>).

<sup>2</sup> Plant status is designated by Cows and Fish in association with Alberta Sustainable Resource Development (Public Lands), Alberta Agriculture, Food and Rural Development and the Alberta *Weed Control Act*. 'unknown' = plant not identified to species; plant status unknown.

<sup>3</sup> Based on visual estimates of the amount of ground the canopy of the plant covers. The percent cover values presented are the mid-values for the following ranges: 0.5=less than 1%; 3.0=1%-5%; 10.0=5%-15%; 20.0=15%-25%; 30.0=25%-35%; 40.0=35%-45%; 50.0=45%-55%; 60.0=55%-65%; 70.0=65%-75%; 80.0=75%-85%; 90.0=85%-95%; 97.5=greater than 95%; — = not observed.

<sup>4</sup> Constancy is the number of times the species occurs divided by the total number of Riparian Health Inventory Sites.

## AURA BASIN WETLANDS (n = 3)

| Life Form                                                     | Plant Status <sup>1,2</sup> | Area by Species (acres) | Area by Species (hectares) | Average Canopy Cover <sup>3</sup> | Constancy <sup>4</sup> |
|---------------------------------------------------------------|-----------------------------|-------------------------|----------------------------|-----------------------------------|------------------------|
| <b>TREES</b>                                                  |                             |                         |                            |                                   |                        |
| aspen ( <i>Populus tremuloides</i> )                          | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| balsam poplar ( <i>Populus balsamifera</i> )                  | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| white spruce ( <i>Picea glauca</i> )                          | native                      | 0.563                   | 0.000                      | 4.8%                              | 66.7%                  |
| <b>SHRUBS</b>                                                 |                             |                         |                            |                                   |                        |
| autumn willow ( <i>Salix serissima</i> )                      | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| balsam willow ( <i>Salix pyrifolia</i> )                      | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| basket willow ( <i>Salix petiolaris</i> )                     | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| bog birch ( <i>Betula glandulosa</i> )                        | native                      | 4.452                   | 0.000                      | 26.0%                             | 100.0%                 |
| common bearberry ( <i>Arctostaphylos uva-ursi</i> )           | native                      | 0.015                   | 0.000                      | 0.5%                              | 33.3%                  |
| Drummond's willow ( <i>Salix drummondiana</i> )               | native                      | 0.280                   | 0.000                      | 2.4%                              | 66.7%                  |
| dwarf raspberry ( <i>Rubus arcticus</i> )                     | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| false mountain willow ( <i>Salix pseudomonticola</i> )        | native                      | 0.089                   | 0.000                      | 3.0%                              | 33.3%                  |
| firm leaf willow ( <i>Salix pseudomyrsinites</i> )            | native                      | 2.521                   | 0.000                      | 14.7%                             | 100.0%                 |
| flat-leaved willow ( <i>Salix planifolia</i> )                | native                      | 0.909                   | 0.000                      | 6.4%                              | 66.7%                  |
| prickly rose ( <i>Rosa acicularis</i> )                       | native                      | 0.015                   | 0.000                      | 0.5%                              | 33.3%                  |
| shrubby cinquefoil ( <i>Potentilla fruticosa</i> )            | native                      | 0.369                   | 0.000                      | 2.2%                              | 100.0%                 |
| smooth willow ( <i>Salix glauca</i> )                         | native                      | 0.116                   | 0.000                      | 1.4%                              | 66.7%                  |
| velvet-fruited willow ( <i>Salix maccalliana</i> )            | native                      | 0.015                   | 0.000                      | 0.5%                              | 33.3%                  |
| <b>GRASSES AND GRASS-LIKES</b>                                |                             |                         |                            |                                   |                        |
| alpine rush ( <i>Juncus alpinoarticulatus</i> )               | native                      | 0.015                   | 0.000                      | 0.5%                              | 33.3%                  |
| beaked sedge / small bottle sedge ( <i>Carex utriculata</i> ) | native                      | 1.323                   | 0.000                      | 9.4%                              | 66.7%                  |
| broad-glumed wheat grass ( <i>Agropyron violaceum</i> )       | native                      | 0.015                   | 0.000                      | 0.5%                              | 33.3%                  |
| creeping spike-rush ( <i>Eleocharis palustris</i> )           | native                      | 0.159                   | 0.000                      | 3.0%                              | 33.3%                  |
| fescue ( <i>Festuca spp.</i> )                                | unknown                     | 0.044                   | 0.000                      | 0.5%                              | 33.3%                  |
| golden sedge ( <i>Carex aurea</i> )                           | native                      | 0.071                   | 0.000                      | 0.5%                              | 66.7%                  |
| hair-like sedge ( <i>Carex capillaris</i> )                   | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| hairy wild rye ( <i>Elymus innovatus</i> )                    | native                      | 0.596                   | 0.000                      | 20.0%                             | 33.3%                  |
| narrow reed grass ( <i>Calamagrostis stricta</i> )            | native                      | 0.026                   | 0.000                      | 0.5%                              | 33.3%                  |
| purple oat grass ( <i>Schizachne purpurascens</i> )           | native                      | 0.015                   | 0.000                      | 0.5%                              | 33.3%                  |
| Raymond's sedge ( <i>Carex raymondii</i> )                    | native                      | 0.089                   | 0.000                      | 3.0%                              | 33.3%                  |
| rush-like sedge ( <i>Carex scirpoidea</i> )                   | native                      | 0.159                   | 0.000                      | 3.0%                              | 33.3%                  |
| Sartwell's sedge ( <i>Carex sartwellii</i> )                  | native                      | 0.354                   | 0.000                      | 3.0%                              | 66.7%                  |
| sedge ( <i>Carex spp.</i> )                                   | native                      | 0.059                   | 0.000                      | 0.5%                              | 66.7%                  |
| small-winged sedge ( <i>Carex microptera</i> )                | native                      | 0.044                   | 0.000                      | 0.5%                              | 33.3%                  |
| tufted hair grass ( <i>Deschampsia cespitosa</i> )            | native                      | 1.092                   | 0.000                      | 6.4%                              | 100.0%                 |
| water sedge ( <i>Carex aquatilis</i> )                        | native                      | 8.606                   | 0.000                      | 50.3%                             | 100.0%                 |



|                                                            |                            |       |       |      |        |
|------------------------------------------------------------|----------------------------|-------|-------|------|--------|
| wire rush ( <i>Juncus balticus</i> )                       | native                     | 0.799 | 0.000 | 4.7% | 100.0% |
| alpine bistort ( <i>Polygonum viviparum</i> )              | native                     | 0.134 | 0.000 | 1.1% | 66.7%  |
| alpine hedysarum ( <i>Hedysarum alpinum</i> )              | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| balsam groundsel ( <i>Senecio pauperculus</i> )            | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| common dandelion ( <i>Taraxacum officinale</i> )           | disturbance,<br>introduced | 0.026 | 0.000 | 0.5% | 33.3%  |
| common fireweed ( <i>Epilobium angustifolium</i> )         | native                     | 0.059 | 0.000 | 0.5% | 66.7%  |
| common yarrow ( <i>Achillea millefolium</i> )              | native                     | 0.059 | 0.000 | 0.5% | 66.7%  |
| curled dock ( <i>Rumex crispus</i> )                       | introduced                 | 0.026 | 0.000 | 0.5% | 33.3%  |
| early blue violet ( <i>Viola adunca</i> )                  | native                     | 0.026 | 0.000 | 0.5% | 33.3%  |
| elephant's-head ( <i>Pedicularis groenlandica</i> )        | native                     | 0.086 | 0.000 | 0.5% | 100.0% |
| entire-leaved groundsel ( <i>Senecio integerrimus</i> )    | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| field mouse-ear chickweed ( <i>Cerastium arvense</i> )     | disturbance,<br>native     | 0.015 | 0.000 | 0.5% | 33.3%  |
| heart-leaved Alexanders ( <i>Zizia aptera</i> )            | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| lance-leaved paintbrush ( <i>Castilleja occidentalis</i> ) | native                     | 0.026 | 0.000 | 0.5% | 33.3%  |
| mealy primrose ( <i>Primula incana</i> )                   | native                     | 0.026 | 0.000 | 0.5% | 33.3%  |
| mountain valerian ( <i>Valeriana sitchensis</i> )          | native                     | 0.059 | 0.000 | 0.5% | 66.7%  |
| northern bedstraw ( <i>Galium boreale</i> )                | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| northern grass-of-parnassus ( <i>Parnassia palustris</i> ) | native                     | 0.071 | 0.000 | 0.5% | 66.7%  |
| northern green bog orchid ( <i>Habenaria hyperborea</i> )  | native                     | 0.059 | 0.000 | 0.5% | 66.7%  |
| purple avens ( <i>Geum rivale</i> )                        | native                     | 0.041 | 0.000 | 0.5% | 66.7%  |
| saline shooting star ( <i>Dodecatheon pulchellum</i> )     | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| showy everlasting ( <i>Antennaria pulcherrima</i> )        | disturbance,<br>native     | 0.015 | 0.000 | 0.5% | 33.3%  |
| tall larkspur ( <i>Delphinium glaucum</i> )                | native,<br>poisonous       | 0.059 | 0.000 | 0.5% | 66.7%  |
| tall lungwort ( <i>Mertensia paniculata</i> )              | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| veiny meadow rue ( <i>Thalictrum venulosum</i> )           | native                     | 0.015 | 0.000 | 0.5% | 33.3%  |
| vine-leaved coltsfoot ( <i>Petasites vitifolius</i> )      | native                     | 0.116 | 0.000 | 1.4% | 66.7%  |
| white camas ( <i>Zigadenus elegans</i> )                   | native,<br>poisonous       | 0.015 | 0.000 | 0.5% | 33.3%  |
| wild strawberry ( <i>Fragaria virginiana</i> )             | disturbance,<br>native     | 0.041 | 0.000 | 0.5% | 66.7%  |
| yellow avens ( <i>Geum aleppicum</i> )                     | native                     | 0.026 | 0.000 | 0.5% | 33.3%  |

<sup>1</sup> Our primary resource for plant species naming is Flora of Alberta by E.H. Moss (1994); for species not listed in Moss (1994), taxonomy follows the Integrated Taxonomic Information System (<http://www.itis.gov/>).

<sup>2</sup> Plant status is designated by Cows and Fish in association with Alberta Sustainable Resource Development (Public Lands), Alberta Agriculture, Food and Rural Development and the Alberta *Weed Control Act*. 'unknown' = plant not identified to species; plant status unknown.

<sup>3</sup> Based on visual estimates of the amount of ground the canopy of the plant covers. The percent cover values presented are the mid-values for the following ranges: 0.5=less than 1%; 3.0=1%-5%; 10.0=5%-15%; 20.0=15%-25%; 30.0=25%-35%; 40.0=35%-45%; 50.0=45%-55%; 60.0=55%-65%; 70.0=65%-75%; 80.0=75%-85%; 90.0=85%-95%; 97.5=greater than 95%; — = not observed.

<sup>4</sup> Constancy is the number of times the species occurs divided by the total number of Riparian Health Inventory Sites.

## **APPENDIX D**

### **Alberta Large River System Health Evaluation (Survey) Form**

# RIVER HEALTH EVALUATION

Record ID No: \_\_\_\_\_

Polygon number: \_\_\_\_\_

|                                                            | Actual Score | Possible Score | Comment |
|------------------------------------------------------------|--------------|----------------|---------|
| 1. Cottonwood and Poplar Regeneration from Seed            | _____        | _____          | _____   |
| 2. Regeneration of other Native Tree Species               | _____        | _____          | _____   |
| 3. Regeneration of Preferred Shrub Species                 | _____        | _____          | _____   |
| 4. Standing Decadent and Dead Woody Material               | _____        | _____          | _____   |
| 5a. Browse Util. of Preferred Trees and Shrubs             | _____        | _____          | _____   |
| 5b. Woody Veg. Removal other than Browsing                 | _____        | _____          | _____   |
| 6. Total Canopy Cover of Woody Species                     | _____        | _____          | _____   |
| 7a. Total Canopy Cover of Invasive Plant Species           | _____        | _____          | _____   |
| 7b. Density/Distribution Pattern of Invasive Plant Species | _____        | _____          | _____   |

|                                                                                                     | Species  | Can.Cov. | Dens.Dist. |
|-----------------------------------------------------------------------------------------------------|----------|----------|------------|
| List Invasive Plant Species present, including Percent Canopy Cover and Density Distribution Class: | 1. _____ | _____    | _____      |
|                                                                                                     | 2. _____ | _____    | _____      |
|                                                                                                     | 3. _____ | _____    | _____      |
|                                                                                                     | 4. _____ | _____    | _____      |
|                                                                                                     | 5. _____ | _____    | _____      |

8. Disturbance-increaser Undesirable Herbaceous Species \_\_\_\_\_

**Vegetation Subtotal:** \_\_\_\_\_

9. Riverbank Root Mass Protection \_\_\_\_\_

10. Human-Caused Bare Ground \_\_\_\_\_

11. Removal or Addition of Water from/to River System \_\_\_\_\_

12. Control of Flood Peak and Timing by Upstream Dam(s) \_\_\_\_\_

13. Riverbanks Structurally Altered by Human Activity \_\_\_\_\_

14. Human Physical Alteration to the Rest of the Polygon \_\_\_\_\_

15. Floodplain Accessibility within the Polygon \_\_\_\_\_

**Soil / Hydrology Subtotal:** \_\_\_\_\_

**Overall Polygon Total:** \_\_\_\_\_

## RATING CALCULATION

(Actual Score/Possible Score) X 100 = Rating Percent

Descriptive Category

Vegetation Rating: \_\_\_\_\_ / \_\_\_\_\_ x 100 = \_\_\_\_\_

Soil / Hydrology: \_\_\_\_\_ / \_\_\_\_\_ x 100 = \_\_\_\_\_

Total: \_\_\_\_\_ / \_\_\_\_\_ x 100 = \_\_\_\_\_

Rating Percent Range

80-100

60-79

<60

Descriptive Category

Proper Functioning Condition (Healthy)

Functional At Risk (Healthy, but with Problems)

Nonfunctional (Unhealthy)

## **APPENDIX E**

### **Factors for Assessing Large River Floodplain Health**



## FACTORS FOR ASSESSING LARGE RIVER FLOODPLAIN HEALTH

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Thompson and Hansen 2001, 2002, 2003, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

The evaluator must keep in mind that this assessment form is designed to account for most sites and conditions in the applicable region. However, rarely will all the questions seem exactly to fit the circumstances on a given site. Therefore, try to answer each question with a literal reading. If necessary, explain anomalies in the comment section. Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet.

**1. Cottonwood and Balsam Poplar Regeneration.** This item is assessed differently on either side of the Red Deer River valley. For areas south of and including the Red Deer River valley, do not count asexual regeneration from root sprouts. In this southern area of the province, count only reproduction from seed. This is because these trees are primarily riverine species that pioneer on recent alluvium from seed, and root sprouts do not serve well to maintain populations. In areas north of the Red Deer River valley (and some areas farther south in higher precipitation zones, such as the foothills west of Highway 2) count any mode of reproduction for this group of trees, because in these cooler/moister zones cottonwoods and balsam poplar populations are not dependent on seed deposited on riverine alluvium. (**NOTE:** In this item do not include the species *Populus tremuloides* (aspen), which is included in the next item below.

Reproduction success can be determined by estimating the established seedling and sapling cover expressed as percentage of the overall cover of the species on the site. (**Note:** For this item, include plants taller than 30 cm (1 ft) in height, but less than 12.5 cm (5 in) in dbh [diameter at breast height: 1.35 m (4.5 ft)]). If no potential for cottonwood or balsam poplar exists on the polygon (such as when it is on the outside of a long meander curve where depositional material is not expected, or there are no such trees on similar site positions nearby) replace both Actual Score and Possible Score with NA. Count plants installed by human planting, if these are successfully established. To be successfully established the new plants need to have at least one complete growing season on the site. Most newly established plants do not survive the first growing season.

**NOTE:** Use judgement and caution in counting occasional seedlings in precarious positions where they have little potential for survival due to natural physical jeopardy (e.g., at water's edge along outside curve).

### Scoring:

**6** = More than 15% of the cottonwood and/or balsam poplar cover is established seedlings and/or saplings.

**4** = 5% to 15% of the cottonwood and/or balsam poplar cover is established seedlings and/or saplings.

**2** = Up to 5% of the cottonwood and/or balsam poplar cover is established seedlings and/or saplings.

**0** = None of the cottonwood and/or balsam poplar cover is established seedlings or saplings.

**2. Regeneration of Other Native Tree Species.** As succession progresses on a riparian site, the pioneer trees and shrub communities are replaced by later seral communities (if river dynamics allow enough time). If the site is not de-watered or otherwise disturbed, this progression is often to communities dominated by other native tree species. Depending upon dynamics of the system (how fast the channel migrates laterally), the potential may exist for equilibrium at different locations along the river between younger (those dominated by young trees and willows) communities and older communities with aging cottonwoods/poplars and later seral species such as *Populus tremuloides* (aspen), *Picea glauca* (white spruce), *Acer negundo* (Manitoba maple), and *Fraxinus pennsylvanica* (green ash). **Note:** Seedlings and saplings of these species include individuals which are less than 7.5 cm (3 in) in dbh. In situations where all plant communities are in an early successional stage and where no later successional species are yet expected (such as a young point bar or a newly formed island), replace both Actual Score and Possible Score with NA.

The health of a population can be based on current regeneration success without having to determine the exact potential distribution between cottonwoods/poplars and the other tree species on a site. This regeneration success can be determined from the seedling and sapling canopy cover expressed as a percentage of the overall cover of the group of tree species on the site other than cottonwoods/poplars. Count plants installed by human planting, if these are successfully established. To be successfully established the new plants need to have at least one complete growing season on the site. Most newly established plants do not survive the first growing season.

**Scoring:**

- 3** = More than 5% of the other (non-cottonwood/balsam poplar) tree cover is seedlings and/or saplings.
- 2** = 1% to 5% of the other (non-cottonwood/balsam poplar) tree cover is seedlings and/or saplings.
- 1** = Less than 1% of the other (non-cottonwood/balsam poplar) tree cover is seedlings and/or saplings.
- 0** = Seedlings and saplings of trees species other than cottonwoods/balsam poplars or absent.

**3. Regeneration of Preferred Shrub Species.** Another indicator of a river system's ecological stability and, therefore, health is the presence of enough shrub regeneration to maintain the lifeform population along the river over the long term. Ecological stability is used in the broad sense that over the reach as a whole there is an equilibrium of community composition and structure.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar]) are excluded from the evaluation of establishment and regeneration. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; **AND** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. **FOR EXAMPLE:** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

For shrubs in general, seedlings and saplings can be distinguished from mature plants as follows. For those species having a mature height generally over 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 1.8 m (6.0 ft) tall. For species normally not exceeding 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 0.45 m (1.5 ft) tall or which lack reproductive structures and the relative stature to suggest maturity. Count plants installed by human planting, if these are successfully established. Establishment success can be assumed for plants surviving at least one full year after planting. (**Note:** Evaluators should take care also not to confuse short stature resulting from heavy browsing with that due to young plants.)

**Scoring:** (If the site has no potential for shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the evaluator is not fairly certain potential exists for preferred shrubs, then enter NC and explain in the comment field below.)

- 6** = More than 5% of the preferred shrub species cover is seedlings and/or saplings.
- 4** = 1% to 5% of the preferred shrub species cover is seedlings and/or saplings.
- 2** = Less than 1% of the preferred shrub species cover is seedlings and/or saplings.
- 0** = None of the preferred shrub species cover is seedlings or saplings.

**4. Standing Decadent and Dead Woody Material.** The amount of decadent and dead woody material on a site can be an indicator of the overall health of a riparian area. Large amounts of decadent and dead woody material may indicate a reduced flow of water through the stream (de-watering) due to either human or natural causes. De-watering of a site, if severe enough, may change the site vegetation potential from riparian species to upland species. In addition, decadent and dead woody material may indicate severe stress from over browsing. Finally, large amounts of decadent and dead woody material may

indicate climatic impacts, disease and insect damage. For instance, severe winters may cause extreme die back of trees and shrubs, and cyclic insect infestations may kill individuals in a stand. In all these cases, a high percentage of dead and decadent woody material reflects degraded vegetative health, which can lead to reduced streambank integrity, channel incisement, and excessive lateral cutting, besides reducing production and other wildlife values.

The most common usage of the term *decadent* may be for over mature trees past their prime and which may be dying, but we use the term in a broader sense. We count decadent plants, both trees and shrubs, as those with 30% or more dead wood in the upper canopy. In this item, scores are based on the percentage of total woody canopy cover which is decadent or dead, not on how much of the total polygon canopy cover consists of dead and decadent woody material. Only decadent and dead standing material is included, not that which is lying on the ground. The observer is to ignore (not count) decadence in poplars or cottonwoods which are decadent *due to old age* (rough and furrowed bark extends substantially up into the crowns of the trees) (species: *Populus deltoides* [plains cottonwood], *P. angustifolia* [narrow-leaf cottonwood], and *P. balsamifera* [balsam poplar]), because cottonwoods/poplars are early seral species and naturally die off in the absence of disturbance to yield the site to later seral species. The observer is to consider (count) decadence in these species if apparently caused by de-watering, browse stress, climatic influences, or parasitic infestation (insects/disease). The observer should comment on conflicting or confounding indicators, and/or if the cause of decadence is simply unknown (*but not due to old age*).

**Scoring:**

**3** = Less than 5% of the total canopy cover of woody species is decadent and/or dead.

**2** = 5% to 25% of the total canopy cover of woody species is decadent and/or dead.

**1** = 25% to 50% of the total canopy cover of woody species is decadent and/or dead.

**0** = More than 50% of the total canopy cover of woody species is decadent and/or dead.

**5a. Browse Utilization of Available Preferred Trees and Shrubs.** (*Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh, or all woody plants have already been removed.*) Livestock and/or wildlife browse many riparian woody species. Excessive browsing can eliminate these important plants from the community and result in their replacement by undesirable invaders. With excessive browsing, the plant loses vigour, is prevented from flowering, or is killed. Utilization in small amounts is normal and not a health concern, but concern increases with greater browse intensity.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar]) are excluded from the evaluation of utilization. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; **AND** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. **FOR EXAMPLE:** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

Consider as available all tree and shrub plants to which animals may gain access and that they can reach. For tree species, this means mostly just seedling and sapling age classes. When estimating degree of utilization, count browsed second year and older leaders on representative plants of woody species normally browsed by ungulates. Do not count current year's use, because this would not accurately reflect actual use when more browsing can occur later in the season. Browsing of second year or older material affects the overall health of the plant and continual high use will affect the ability of the plant to maintain itself on the site. Determine percentage by comparing the number of leaders browsed or utilised with the total number of leaders available (those within animal reach) on a representative sample (at least three plants) of each tree and

shrub species present. Do not count utilization on dead plants, unless it is clear that death resulted from over-grazing. **Note:** If a shrub is entirely mushroom/umbrella shaped by long term heavy browse or rubbing, count utilization of it as heavy.

**Scoring:** (Consider all shrubs within animal reach and seedlings and saplings of tree species. If the site has no woody vegetation [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.)

**3** = None (0% to 5% of available second year and older leaders of preferred species are browsed).

**2** = Light (5% to 25% of available second year and older leaders of preferred species are browsed).

**1** = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).

**0** = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

**5b. Live Woody Vegetation Removal by Other Than Browsing.** (Skip this item if the polygon lacks trees and shrubs AND there are no stumps or cut woody plants to indicate that it ever had any.) Excessive cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.) can result in many of the same negative effects to the community that are caused by excessive browsing. However, other effects from this kind of removal are direct and immediate, including reduction of physical community structure and wildlife habitat values. Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

Four non-native species or genera are excluded from consideration here because these are aggressive, undesirable exotic plants that should be removed. They are *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* (European/common buckthorne), and *Tamarix* species (salt cedar).

Determine the extent to which woody vegetation (trees and shrubs) is lacking due to being physically removed in the recent past (i.e., cut, mowed, trimmed, logged, cut by beaver, or otherwise cut from their growing position). When you have determined how much was removed, then compare that to the amount remaining uncut/re-grown, and choose a “best fit estimate” from the categories below. (**NOTE:** In general, the more recent the removal, the more entirely it is fully counted; and conversely, the older the removal, the more likely it is to be mitigated by re-growth.)

This question is really looking at volume (three dimensions) and not canopy cover (two dimensions). For example, if an old growth spruce tree is removed, a number of new seedlings/saplings may become established and could soon achieve the same canopy cover as the old tree had. However, the value of the old tree to wildlife and overall habitat values is far less than that of the seedling/saplings. It will take a very long time before the seedlings/saplings can grow to replace all the habitat values that were provided by the tall old tree. On the other hand, shrubs, such as willows, grow faster and may replace the volume of removed plants in a much shorter time.

**Scoring:** (If the site has no trees or shrubs AND no cut plants or stumps of any trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.)

**3** = None (0% to 5% of live woody vegetation expected on the site is lacking due to cutting).

**2** = Light (5% to 25% of live woody vegetation expected on the site is lacking due to cutting).

**1** = Moderate (25% to 50% of live woody vegetation expected on the site is lacking due to cutting).

**0** = Heavy (More than 50% of live woody vegetation expected on the site is lacking due to cutting).

**6. Total Canopy Cover of Woody Species.** Woody species play a critical role in riverbank integrity. Natural riverbanks are protected by large bank rock (e.g., boulders and cobbles) and by woody vegetation. On floodplains comprised primarily of fine textured materials—which are typical of many western rivers—riverbanks are protected only by the woody vegetation. In these cases, it is critically important to manage for healthy woody vegetation. Woody vegetation also traps sediment, helps to reduce velocity of flood waters, protects the soil from extreme temperatures, and provides wildlife habitat. **Note:** Unlike other items dealing with woody plants, this item focuses on how much of the total polygon is covered by woody plants.

**Scoring:**

**3** = More than 50% of the total area is occupied by all woody species.

**2** = 25% to 50% of the total area is occupied by all woody species.

**1** = 5% to 25% of the total area is occupied by all woody species.

**0** = Less than 5% of the total area is occupied by all woody species.



**7. Invasive Plant Species (Weeds).** Invasive plants (weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. Whether the disturbance that allowed their establishment is natural or human-caused, weed presence indicates a degrading ecosystem. While some of these species may contribute to some riparian functions, their negative impacts reduce overall site health. This item assesses the degree and extent to which the site is infested by invasive plants. The severity of the problem is a function of the density/distribution (pattern of occurrence), as well as canopy cover (abundance) of the weeds. In determining the health score, all invasive species are considered collectively, not individually. A weed list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). Space is provided on the form for recording weed species counted. Include both woody and herbaceous invasive species. **Leave no listed species field blank, however; enter "0" to indicate absence of a value.** (A blank field means the observer forgot to collect the data; a value means the observer looked.)

The site's health rating on this item combines two factors: weed density/distribution class and total canopy cover. A perfect score of 6 out of 6 points can only be achieved if the site is weed free. A score of 4 out of the 6 points means the weed problem is just beginning (i.e., very few weeds and small total canopy cover (less than 1%). A moderate weed problem gets 2 out of 6 points. It has a moderately dense weed plant distribution (a class between 4 and 7) and moderate total weed canopy cover (between 1% and 15%). A site scores 0 points if the density/distribution is in class 8 or higher, or if the total weed canopy cover is 15% or more.

**7a. Total Canopy Cover of Invasive Plant Species (Weeds).** The evaluator must evaluate the total percentage of the polygon area that is covered by the combined canopy of all plants of all species of invasive plants. Determine which rating applies in the scoring scale below.

**Scoring:** **6** = No invasive plant species (weeds) on the site. **4** = Invasive plants present with total canopy cover less than 1% of the polygon area. **2** = Invasive plants present with total canopy cover between 1% and 15% of the polygon area. **0** = Invasive plants present with total canopy cover more than 15% of the polygon area.

**7b. Density Distribution of Invasive Plant Species (Weeds).** The evaluator must pick a category of pattern and extent of invasive plant distribution from the chart below that best fits what is observed on the polygon, while realising that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches the view of the polygon.

**Scoring:** **3** = No invasive plant species (weeds) on the site. **2** = Invasive plants present with density/distribution in categories 1, 2, or 3. **1** = Invasive plants present with density/distribution in categories 4, 5, 6, or 7. **0** = Invasive plants present with density/distribution in categories 8, or higher.

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

Figure E1. Weed density distribution class guidelines

**NOTE:** Prior to the 2001 season, the health score for weed infestation was assessed from a single numerical value that does not represent weed canopy cover, but instead represents the fraction of the polygon area on which weeds had a well established population of individuals (i.e., the area infested).

**8. Disturbance-Increaser Undesirable Herbaceous Species.** A large cover of disturbance-increaser undesirable herbaceous species, native or exotic, indicates displacement from the potential natural community (PNC) and a reduction in riparian health. These species generally are less productive, have shallow roots, and poorly perform most riparian functions. They usually result from some disturbance, which removes more desirable species. Invasive species considered in the previous item are not reconsidered here. As in the previous item, the evaluator should state the list of species considered. A partial list of undesirable herbaceous species appropriate for use in Alberta follows. A list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). The evaluator should list any additional species included.

*Antennaria* spp. (pussy-toes) *Hordeum jubatum* (foxtail barley) *Potentilla anserina* (silverweed) *Brassicaceae* (mustards)  
*Plantago* spp. (plantains) *Taraxacum* spp. (dandelion) *Bromus inermis* (awnless brome) *Poa pratensis* (Kentucky bluegrass)  
*Trifolium* spp. (clovers) *Fragaria* spp. (strawberries) \_\_\_\_\_

**Scoring:** **3** = Less than 5% of the reach covered by undesirable herbaceous species. **2** = 5% to 25% of the reach covered by undesirable herbaceous species. **1** = 25% to 50% of the reach covered by undesirable herbaceous species. **0** = More than 50% of the reach covered by undesirable herbaceous species.

**9. Riverbank Root Mass Protection.** Vegetation along river banks performs the primary physical functions of stabilising the soil with a binding root mass and of filtering sediments from overland flow. Few studies have documented depth and extent of root systems of plant species found in wetlands, however flow energies commonly experienced by rivers are effectively resisted only by the deep and extensive roots provided by tree and shrub species. Natural rivers typically move dynamically across their valley bottom. The vegetation roots serve to slow this lateral movement to a rate that allows normal floodplain ecosystem function, such as development of mid and later seral vegetation communities for habitat values. For this reason there needs to be good root mass protection well back from the immediate toe of the current bank position.

In situations where you are assessing a high, cut bank (usually on an outside bend), the top may be upland, but the bottom is riparian. Do not assess the area that is non-riparian. In cases of tall, nearly vertical cut banks, assess the bottom portion that comes in contact with floodwaters. Omit from consideration those areas where the bank is comprised of bedrock, since these neither provide binding root mass, nor erode at a rate that is normally a concern. In assessing root mass protection along a river, consider a band that extends back approximately 15 m (50 ft) from the bank top. (This is a “rule of thumb” for guidance that requires only estimated measurements.) The bank top is that point where the upper bank levels off to the relatively flat surface of a floodplain or terrace. This question is most critically assessed along straight reaches and outside curves, therefore do not get too concerned with trying to find the exact location of the bank top along inside curve point bar positions. **Note:** *Riprap does not substitute for, act as, nor preclude the need for deep, binding root mass.*

**Scoring:**

**6** = More than 85% of the riverbank has a deep, binding root mass.

**4** = 65% to 85% of the riverbank has a deep, binding root mass.

**2** = 35% to 65% of the riverbank has a deep, binding root mass.

**0** = Less than 35% of the riverbank has a deep, binding root mass.

**10. Human-Caused Bare Ground.** Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 6 cm (2.5 in). Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground—these do not erode nor allow weeds sites to invade. Bare ground caused by human activity indicates a deterioration of riparian health. Sediment deposits and other natural bare ground are excluded as normal or probably beyond immediate management control. Human land uses causing bare ground include livestock grazing, recreation, roads, and industrial activities. The evaluator should consider the causes of all bare ground observed and estimate the fraction that is human-caused.

River channels that go dry during the growing season can create problems for polygon delineation. On most rivers, the area of the channel bottom is excluded from the polygon. (**Note:** *The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the “bottom.”*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the river. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially along prairie rivers, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is **included** in the polygon as area to be inventoried. Typically, these are the “pooled channel” river type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half (>50%) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon as a whole, then the entire channel qualifies for inclusion within the inventoried polygon area. If you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

**Scoring:**

**6** = Less than 1% of the polygon is human-caused bare ground.

**4** = 1% to 5% of the polygon is human-caused bare ground.

**2** = 5% to 15% of the polygon is human-caused bare ground.

**0** = More than 15% of the polygon is human-caused bare ground.

**NOTE:** Questions 11 and 12 below generally must be answered in the office using maps and other data.

**11. Removal or Addition of Water from/to the River System.** Proper functioning of any riparian ecosystem depends, by definition, upon the system supply of water. The degree to which this “lifeblood” is artificially manipulated by removal or addition from/to the system is directly reflected in a reduction of riparian functions (e.g., wetland plant community maintenance, channel bank stability, wildlife habitat, overall system primary production). The extent of this alteration of the system can be estimated by determining the fraction of the average river flow, which is removed or added during the critical growing season each year. This determination can be based upon gauging station records as they relate to historic flow records established before construction of diversions. This question only deals with water volume changes. The question of dams controlling the timing of peak runoff is taken care of in the next question.

**Scoring:** **9** = Less than 10% of average river flow volume during the critical growing season is changed. **6** = 10% to 25% of average river flow volume during the critical growing season is changed. **3** = 25% to 50% of average river flow volume during the critical growing season is changed. **0** = More than 50% of average river flow volume during the critical growing season is changed.

**12. Control of Flood Peak and Timing by Upstream Dam(s).** Natural riverine ecosystems adapt to, and depend upon, the volume and timing of annual peak flows, which are determined by the watershed water yield and variability of the local climate. Humans have installed dams on many rivers for agricultural and industrial purposes and to mitigate the damages caused by the natural flooding to human development on the floodplain. The dams affect the functional health of the natural system. In this context, the health of the river system relates directly to the fraction of the watershed which remains undammed. Thus, this item includes all tributaries which flow into the river upstream of the reach being assessed.

**Scoring:** **9** = Less than 10% of the watershed upstream of the reach is controlled by dams. **6** = 10% to 25% of the watershed upstream of the reach is controlled by dams. **3** = 25% to 50% of the watershed upstream of the reach is controlled by dams. **0** = More than 50% of the watershed upstream of the reach is controlled by dams.

**13. Riverbanks Structurally Altered by Human Activity.** Altered riverbanks are those having impaired structural integrity (strength or stability) due to human causes. These banks are more susceptible to cracking and/or slumping. Count as riverbank alteration such damage as livestock or wildlife hoof shear and concentrated trampling, vehicle or ATV tracks, and any other areas of human-caused disruption of bank integrity, including riprap or use of fill. The basic criterion is any disturbance to bank structure that increases erosion potential or bank profile shape change. One large exception is lateral bank cutting caused by stream flow, even if thought to result from upstream human manipulation of the flow. The intent of this item is to assess only direct, on-site mechanical or structural damage to the banks. Each bank is considered separately, so total bank length for this item is approximately twice the reach length of channel in the polygon (more if the river is braided). **NOTE:** Constructed riverbanks (especially those with riprap) may be stabilised at the immediate location, but are likely to disrupt normal flow dynamics and cause erosion of banks downstream. In assessing structural alteration, consider a band along the river bank approximately 4 m (13 ft) wide back from the bank toe. As with deep, binding root mass, this question is most critically assessed along straight reaches and outside curves, therefore do not get hung up trying to find the exact location of the bank top along inside curve point bar positions.

**Scoring:** **6** = Less than 5% of the bank length has been structurally altered by human activity. **4** = 5% to 15% of the bank length has been structurally altered by human activity. **2** = 15% to 35% of the bank length has been structurally altered by human activity. **0** = More than 35% of the bank length has been structurally altered by human activity.

**14. Human Physical Alteration to the Rest of the Polygon.** Within the remainder of the polygon area, outside the stream bank area that was addressed in the previous question, estimate the amount of area that has been physically altered by human causes. The purpose of this question is to evaluate physical change to the soil, hydrology, etc. as it affects the ability of the natural system to function normally. Changes in soil structure will alter infiltration of water, increase soil compaction, and change the amount of sediment contributed to the water body. Every human activity in or around a natural site can alter that site. This question seeks to assess the accumulated effects of all human-caused change. Count such things as:

- **Soil Compaction.** This kind of alteration includes livestock-caused hummocking and pugging, recreational trails that obviously have compacted the soil, vehicle and machine tracks and ruts in soft soil, etc.
- **Plowing/Tilling.** This is disruption of the soil surface for cultivation purposes.
- **Results of Hydrologic Change.** Include in this category any area that is physically affected by removal or addition of water for human purpose, although cause may be occurring upstream off-site. The physical effects to look for are erosion due to reduced or increased water, bared soil surface that had water cover removed, or flooded area that normally supports a drier vegetation type.
- **Human Impervious Surface.** This includes roofs, hardened surfaces like walkways and roads, boat launches, etc.
- **Topographic Change.** This is the deliberate alteration of terrain and/or drainage pattern for human purposes. It may be for aesthetic (landscaping) or other reasons, including such structures as water diversions ditches and canals.



**Scoring:** **6** = Less than 5% of the polygon is altered by human causes. **4** = 5% to 15% of the polygon is altered by human causes. **2** = 15% to 25% of the polygon is altered by human causes. **0** = More than 25% of the polygon is altered by human causes.

**15. Floodplain Accessibility within the Polygon.** Many of the most important functions of a riparian ecosystem depend upon the ability of the channel to access its floodplain during high flows. This access is restricted by levees and other human constructed embankments, such as roadbeds. Evaluators should determine what fraction of the historic 100 year floodplain within the polygon remains unrestricted by such embankments. This can usually be determined by comparing the area within the embankments (as shown on the latest photos or maps available).

**Scoring:** **6** = More than 85% of the floodplain is accessible to flood flows. **4** = 65% to 85% of the floodplain is accessible to flood flows. **2** = 35% to 65% of the floodplain is accessible to flood flows. **0** = Less than 35% of the floodplain is accessible to flood flows.

## REFERENCES

- Cows and Fish. 2002. Invasive Weed and Disturbance-caused Herbaceous Species List For Use in Riparian Health Assessment and Inventory in Alberta. Alberta Riparian Habitat Management Program. Lethbridge, Alberta, Canada. <http://www.cowsandfish.org/pdfs/weeds.pdf>
- Thompson, William H. and Paul L. Hansen. 2001. Classification and management of riparian and wetland sites of the Saskatchewan Prairie Ecozone and parts of adjacent subregions. Riparian and Wetland Research Program, the University of Montana, Prepared for the Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan, Canada. 298 pp.
- Thompson, William H. and Paul L. Hansen. 2002. Classification and management of riparian and wetland sites of Alberta's Grasslands Natural Region and adjacent subregions. Bitterroot Restoration, Inc., Prepared for the Alberta Riparian Habitat Management Program-Cows and Fish, Lethbridge, Alberta. 416 pp.
- Thompson, William H. and Paul L. Hansen. 2003. Classification and management of riparian and wetland sites of Alberta's Parkland Natural Region and Dry Mixedwood Natural Subregion. Bitterroot Restoration, Inc. Prepared for the Alberta Riparian Habitat Management Program-Cows and Fish, Lethbridge, Alberta. 340 pp.

## **APPENDIX F**

### **Factors for Assessing Lotic Wetland Health of Streams and Small Rivers**

## FACTORS FOR ASSESSING LOTIC WETLAND HEALTH (SURVEY)

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Thompson and Hansen 2001, 2002, 2003, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

The evaluator must keep in mind that this assessment form is designed to account for most sites and conditions in the applicable region. However, rarely will all the questions seem exactly to fit the circumstances on a given site. Therefore, try to answer each question with a literal reading. If necessary, explain anomalies in the comment section. Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet.

**1. Vegetative Cover of Floodplain and Streambanks.** Vegetation cover helps to stabilise banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts and others 1987). On most streams the area of the channel bottom is excluded from the polygon. (*Note: The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the “bottom.”*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the stream. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially the prairie streams, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is *included* in the polygon as area to be inventoried. Typically these are the “pooled channel” stream type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half (>50%) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon as a whole, then it qualifies for inclusion within the inventoried polygon area. If the you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

The evaluator is to estimate the fraction of the polygon covered by plant growth. Vegetation cover is ocularly estimated using the canopy cover method (Daubenmire 1959).

### Scoring:

- 6** = More than 95% of the polygon area is covered by live plant growth.
- 4** = 85% to 95% of the polygon area is covered by live plant growth.
- 2** = 75% to 85% of the polygon area is covered by live plant growth.
- 0** = Less than 75% of the polygon area is covered by live plant growth.

**2. Invasive Plant Species (Weeds).** Invasive plants (weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. Whether the disturbance that allowed their establishment is natural or human-caused, weed presence indicates a degrading ecosystem. While some of these species may contribute to some riparian functions, their negative impacts reduce overall site health. This item assesses the degree and extent to which the site is infested by invasive plants. The severity of the problem is a function of the density/distribution (pattern of occurrence), as well as canopy cover (abundance) of the weeds. In determining the health score, all invasive species are considered collectively, not individually. A weed list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). Space is provided on the form for recording weed species counted. Include both woody and herbaceous invasive species. **Leave no listed species field blank, however;**

enter "0" to indicate absence of a value. (A blank field means the observer forgot to collect the data; a value means the observer looked.)

The site's health rating on this item combines two factors: weed density/distribution class and total canopy cover. A perfect score of 6 out of 6 points can only be achieved if the site is weed free. A score of 4 out of the 6 points means the weed problem is just beginning (i.e., very few weeds and small total canopy cover (less than 1%). A moderate weed problem gets 2 out of 6 points. It has a moderately dense weed plant distribution (a class between 4 and 7) and moderate total weed canopy cover (between 1% and 15%). A site scores 0 points if the density/distribution is in class 8 or higher, or if the total weed canopy cover is 15% or more.

**2a. Total Canopy Cover of Invasive Plant Species (Weeds).** The evaluator must evaluate the total percentage of the polygon area that is covered by the combined canopy of all plants of all species of invasive plants. Determine which rating applies in the scoring scale below.

**Scoring:** **3** = No invasive plant species (weeds) on the site. **2** = Invasive plants present with total canopy cover less than 1% of the polygon area. **1** = Invasive plants present with total canopy cover between 1% and 15% of the polygon area. **0** = Invasive plants present with total canopy cover more than 15% of the polygon area.

**2b. Density/Distribution Pattern of Invasive Plant Species (Weeds).** The observer must pick a category of pattern and extent of invasive plant distribution from the chart below that best fits what is observed on the polygon, while realising that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches the view of the polygon.

**Scoring:** **3** = No invasive plant species (weeds) on the site. **2** = Invasive plants present with density/distribution in categories 1, 2, or 3. **1** = Invasive plants present with density/distribution in categories 4, 5, 6, or 7. **0** = Invasive plants present with density/distribution in categories 8, or higher.

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

**NOTE:** Prior to the 2001 season, the health score for weed infestation was assessed from a single numerical value that does not represent weed canopy cover, but instead represents the fraction of the polygon area on which weeds had a well established population of individuals (i.e., the area infested).



**3. Disturbance-Increaser Undesirable Herbaceous Species.** A large cover of disturbance-increaser undesirable herbaceous species, native or exotic, indicates displacement from the potential natural community (PNC) and a reduction in riparian health. These species generally are less productive, have shallow roots, and poorly perform most riparian functions. They usually result from some disturbance, which removes more desirable species. Invasive species considered in the previous item are not reconsidered here. As in the previous item, the evaluator should state the list of species considered. A partial list of undesirable herbaceous species appropriate for use in Alberta follows. A list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). The evaluator should list any additional species included.

|                                       |                                           |                                         |              |
|---------------------------------------|-------------------------------------------|-----------------------------------------|--------------|
| <i>Antennaria</i> spp. (pussy-toes)   | <i>Hordeum jubatum</i> (foxtail barley)   | <i>Potentilla anserina</i> (silverweed) | Brassicaceae |
| (mustards)                            | <i>Plantago</i> spp. (plantains)          | <i>Taraxacum</i> spp. (dandelion)       |              |
| <i>Bromus inermis</i> (awnless brome) | <i>Poa pratensis</i> (Kentucky bluegrass) | <i>Trifolium</i> spp. (clovers)         |              |
| <i>Fragaria</i> spp. (strawberries)   |                                           |                                         |              |

#### Scoring:

- 3** = Less than 5% of the site covered by disturbance-increaser undesirable herbaceous species.
- 2** = 5% to 25% of the site covered by disturbance-increaser undesirable herbaceous species.
- 1** = 25% to 50% of the site covered by disturbance-increaser undesirable herbaceous species.
- 0** = More than 50% of the site covered by disturbance-increaser undesirable herbaceous species.

**4. Preferred Tree and Shrub Establishment and/or Regeneration.** (Skip this item if the site lacks potential for trees or shrubs; for example, the site is a herbaceous wet meadow or marsh.) Not all riparian areas can support trees and/or shrubs. However, on those sites where such species do belong, they play important roles. The root systems of woody species are excellent bank stabilisers, while their spreading canopies provide protection to soil, water, wildlife, and livestock. Young age classes of woody species are important indicators of the continued presence of woody communities not only at a given point in time but into the future. Woody species potential can be determined by using a key to site type (Thompson and Hansen 2001, 2002, 2003, etc.). On severely disturbed sites, the evaluator should seek clues to potential by observing nearby sites with similar landscape position. (**Note:** Vegetation potential is commonly underestimated on sites with a long history of disturbance.)

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar]) are excluded from the evaluation of establishment and regeneration. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; **AND** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. **FOR EXAMPLE:** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

For shrubs in general, seedlings and saplings can be distinguished from mature plants as follows. For those species having a mature height generally over 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 1.8 m (6.0 ft) tall. For species normally not exceeding 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 0.45 m (1.5 ft) tall or which lack reproductive structures and the relative stature to suggest maturity. (**Note:** Evaluators should take care not to confuse short stature resulting from heavy browsing with that due to young plants.)

**Scoring:** (If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the evaluator is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below.)

**6** = More than 15% of the total canopy cover of preferred trees/shrubs is seedlings and/or saplings.

**4** = 5% to 15% of the total canopy cover of preferred trees/shrubs is seedlings and/or saplings.

**2** = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and/or saplings.

**0** = Preferred tree/shrub seedlings and saplings absent.

**5a. Browse Utilization of Available Preferred Trees and Shrubs.** (Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh, or all woody plants have already been removed.) Livestock and/or wildlife browse many riparian woody species. Excessive browsing can eliminate these important plants from the community and result in their replacement by undesirable invaders. With excessive browsing, the plant loses vigour, is prevented from flowering, or is killed. Utilization in small amounts is normal and not a health concern, but concern increases with greater browse intensity.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar]) are excluded from the evaluation of utilization. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; **AND** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. **FOR EXAMPLE:** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

Consider as available all tree and shrub plants to which animals may gain access and that they can reach. For tree species, this means mostly just seedling and sapling age classes. When estimating degree of utilization, count browsed second year and older leaders on representative plants of woody species normally browsed by ungulates. Do not count current year's use, because this would not accurately reflect actual use when more browsing can occur later in the season. Browsing of second year or older material affects the overall health of the plant and continual high use will affect the ability of the plant to maintain itself on the site. Determine percentage by comparing the number of leaders browsed or utilised with the total number of leaders available (those within animal reach) on a representative sample (at least three plants) of each tree and shrub species present. Do not count utilization on dead plants, unless it is clear that death resulted from over-grazing. **Note:** If a shrub is entirely mushroom/umbrella shaped by long term heavy browse or rubbing, count utilization of it as heavy.

**Scoring:** (Consider all shrubs within animal reach and seedlings and saplings of tree species. If the site has no woody vegetation [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.)

**3** = None (0% to 5% of available second year and older leaders of preferred species are browsed).

**2** = Light (5% to 25% of available second year and older leaders of preferred species are browsed).

**1** = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).

**0** = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

**5b. Live Woody Vegetation Removal by Other Than Browsing.** (Skip this item if the polygon lacks trees and shrubs **AND** there are no stumps or cut woody plants to indicate that it ever had any.) Excessive cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.) can result in many of the same negative effects to the community that are caused by excessive browsing. However, other effects from this kind of removal are direct and immediate, including reduction of physical community structure and wildlife habitat values. Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

Four non-native species or genera are excluded from consideration here because these are aggressive, undesirable exotic plants that should be removed. They are *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* (European/common buckthorne), and *Tamarix* species (salt cedar).

Determine the extent to which woody vegetation (trees and shrubs) is lacking due to being physically removed in the recent past (i.e., cut, mowed, trimmed, logged, cut by beaver, or otherwise cut from their growing position). When you have determined how much was removed, then compare that to the amount remaining uncut/re-grown, and choose a “best fit estimate” from the categories below. (**NOTE:** In general, the more recent the removal, the more entirely it is fully counted; and conversely, the older the removal, the more likely it is to be mitigated by re-growth.)

This question is really looking at volume (three dimensions) and not canopy cover (two dimensions). For example, if an old growth spruce tree is removed, a number of new seedlings/saplings may become established and could soon achieve the same canopy cover as the old tree had. However, the value of the old tree to wildlife and overall habitat values is far less than that of the seedling/saplings. It will take a very long time before the seedlings/saplings can grow to replace all the habitat values that were provided by the tall old tree. On the other hand, shrubs, such as willows, grow faster and may replace the volume of removed plants in a much shorter time.

**Scoring:** (If the site has no trees or shrubs AND no cut plants or stumps of any trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.)

**3** = None (0% to 5% of live woody vegetation expected on the site is lacking due to cutting).

**2** = Light (5% to 25% of live woody vegetation expected on the site is lacking due to cutting).

**1** = Moderate (25% to 50% of live woody vegetation expected on the site is lacking due to cutting).

**0** = Heavy (More than 50% of live woody vegetation expected on the site is lacking due to cutting).

**6. Standing Decadent and Dead Woody Material.** (Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh.) The amount of decadent and dead woody material on a site can be an indicator of the overall health of a riparian area. Large amounts of decadent and dead woody material may indicate a reduced flow of water through the stream (dewatering) due to either human or natural causes. Dewatering of a site, if severe enough, may change the site vegetation potential from riparian species to upland species. In addition, decadent and dead woody material may indicate severe stress from over browsing. Finally, large amounts of decadent and dead woody material may indicate climatic impacts, disease and insect damage. For instance, severe winters may cause extreme die back of trees and shrubs, and cyclic insect infestations may kill individuals in a stand. In all these cases, a high percentage of dead and decadent woody material reflects degraded vegetative health, which can lead to reduced streambank integrity, channel incisement, and excessive lateral cutting, besides reducing production and other wildlife values.

The most common usage of the term *decadent* may be for over mature trees past their prime and which may be dying, but we use the term in a broader sense. We count decadent plants, both trees and shrubs, as those with 30% or more dead wood in the upper canopy. In this item, scores are based on the percentage of total woody canopy cover which is decadent or dead, not on how much of the total polygon canopy cover consists of dead and decadent woody material. Only decadent and dead standing material is included, not that which is lying on the ground. The observer is to ignore (not count) decadence in poplars or cottonwoods which are decadent *due to old age* (rough and furrowed bark extends substantially up into the crowns of the trees) (species: *Populus deltoides* [plains cottonwood], *P. angustifolia* [narrow-leaf cottonwood], and *P. balsamifera* [balsam poplar]), because cottonwoods/poplars are early seral species and naturally die off in the absence of disturbance to yield the site to later seral species. The observer is to consider (count) decadence in these species if apparently caused by de-watering, browse stress, climatic influences, or parasitic infestation (insects/disease). The observer should comment on conflicting or confounding indicators, and/or if the cause of decadence is simply unknown (*but not due to old age*).

**Scoring:** (If site lacks potential for woody species, replace both Actual and Potential Scores with NA.)

**3** = Less than 5% of the total canopy cover of woody species is decadent and/or dead.

**2** = 5% to 25% of the total canopy cover of woody species is decadent and/or dead.

**1** = 25% to 50% of the total canopy cover of woody species is decadent and/or dead.

**0** = More than 50% of the total canopy cover of woody species is decadent and/or dead.

**7. Streambank Root Mass Protection.** Vegetation along streambanks performs the primary physical functions of stabilising the soil with a binding root mass and of filtering sediments from overland flow. Few studies have documented depth and extent of root systems of plant species found in wetlands. Despite this lack of documented evidence, some generalisations can be made. All tree and shrub species are considered to have deep, binding root masses. Among wetland herbaceous species, the first rule is that annual plants lack deep, binding roots. Perennial species offer a wide range of root mass qualities. Some rhizomatous species such as the deep rooted *Carex* species (sedges) are excellent bank stabilisers. Others, such as *Poa pratensis* (Kentucky bluegrass), have only shallow roots and are poor bank stabilisers. Still others, such as *Juncus balticus* (wire rush), are intermediate in their ability to stabilise banks. The size and nature of the stream will determine which herbaceous species can be effective. The evaluator should try to determine if the types of root systems present in the polygon are in fact contributing to the stability of the streambanks.

In situations where you are assessing a high, cut bank (usually on an outside bend), the top may be upland, but the bottom is riparian. Do not assess the area that is non-riparian. In cases of tall, nearly vertical cut banks, assess the bottom portion that comes in contact with floodwaters. Omit from consideration those areas where the bank is comprised of bedrock, since these neither provide binding root mass, nor erode at a perceptible rate.

**Note:** Riprap does not substitute for, act as, or preclude the need for deep, binding root mass.

Since the kind and amount of deep, binding roots needed to anchor a bank is dependent on size of the stream, use the following table as a general guide to determine width of a band along the banks to assess for deep, binding roots. This is a “rule of thumb” for guidance that requires only estimated measurements.

---

**Stream Size (Bankfull Channel Width) Width of Band to Assess for Deep, Binding Roots**

---

|                                            |              |
|--------------------------------------------|--------------|
| Rivers (Larger Than 30 m [ $>100$ ft])     | 15 m (50 ft) |
| Large Streams (Approx. 5-30 m [16-100 ft]) | 5 m (16 ft)  |
| Small Streams (Up To Approx. 5 m [16 ft])  | 2 m (6 ft)   |

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**Scoring:**

**6** = More than 85% of the streambank has a deep, binding root mass.

**4** = 65% to 85% of the streambank has a deep, binding root mass.

**2** = 35% to 65% of the streambank has a deep, binding root mass.

**0** = Less than 35% of the streambank has a deep, binding root mass.

**8. Human-Caused Bare Ground.** Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 6 cm (2.5 in). Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground—these do not erode nor allow weeds sites to invade. Bare ground caused by human activity indicates a deterioration of riparian health. Sediment deposits and other natural bare ground are excluded as normal or probably beyond immediate management control. Human land uses causing bare ground include livestock grazing, recreation, roads, and industrial activities. The evaluator should consider the causes of all bare ground observed and estimate the fraction that is human-caused.

Stream channels that go dry during the growing season can create problems for polygon delineation. Some stream channels remain unvegetated after the water is gone. On most streams the area of the channel bottom is excluded from the polygon. (**Note:** *The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the “bottom.”*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the stream. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially the prairie streams, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is **included** in the polygon as area to be inventoried. Typically, these are the “pooled channel” stream type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half ( $>50\%$ ) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon



as a whole, then it qualifies for inclusion within the inventoried polygon area. If you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

**Scoring:**

- 6** = Less than 1% of the polygon is human-caused bare ground.
- 4** = 1% to 5% of the polygon is human-caused bare ground.
- 2** = 5% to 15% of the polygon is human-caused bare ground.
- 0** = More than 15% of the polygon is human-caused bare ground.

**9. Streambank Structurally Altered by Human Activity.** Altered streambanks are those having impaired structural integrity (strength or stability) usually due to human causes. These banks are more susceptible to cracking and/or slumping. Count as streambank alteration such damage as livestock or wildlife hoof shear and concentrated trampling, vehicle or ATV tracks, and any other areas of human-caused disruption of bank integrity, including riprap or use of fill. The basic criterion is any disturbance to bank structure that increases erosion potential or bank profile shape change. One large exception is lateral bank cutting caused by stream flow, even if thought to result from upstream human manipulation of the flow. The intent of this item is to assess only direct, on-site mechanical or structural damage to the banks. Each bank is considered separately, so total bank length for this item is approximately twice the reach length of stream channel in the polygon (more if the stream is braided). **NOTE:** Constructed streambanks (especially those with riprap) may be stabilised at the immediate location, but are likely to disrupt normal flow dynamics and cause erosion of banks downstream. The width of the bank to be considered is proportional to stream size. The table below gives a conceptual guideline for how wide a band along the bank to assess. —

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**Stream Size (Bankfull Channel Width)      Width of Band to Assess for Bank Alteration**

---

|               |                                             |
|---------------|---------------------------------------------|
| Rivers        | (Larger Than 30 m [ $>100$ ft]) 4 m (13 ft) |
| Large Streams | (Approx. 5-30 m [16-100 ft]) 2 m (6 ft)     |
| Small Streams | (Up To Approx. 5 m [16 ft]) 1 m (3 ft)      |

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**Scoring:**

- 6** = Less than 5% of the bank is structurally altered by human activity.
- 4** = 5% to 15% of the bank is structurally altered by human activity.
- 2** = 15% to 35% of the bank is structurally altered by human activity.
- 0** = More than 35% of the bank is structurally altered by human activity.

**10. Human Physical Alteration to the Rest of the Polygon.** Within the remainder of the polygon area, outside the stream bank area that was addressed in the previous question, estimate the amount of area that has been physically altered by human causes. The purpose of this question is to evaluate physical change to the soil, hydrology, etc. as it affects the ability of the natural system to function normally. Changes in soil structure will alter infiltration of water, increase soil compaction, and change the amount of sediment contributed to the water body. Every human activity in or around a natural site can alter that site. This question seeks to assess the accumulated effects of all human-caused change. Count such things as:

- **Soil Compaction.** This kind of alteration includes livestock-caused hummocking and pugging, recreational trails that obviously have compacted the soil, vehicle and machine tracks and ruts in soft soil, etc.
- **Plowing/Tilling.** This is disruption of the soil surface for cultivation purposes. It does not include the alteration of drainage or topographic pattern, which are included in the **Topographic Change** category.
- **Hydrologic Change.** Include in this category any area that is physically affected by removal or addition of water for human purpose. The physical effects to look for are erosion due to reduced or increased water, bared soil surface that had water cover removed, or flooded area that normally supports a drier vegetation type.
- **Human Impervious Surface.** This includes roofs, hardened surfaces like walkways and roads, boat launches, etc.
- **Topographic Change.** This is the deliberate alteration of terrain and/or drainage pattern for human purposes. It may be for aesthetic (landscaping) or other reasons, including such structures as water diversions ditches and canals.

**Scoring:**

- 3** = Less than 5% of the polygon is altered by human causes.
- 2** = 5% to 15% of the polygon is altered by human causes.
- 1** = 15% to 25% of the polygon is altered by human causes.
- 0** = More than 25% of the polygon is altered by human causes.

**11. Stream Channel Incisement (Vertical Stability).** Incisement can lower the water table enough to change current vegetation and site potential. It can also increase stream energy, reduce water retention/storage, and increase erosion. A stream is incised when downcutting has lowered the channel bed so that two-year flood events cannot overflow the banks. Four typical downcutting indicators are: a) headcuts; b) exposed cultural features (pipelines, bridge footings, culverts, etc.); c) lack of sediment and exposed bedrock; and d) a low, vertical scarp at the bank toe on the inside of a channel bend. Channel incisement can occur in any of several stages (Figure 4). A severe disturbance can initiate downcutting, transforming the system from a steady state of high water table, appropriate floodplain, and high productivity to one of degraded water table, narrow [or no] active floodplain, and low productivity. (These stages of incisement can be categorised in terms of Rosgen Level I channel types [Rosgen 1996].)

A top rating goes to those unincised channels from which the 1-2 year high flow can begin to access its floodplain. These can be meandering meadow streams (Rosgen E-type) and wide valley bottom streams (Rosgen C-type) which access floodplains much wider than the stream channel, or they may be mountain and foothill streams in V-shaped valleys which have limited floodplains because of topography. These latter types are usually armoured (well-rocked) systems with highly stable beds and streambanks that are not susceptible to downcutting. The lowest rating goes to entrenched channels (Rosgen F- or G-type) where even medium high flows which occur at 5-10 year intervals cannot overtop the high banks. Intermediate stages can be improving or degrading and may reflect slightly incised channels not yet so downcut that intermediate floods cannot access the floodplain, or they may be old incisements that are healing and rebuilding floodplain at a new, lower elevation.

**Scoring:**

**9** = Channel vertically stable and not incised; 1-2 year high flows can begin to access a floodplain appropriate to the stream type. Active downcutting is not evident. Any old incisement is characterised by a broad floodplain inside which perennial riparian plant communities are well established. This condition is described by the following three stages.

**Stage A-1.** A stable, unincised meandering meadow channel (Rosgen E-type). Flows greater than bankfull (1-2 year event) spread over a floodplain more than twice the bankfull channel width. **Stage A-2.** A fairly stable, unincised wide valley bottom stream with broad curves and point bars (Rosgen C-type). Although these streams typically cut laterally on the outside of curves and deposit sediment on inside point bars, bankfull flows (1-2 year events) have access to a floodplain more than twice bankfull channel width. **Stage A-3.** A stable, unincised mountain (Rosgen A-type) or foothill (Rosgen B-type) channel with limited sinuosity and slopes greater than 2%. Although bankfull flow stage is reached every 1-2 years, the adjacent floodplain is often narrower than twice the bankfull channel width. Consequently, overflow conditions are not so obvious as in Stages A-1 and A-2 systems.

**6** = Either of two incisement phases: (a) an improving phase with a sinuous curve/point bar system (Rosgen C-type) or a narrow, meandering stream (E-type) establishing in an old incisement which now represents the new floodplain, although this may be much narrower than it will become; (b) an early degrading phase in which a narrow, meandering meadow stream (E-type) is degrading into a curve/point bar type (C-type) or a wide, shallow channel (Rosgen F-type). In either case, the 1-2 year high flow event can access only a narrow floodplain less than or only slightly wider than twice the bankfull channel width. Perennial riparian vegetation is well established along much of the reach. These conditions are represented in **Stage B**.

**3** = Two phases of incisement fit this rating. (a) A deep incisement that is starting to heal. In this phase new floodplain development, though very limited, is key. This phase is characterised by a wide, shallow channel unable to access a floodplain (Rosgen F-type) evolving into a curve/point bar system (C-type) through sediment deposition and lateral cutting. Pioneer perennial plants are beginning to establish on the new depositional surfaces. (b) An intermediate phase with downcutting and headcuts probable. Flows less than a 5-10 year event can access a narrow floodplain less than twice bankfull channel width. These conditions are represented in **Stage C**.

**0** = The channel is deeply incised to resemble a ditch or a gully. Downcutting is likely ongoing. Only extreme floods overtop the banks, and no floodplain development has begun. Both **Stages D-1** and **D-2** fall into this rating. **Stage D-1.** An incised stream with a wide, shallow (F-type) channel. Commonly found in fine substrates (sands, silts, and clays), channel banks are very erodible. Only limited vegetation, primarily pioneer species, is present along the side of the stream. **Stage D-2.** A narrow, deep "gully" system (Rosgen G-type) downcut to the point that only extreme floods can overtop the banks. Distinguished from narrow mountain streams (A-type) by the presence of a flat floodplain through which the stream has downcut and by banks consisting of fine materials rather than larger rocks, cobbles, or boulders.

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# APPENDIX G

## Factors for Assessing Lentic Riparian Health of Lakes and Wetlands



## FACTORS FOR ASSESSING LENTIC (STANDING WATER) WETLAND HEALTH (SURVEY)

The riparian health score is based on 9 basic parameters pertaining to riparian health. This appendix addresses the guidelines and stipulations followed when each parameter was answered during the assessment. Keep in mind that these parameters are meant to encompass the broad range of ecological diversity that lake and wetland systems have the potential to express. The interpretations are not completely specific to any one type of stream system, yet still capture the essential factors of riparian health and function.

Many different factors must be considered when answering any one of these parameters. It is quite possible that every scenario that could be encountered when conducting assessments is not covered here. Personal judgment based on sound riparian knowledge and good visual estimations are critical tools necessary for answering these questions consistently.

*This description of riparian health parameters is based on the Alberta Lentic Wetland Health (Survey) User Manual as created by Bitterroot Restoration, Inc. (2002).*

### LENTIC RIPARIAN HEALTH PARAMETERS

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Hansen and others 1995, Kovalchik 1987, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet.

**1. Vegetative Cover of the Polygon.** Around lentic water bodies vegetation cover helps to stabilize shorelines, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, reduce the rate of evaporation (Platts and others 1987), and contributes primary production to the ecosystem. This question focuses on how much of the entire polygon area is covered by plant growth. Item #10 below assesses the amount of human-caused bare ground. Although there is some overlap between these two items, the bare ground to be counted in item #10 is strictly limited in definition, whereas all unvegetated area not inundated by water is counted in this item. The only area within the polygon exempt from consideration here is area covered by water. Areas such as boat docks, hardened pathways, and artificial structures are counted as unvegetated along with any bare ground, human-caused or natural. The rationale is that all such unvegetated areas contribute nothing to several of the important lentic wetland functions.

The evaluator is to estimate the fraction of the polygon covered by plant growth. Vegetation cover is ocularly estimated using the canopy cover method (Daubenmire 1959).

**Scoring:**

6 = More than 95% of the polygon area is covered by plant growth.

4 = 85% to 95% of the polygon area is covered by plant growth.

2 = 75% to 85% of the polygon area is covered by plant growth.

0 = Less than 75% of the polygon area is covered by plant growth.

**2. Invasive Plant Species.** Invasive plants (weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. Whether the disturbance that allowed their establishment is natural or human-caused, weed presence indicates a degrading ecosystem. While some of these species may contribute to some riparian functions, their negative impacts reduce overall site health. This item assesses the degree and extent to which the site is infested by invasive plants. The severity of the problem is a function of the density/distribution (pattern of occurrence), as well as canopy cover (abundance) of the weeds. In determining the health score, all invasive species are considered collectively, not individually. A weed list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbancecaused Undesirable Plant List* [Cows and Fish 2002]). Some common invasive species are listed on the form, and space is allowed for recording others. **Leave no listed species field blank, however;** enter “0” to indicate absence of a value.

**2a. Total Canopy Cover of Invasive Plant Species.** The observer must evaluate the total percentage of the polygon area that is covered by the combined canopy of all plants of all species of invasive plants. Determine which rating applies in the scoring scale below.

**Scoring:**

3 = No invasive plant species (weeds) on the site.

2 = Invasive plants present with total canopy cover less than 1 percent of the polygon area.

1 = Invasive plants present with total canopy cover between 1 and 15 percent of the polygon area.

0 = Invasive plants present with total canopy cover more than 15 percent of the polygon area.

**2b. Density/Distribution Pattern of Invasive Plant Species.** The observer must pick a category of pattern and extent of invasive plant distribution from the chart below that best fits what is observed on the polygon, while realizing that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches what you see.

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

**Figure G1.** Density and distribution of invasive plants.

**Scoring:**

- 3 = No invasive plant species (weeds) on the site.  
 2 = Invasive plants present with density/distribution in categories 1, 2, or 3.  
 1 = Invasive plants present with density/distribution in categories 4, 5, 6, or 7.  
 0 = Invasive plants present with density/distribution in categories 8, or higher.

**3. Disturbance-Caused Undesirable Herbaceous Species.** A large cover of disturbance-increaser undesirable herbaceous species, native or exotic, indicates displacement from the potential natural community (PNC) and a reduction in riparian health. These species generally are less productive, have shallow roots, and poorly perform most riparian functions.

They usually result from some disturbance which removes more desirable species. Invasive species considered in the previous item are not reconsidered here. As in the previous item, the evaluator should state the list of species considered. A partial list of undesirable herbaceous species appropriate for use in Alberta follows. The evaluator should list additional species included.

*Antennaria* spp. (pussy-toes)      *Hordeum jubatum* (foxtail barley)      *Potentilla anserina* (silverweed)  
*Brassicaceae* (mustards)      *Plantago* spp. (plantains)      *Taraxacum* spp. (dandelion)  
*Bromus inermis* (smooth brome)      *Poa pratensis* (Kentucky bluegrass)      *Trifolium* spp. (clovers)  
*Fragaria* spp. (strawberries) \_\_\_\_\_

**Scoring:**

- 3 = Less than 5% of the site covered by disturbance-caused undesirable herbaceous species.  
 2 = 5% to 25% of the site covered by disturbance-caused undesirable herbaceous species.  
 1 = 25% to 45% of the site covered by disturbance-caused undesirable herbaceous species.  
 0 = More than 45% of the site covered by disturbance-caused undesirable herbaceous species.

**4. Preferred Tree and Shrub Establishment and Regeneration.** (Skip this item if the site lacks potential for trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh.) Not all riparian areas can support trees and/or shrubs. However, on those sites where such species do belong, they play important roles. The root systems of woody species are excellent bank stabilizers, while their spreading canopies provide protection to soil, water, wildlife, and livestock. Young age classes of woody species are important indicators of the continued presence of woody communities not only at a given point in time but into the future. Woody species potential can be determined by using a key to site type (Thompson and Hansen 2001, Hansen and others 1995). On severely disturbed sites, the evaluator should seek clues to potential by observing nearby sites with similar landscape position. (**Note:** Vegetation potential is commonly underestimated on sites with a long history of disturbance.)

*Elaeagnus angustifolia* (Russian olive) and three other shrub genera (*Symphoricarpos* spp. [buckbrush/snowberry], *Rosa* spp. [rose], and *Crataegus* spp. [hawthorn]) are excluded from the evaluation of establishment and regeneration. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; **AND** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive) is considered an especially aggressive, undesirable exotic plant. The main reason for excluding these plants is that they are far more abundant on many sites than are species of greater concern (i.e., *Salix* spp. [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern.

**FOR EXAMPLE:** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount)

is very important in the health evaluation, but by including the snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

For shrubs in general, seedlings and saplings can be distinguished from mature plants as follows. For those species having a mature height generally over 6.0 ft (1.8 m), seedlings and saplings are those individuals less than 6.0 ft (1.8 m) tall. For species normally not exceeding 6.0 ft (1.8 m), seedlings and saplings are those individuals less than 1.5 ft (0.45 m) tall or which lack reproductive structures and the relative stature to suggest maturity. (**Note:** Evaluators should take care not to confuse short stature resulting from heavy browsing with that due to youth.)

**Scoring:** (If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.)

**6** = More than 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings.

**4** = 5% to 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings.

**2** = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and saplings.

**0** = Preferred tree/shrub seedlings or saplings absent.

**5a. Utilization of Preferred Trees and Shrubs.** (Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh.) Many riparian woody species are browsed by livestock and/or wildlife. Heavy browsing can prevent establishment or regeneration of these important species. Excessive browsing can eliminate them from the community and result in their replacement by undesirable invaders.

*Elaeagnus angustifolia* (Russian olive) and three other shrub genera (*Symphoricarpos* spp. [buckbrush/snowberry], *Rosa* spp. [rose], and *Crataegus* spp. [hawthorn]) are excluded from the evaluation of utilization of woody species. These are plants that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; **AND** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive) is considered an especially aggressive, undesirable exotic plant.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (i.e., *Salix* spp. [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a heavily utilized species of greater concern. **FOR EXAMPLE:** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing only light utilization, while also having a trace of *Salix exigua* (sandbar willow) present showing heavy utilization. We feel that, although there is only a small amount of willow present, the fact that it is being heavily utilized is very important to the health evaluation. By including the snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

When estimating degree of utilization, count browsed second year and older leaders on representative plants of woody species normally browsed by ungulates. Do not count current year's use since this may not accurately reflect actual use because significant browsing can occur late in the season. Determine percentage by comparing the number of leaders browsed with the total number of leaders available (those within animal reach) on a representative sample (at least three plants) of each tree and shrub species present. Do not include use of dead plants unless it is clear this condition was the result of over-grazing.

**Scoring:** (If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.)

**3** = None (0% to 5% of available second year and older leaders of preferred species are browsed).

**2** = Light (5% to 25% of available second year and older leaders of preferred species are browsed).

**1** = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).

**0** = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

**5b. Live Woody Vegetation Removal by Other Than Browsing.** (Skip this item if the polygon lacks trees and shrubs AND there are no stumps or cut woody plants to indicate that it ever had any.)

Excessive cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.) can result in many of the same negative effects to the community that are caused by excessive browsing. However, other effects from this kind of removal are direct and immediate, including reduction of physical community structure and wildlife habitat values. Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.

For this item consider all woody vegetation together: trees and shrubs of all age classes, except for the invasive species (*Elaeagnus angustifolia* [Russian olive], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar]). Record the amount of cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.). Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). This question is not so much to assess long term incremental harvest, as it is to assess the extent that the stand is lacking vegetation that would otherwise be there today. Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

**Scoring:** (If the site has no trees or shrubs AND no cut plants or stumps of any trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.)

**3** = None (0% to 5% of live woody vegetation expected on the site is lacking due to cutting).

**2** = Light (5% to 25% of live woody vegetation expected on the site is lacking due to cutting).

**1** = Moderate (25% to 50% of live woody vegetation expected on the site is lacking due to cutting).

**0** = Heavy (More than 50% of live woody vegetation expected on the site is lacking due to cutting).

**6. Human Alteration of Polygon Vegetation.** Human alteration of the vegetation is meant to include all changes to the plant community composition or structure on the polygon caused by human actions (e.g., logging, mining, roads, construction, or development) or by agents of human management (e.g., livestock). It is not meant to include transitory or short-term removal of plant material that does not impact plant community composition (i.e., grazing at carefully managed levels). Of concern are the kinds of change that diminish or disrupt the natural wetland function of the vegetation. These include, but are not limited to, vegetation clearing, changing plant community composition (e.g., replacing willows with rose and buckbrush, woody species with herbaceous species, etc.), replacing native plants with tame plants, replacing deep rooted plants with shallow rooted plants, and/or replacing tall species with short species. On polygons adjacent to deep water, remember that the polygon extends out to where the water is two meters deep. (**NOTE:** Do not count the same area twice by including it as both a vegetative and a physical alteration, unless there clearly are both kinds of alteration. Decide into which category a particular effect should go. For example: A timber harvest may clear vegetation, but not necessarily cause physical damage on one area; while on another area cause both clearing of vegetation and disruption of the soil by skidding of logs.)

**Scoring:**

**6** = Less than 5% of polygon vegetation is altered by human activity.

**4** = 5% to 15% of polygon vegetation is altered by human activity.

**2** = 15% to 35% of polygon vegetation is altered by human activity.

**0** = 35% or more of polygon vegetation is altered by human activity.



**7. Human Alteration of Polygon Physical Site.** This evaluation of human alteration of the physical site is meant to include all changes to the physical attributes of the site caused by human actions (e.g., logging, mining, housing development) or by agents of human management (e.g., livestock). The kinds of physical change that diminish or disrupt the natural wetland functions on the site include, but are not limited to, hummocking, pugging, and trails by livestock; human roads, trails, buildings, landscaping, boat launches/docks, beach clearing and building, or rip-rapping shores and banks. (**NOTE:** Do not count the same area twice by including it as both a vegetative and a physical alteration, unless there clearly are both kinds of alteration. Decide into which category a particular effect should go. For example: A cottage owner may clear vegetation to gain a view of the lake without causing physical damage to one area; whereas, if he/she hauls in sand to enhance the beach, there is also physical alteration.)

**Scoring:**

**12** = Less than 5% of the polygon is physically altered by human activity.

**8** = 5% to 15% of the polygon is physically altered by human activity.

**4** = 15% to 35% of the polygon is physically altered by human activity.

**0** = 35% or more of the polygon is physically altered by human activity.

**8. Human-Caused Bare Ground.** Bare ground is exposed soil surface (not covered by plants, litter or duff, down wood, or rocks larger than 2.5 inches [6 cm]). Bare ground may result naturally from several processes (i.e., sedimentation, flood erosion, fire, tree fall, and exposure of lakebed by low water level), but that caused by human activity always indicates an impairment of wetland health. Exposed soil is vulnerable to erosion and is where weeds become established. Bare soil is not producing, nor providing habitat. Sediment deposits and other natural bare ground are excluded as normal and probably beyond management control. Human land uses often causing bare ground include livestock grazing, recreation, off road vehicle use, and resource extraction activities. After considering the causes of all bare ground on the site, the evaluator must estimate what percent of the site (polygon) area is human-caused bare ground.

**Scoring:**

**6** = Less than 1% of the site is human-caused bare ground.

**4** = 1% to 5% of the site is human-caused bare ground.

**2** = 5% to 15% of the site is human-caused bare ground.

**0** = 15% or more of the site is human-caused bare ground.

**9. Degree of Artificial Removal of Water.** Although water levels naturally fluctuate on a seasonal basis in most systems, many wetland systems are affected by water removal for human uses. This artificial removal of water level often does not follow a temporal regime conducive to maintaining healthy native wetland plant communities. The result is often a barren band of shore exposed for much of the growing season. This withdraws soil water from the rooting zone of established shore vegetation communities, causes shore material to destabilize, and provides sites for weeds to invade. Such conditions are extremely detrimental to the riparian vegetation, site productivity, and wildlife values.

Not all lentic wetlands evaluated with this form will have surface water potential, but any wetland may have its water table degraded by draining, pumping, or diverting its surface or subsurface supply. On such lentic wetlands as marshes and wet meadows, look for evidence of drainage ditching, pumping, and the interruption of normal surface drainage inputs by livestock watering dugouts, cross slope ditches, or dams upslope.

In this item the evaluator is asked to categorize the degree to which the system is subjected to artificially rapid or unnaturally timed fluctuations in water level. Reservoirs intended for storage of water for power generation, irrigation, and/or livestock watering typically exhibit the most severe effects, but water may be diverted or pumped from natural systems for many other reasons (domestic use, industrial use, livestock watering, etc.). This item requires the evaluator to make a subjective call by

choosing as a “best fit” one of the categories of drawdown severity described below. (**Note:** Be careful to consider the scale of the water body as it relates to the scale of water removal. Pumping a small dugout full of water for livestock might severely impact a two acre slough, but be negligible to a lake covering a section of land.)

Be sure to document the grounds for your estimate here. If there is no way to know with any reasonable degree of certainty how much water is being removed, it may be better to document the situation and to “zero out” this item (not answer it). During periods of drought lakebeds become exposed and often exhibit wide zones of almost barren shore. The evaluator must be careful not to attribute this natural phenomenon unfairly to a human cause.

#### Categories of Lentic Water Removal Severity

| CATEGORY      | DEFINITION                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Not Subjected | The waterbody is not subjected to artificial drawdown.                                                                                                                                                                                                                                                                                                                                                                                     |
| Minor         | The waterbody is subject to no more than minor artificial water level change. The shore area remains vegetated and withdrawal of water is limited or slow enough that vegetation is able to maintain growth and prevent exposed soil. A relatively narrow band affected by the water level fluctuation may support only annual plants.                                                                                                     |
| Moderate      | The waterbody is subject to moderate quantities, speed and/or frequency of artificial water level change. Where water is removed, it is done in a way that allows pioneer plants to vegetate at least half of the exposed area resulting from drawdown. Where water is added, some flooding may occur at levels or times not typical to the area/season.                                                                                   |
| Extreme       | The waterbody is subjected to extreme changes in water level due to volume (extent), speed and/or frequency of artificial water addition or removal. Frequent or unnatural levels of flooding occur where water is added, including extensive flooding into riparian and/or upland areas; or no natural annual drawdown is allowed to occur. In extreme artificial drawdown situations, a wide band of exposed bottom remains unvegetated. |

#### Scoring:

**9** = The waterbody, or wetland, is “Not Subjected” to artificial water removal

**6** = The degree of artificial water removal is “Minor”

**3** = The degree of artificial water removal is “Moderate”

**0** = The degree of artificial water removal is “Extreme”