THERRIAULT CREEK RIPARIAN REVEGETATION PLAN

PREPARED FOR:

KOOTENAI RIVER NETWORK
P.O. BOX 491
LIBBY, MT 59923

PREPARED BY:

GEUM ENVIRONMENTAL CONSULTING, INC.
307 STATE STREET, P.O. BOX 1956
HAMILTON, MT 59840

Table of Contents

Introduction

Purpose and Need

This document describes a riparian revegetation plan for a restored reach of Therriault Creek. The document was prepared by Geum Environmental Consulting, Inc. (Geum) for the Kootenai River Network (KRN). Therriault Creek is a tributary to the Tobacco River located about six miles south of Eureka, Montana. This riparian revegetation plan includes assessment results and recommendations for a 9,500 foot long reach of the stream where an extensive channel restoration effort was completed in 2004 and 2005. The goal of restoration was to reduce nonpoint source pollution to Therriault Creek and the Tobacco River through mitigation of chronic instream sources of sediment and to restore native fish habitat through the use of natural stream stabilization techniques that would allow the stream to adjust slowly over time as a natural, dynamic stream system (CITE). A focused revegetation effort is important to achieve the functioning mosaic of riparian plant communities necessary to achieve this goal.

The initial request for this revegetation plan was prompted by poor survival of plants installed during early revegetation efforts. Initial revegetation of the restored channel included installation of 5,000 riparian shrubs, 10,000 dormant willow cuttings and seeding of disturbed areas. While this revegetation plan includes treatments to improve containerized plant survival, the plan also includes additional revegetation treatments to restore site conditions that will support native riparian woody vegetation along the restored Therriault Creek channel.

Methods

On August 29, 2006 Geum collected data within the Therriault Creek restoration project reach to support development of a riparian revegetation plan. Data collection included: identification of existing plant communities and major weed infestation areas; assessment of natural vegetation recruitment potential; and evaluation of ecological processes occurring on the site. In addition to the site visit and assessment, methods used to develop this revegetation plan also included a review of wetland documentation for the site completed in 1999 and 2000 by the Natural Resources Conservation Service (NRCS) and an evaluation of historical, pre-project and current aerial photos of the site to ascertain historical land use practices and the geomorphic succession of Therriault Creek in the project reach.

Field data collection and review of existing and historical information was used to determine the major limiting factors to establishing woody riparian vegetation along the channel, and to develop strategies for restoring or enhancing natural processes to promote long-term establishment of desired riparian plant communities in the project reach.

Historical Conditions

Historically, conditions within the Therriault Creek restoration project reach were likely created by a different disturbance regime than is present today. Historical disturbances were likely periodic and intense; for example, beaver dam construction and failure probably induced flooding, which likely caused patchy shifts in vegetation cover types as hydrologic regimes changed. Occasional wild fire may have also affected vegetation patterns over longer time frames than beavers (evidence of fire was seen in soil layers within exposed banks). More recently, conversion of the site from a stream complex dominated by woody riparian plant communities to one dominated by introduced agricultural grasses has occurred. Evidence of this shift is apparent from historical aerial photos, which show a significant reduction in streamside vegetation occurring between 1947 and 1963 (Figure 1). Riparian vegetation was likely removed in conjunction with stream straightening and relocation to increase available land for agricultural production. Grazing and other land management activities associated with agriculture likely precluded native woody vegetation from recolonizing the relocated channel, and further reduced native species composition within the converted meadow wetland.

Based on data collected in 1999 and 2000 by NRCS, it was estimated that at least 80 percent of the 68 acre meadow within the project reach was historically wetland dominated by willow, alder, and other woody plant communities with wetter inclusions of sedges (NRCS 2000). Restoring this type of diverse riparian and wetland system is the desired future condition of the project reach.

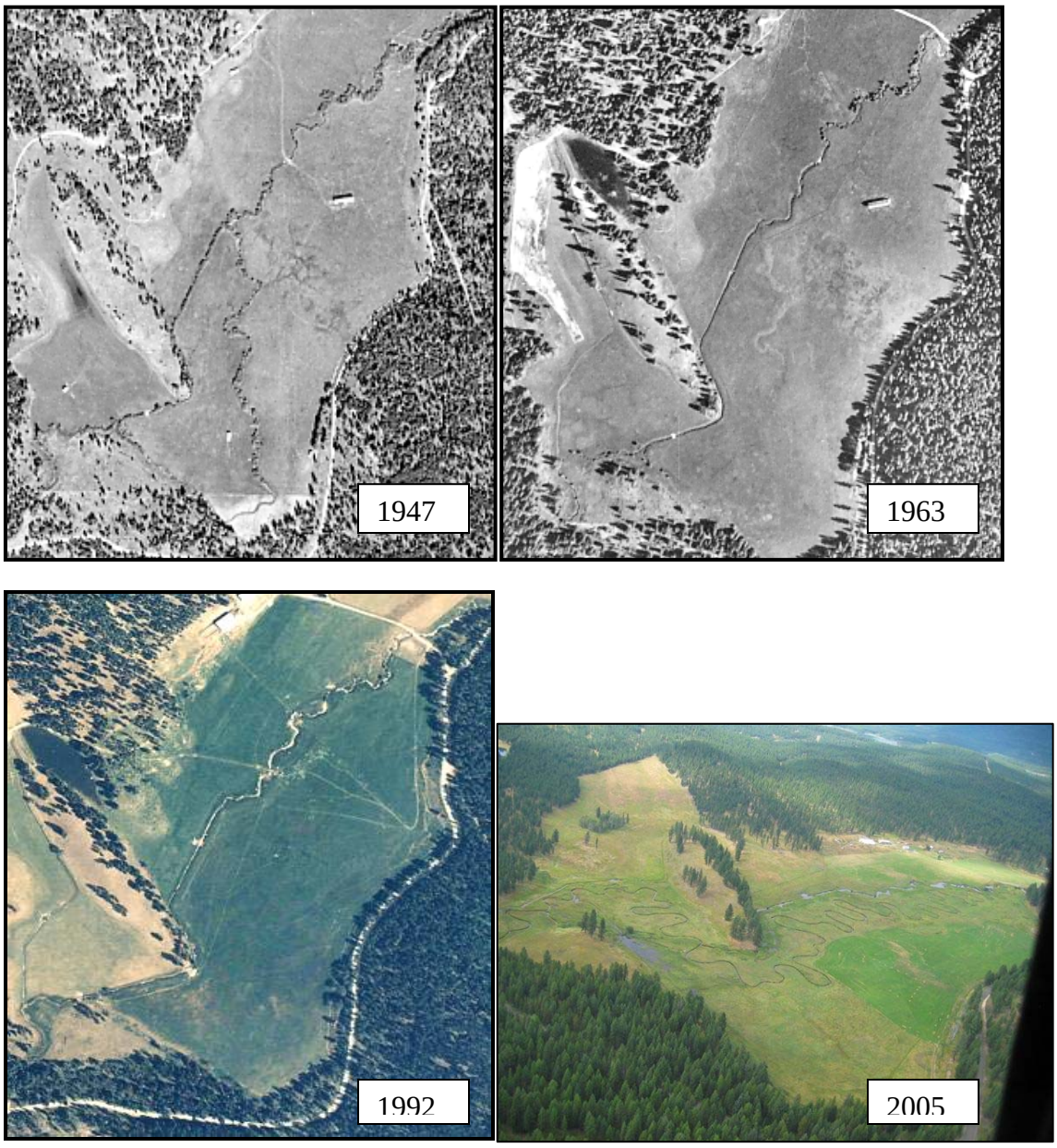

Figure 1. Aerial photos of Therriault Creek restoration project reach dated 1947 (upper left), 1963 (upper right), 1992 (lower left) and 2005 (lower right).

Existing Conditions

This section describes existing conditions within the project reach. Existing channel, soils, and plant communities are described below.

Channel

In 2004 and 2005, Therriault Creek was restored to a slightly entrenched, meandering single threaded channel type through the project reach. The new channel location is shown in Figure 1 (bottom right photo). The constructed channel transitions from a moderate gradient channel with a moderate width to depth ratio, in the upper portion of the reach, to a low gradient channel with a very low width to depth ratio in the lower portion of the reach. The channel gradient lessens proportionately to the valley gradient, moving down valley. The new channel was constructed with dimensions intended to provide channel connectivity with the adjacent floodplain. In addition, channel dimensions were intended to maintain habitat features such as pools and riffles and be capable of balancing the sediment load entering the reach.

The stability of the channel is tied to the structure and composition of riparian vegetation which provides rooting structure to maintain lateral channel stability by preventing accelerated lateral erosion. The new Therriault Creek channel is located within a prior converted riparian and wetland shrub meadow that currently consists of primarily non-native grass species.

The 2004 and 2005 channel work along Therriault Creek restored appropriate channel pattern, profile and dimension for this valley type. Thus, the channel restoration created hydrologic and geomorphic conditions necessary to sustain ecological processes that will support long term establishment and maintenance of a mosaic of riparian plant communities. Proper channel dimensions allow the channel to access the floodplain during most years, resulting in a hydroperiod that supports native shrubs. Balanced sediment transport and deposition allows for processes such as scour and deposition within the channel and floodplain, which create sites and substrate where native willows and other shrubs can establish.

Soils

Riparian soils are distributed and developed by hydrologic processes such as inundation, fluctuating water tables, and deposition of fluvially transported sediments. The mineral component of riparian soils originates as stream deposited sediment in stratified layers of varying textures. The periodic deposition of sediment in riparian areas is accompanied by the import and flushing of organic matter and nutrients from the site by water resulting in a highly dynamic soil environment (Naiman et al. 2005). Soils within the project reach exhibit strong evidence of having developed under the influence of hydrologic processes. However, soils have also been influenced by a history of agriculture.

Within the project reach soil data is available from NRCS soil maps, soil pit data collected by NRCS during early stages of the initial restoration planning, and general

observations made by Geum during field visits in summer 2006. Two mapped soil types occur within the project reach. Both soil types are poorly drained and formed in alluvial deposits. Within the upstream, steeper portion of the valley, soils consist of loam or silt loam texture. In the downstream, gentler portions of the valley soils transition to muck and peat type soil formed in organic deposits (NRCS 2000). The transition between the two soil types corresponds with a break in valley slope and also the break in channel type described above. This soil break also corresponds with a break in vegetation types between those dominated by drier pasture grasses, and those consisting of wetter species such as sedges and rushes. These vegetation communities are described in the following section.

Soil pit data collected by NRCS in 1999 generally verified these mapped soil types. In general, soil pits dug throughout the meadow showed indicators of having formed under inundated or wet conditions (hydric). Observed soil textures were primarily silt. Soil pits near the valley slope break had a layer of mucky peat present below approximately 15 inches. The mucky peat layer extends to the bottom of observed pits in this area (greater than 20 inches). Because peat forms very slowly and only under extended periods of inundation, it is likely that this area was ponded or had water tables very near the ground surface for long periods during the growing season each year historically. Organic layers, such as peat, under mineral layers, suggest the process of beaver dam formation and resulting ponding, followed by dam breaches and concurrent sediment flushes.

In addition to review of mapped soil types and soil pit data, general observations of exposed stream banks along the restored channel made by Geum, were also useful in determining the range of soil textures and historical processes occurring in the project reach. Observations of these exposed areas showed a transition in a downstream direction that generally corresponded to the shift in vegetation communities and mapped soil types. Observed soil textures in the upper reach stream banks were primarily silt with moderate levels of ash concentrations and lenses of thick clay. At the valley break, stream bank soil composition transitioned, to a mixed muck/silt texture. Downstream of the valley break, decomposing conifer wood and bark was present in exposed banks, indicating that a portion of the meadow may have been dominated by conifers in the past, or that large conifer logs were recruited and retained in the reach under inundated conditions (e.g. beaver dam induced ponding). Spruce are present immediately downstream of the project reach, suggesting the downstream portion of the project area may have once been a spruce bottom.

Based on reviewing existing data and observations of existing soil conditions within the project reach, it is not likely that soil texture and composition (particularly organic matter content and nutrient levels) will limit riparian revegetation efforts. Conversion of the site to agriculture has likely shifted nitrogen levels in the upper portion of the soil profile. Elevated nitrogen levels may favor weedy species and aggressive grasses, but will not necessarily preclude native shrub establishment, aside from possibly stimulating more vigorous grass and forb competition. Treatments proposed in the *Revegetation Plan* section below are aimed at limiting competition with these species and shifting the site to

one better suited to support native woody vegetation. This approach is more cost effective than treatments aimed at directly altering soil nutrients.

Plant Communities

Plant communities within the project reach are representative of the altered disturbance regime that has existed at the site for approximately the past 50 years. Changes in hydrology and land use have led to native wetland and riparian plant communities being replaced by crops or post-agricultural assemblages, or by mixed exotic species types. This conversion of the site from a woody riparian complex to agricultural pasture has resulted in simpler topography; more homogeneous light, nutrient, and hydrologic regimes; few barriers to herbivory; and a stable, self-sustaining non-native grass community. These changes are limiting the sites' potential to support native shrubs and trees.

Based on observations made by Geum during the summer 2006 site visit, the following plant communities are found in the project reach. Plant communities are listed by their occurrence through the project reach from upstream to downstream.

- Bebb willow
- Pasture grasses
  - Drier pasture grasses
  - Wetter pasture grasses
- Quackgrass
- Pond associated plant communities
- Wetter quackgrass
- Sedges/rushes
- Spruce/Red-osier dogwood

Each of these plant communities is described in more detail in the following section, *Revegetation Plan*. In general, there are distinct breaks between these plant community types. These breaks are shown on Figure A-1 in Appendix A. Within each plant community there are typically small inclusions of other plant community types resulting from subtle changes in floodplain topography. These inclusions are shown on the Figure A-1 in Appendix A. A species list for each plant community is also provided in Appendix A. Weedy species are present throughout the project reach. An (*) is placed next to all species recorded during field visits that are considered invasive or weedy in the plant lists provided in Appendix A.

Revegetation Plan

Introduction

Based on our assessment of the project reach and previous communications with KRN, the objectives for revegetation of the Therriault Creek restoration project reach include:

- Protect the stability of the restored channel using native woody vegetation;
- Enhance habitat for native fish populations through use of native woody vegetation;
- Limit invasion and continued spread of Canada thistle and other noxious weeds;
- Protect surviving containerized plantings from initial revegetation efforts; and
- Create conditions that will promote natural revegetation by native species.

The treatments included in this revegetation plan are aimed at achieving these objectives. To achieve project objectives will require creating conditions in the project reach aimed at restoring or enhancing the processes necessary for native woody vegetation to become established and persist along the reach over the long term. Previous restoration work at the site created a stream channel that is connected to the floodplain and capable of balancing sediment transport and deposition along the channel length; both of these are important processes to support riparian shrub establishment and maintenance. Because these processes have been restored, the most important remaining factor limiting restoration of the Therriault Creek riparian and wetland plant communities is the existing agricultural plant community. Established grasses, and the simplified structure and ecological processes associated with an agricultural floodplain, are limiting the site's potential to support native shrubs and trees. As described earlier, this conversion has resulted in simpler topography; more homogeneous light, nutrient, and hydrologic regimes; few barriers to herbivory; and a stable, self-sustaining non-native grass community. The techniques and strategies outlined in this revegetation plan are aimed at converting the site from one favoring non-native pasture grasses and invasive species to one capable of supporting native woody riparian vegetation.

This section describes an initial revegetation phase for the project reach. The purpose of this initial phase is to determine what treatments will be most effective at the site to control weedy species and support native shrub growth and establishment. Additional phases of the project are described in a later section.

Revegetation Strategies and Techniques

Given site constraints and riparian revegetation objectives described above, this section describes the recommended revegetation strategies and techniques for the project reach. Detailed descriptions of each technique are provided in Appendix B. Revegetation strategies and techniques are applied to the project reach by plant community. The existing plant communities represent a range of ecological conditions and processes occurring on the site. For this reason, each plant community will require different treatments and different levels of treatment to enhance, restore or mimic ecological processes missing in that community. Applying that approach to each community will

ultimately result in a complex mosaic of native riparian vegetation communities throughout the project area. Recommended treatments and techniques include:

- **Protection** of original shrub plantings with browse protectors and mulch mats;
- **Planting** one gallon native shrubs from a local seed source at select locations along the channel including mulch mats, browse and vole protection;
- **Solarization** (temporary and long-term) of select areas dominated by quackgrass and/or reed canarygrass followed by **supplementing the seed bank** with native wetland species;
- **Herbicide** application in select areas to control Canada thistle, yellow toadflax and reed canarygrass spread;
- **Vegetated soil lifts** at outer meander bends near the upstream end of the project where there is risk of channel avulsion;
- **Coir logs** combined with dormant willow cuttings at the toe of selected outer meander bends;
- **Live willow fascines** (bundles) in depositional areas and in conjunction with coir log treatments; and
- **Large woody debris** placed in the channel and extending into the floodplain at the downstream end of the project reach.

Locations for each treatment are generally described below by plant community. Approximate quantities of each treatment by plant community are summarized in Table 1. Preliminary treatment locations are shown on Figure C-1 in Appendix C.

Table 1. Overview of revegetation treatments and approximate quantities of treatments by plant community.

Plant Community / **Treatment**	Bebb willow	Drier pasture grass	Wetter pasture grass	Quackgrass	Pond	Wetter Quackgrass	Sedge/ Rush	Spruce/ Red-osier dogwood
Residual shrub protection	50	100	150	100	No	100	No	No
Planting	No	0	400	450	No	No	No	No
Solarization (temporary)	No	No	No	0.1 ac	No	0.3 ac	No	No
Solarization (planted)	No	No	0.05 ac (100 plants)	0.05 ac (100 plants)	No	No	No	No
Herbicide	No	8 ac*	N/A	0.55 ac	No	5 ac	1.15	No
Vegetated soil lifts	No	100’	No	No	No	No	No	No
Coir logs	No	No	100’	300’	No	No	No	No
Willow fascines	No	100’	100’	300’	No	No	No	No
Large woody debris	No	No	No	No	No	3-5 structures	No	No

*Includes herbicide treatments in both ‘Drier Pasture grass’ and ‘Wetter pasture grass’ plant communities.

Revegetation Strategies by Plant Community

This section describes the existing plant communities within the project reach and the restoration strategies and techniques recommended for each plant community. Plant community distribution through the project reach is shown on Figure A-1 in Appendix A. Revegetation treatments for the project reach are shown on Figure C-1 in Appendix C and described in detail in Appendix B.

Bebb willow community

The Bebb willow plant community occurs directly adjacent to the channel at the upstream end of the project reach (upstream of the property access road) (Figure 2). The Bebb willow community type is a common riparian plant community in northwestern Montana (Hansen et al. 1995). Bebb willow (*Salix bebbiana*) is the dominant shrub species in this plant community with lesser amounts of Geyer willow (*Salix geyeriana*) and sandbar willow (*Salix exigua*). Bebb willow communities often represent a browsing/grazing disclimax of the Geyer willow dominant habitat type (Hansen et al. 1995). A Geyer willow habitat type may represent the potential natural community for the upstream portions of the project reach. The stream channel appears to have incised through this reach resulting in loss of connectivity with the floodplain and reduced the extent of riparian vegetation. The plant community occurs on low elevation benches that have formed along the channel at the incised elevation. These benches are supporting willows and other native shrubs, sedges, forbs and grasses. In addition, this section of channel was planted with containerized shrubs and dormant willow cuttings during initial restoration efforts. Planted shrubs are surviving where they were installed on the low floodplain benches along the channel.

Overall, this plant community consists of desired species directly along the stream channel; containerized plants and willow cuttings are surviving; and riparian maintenance processes such as deposition and scour, natural recruitment and sufficient hydroperiod are present. Residual surviving shrubs that were planted during initial restoration should be protected from browse and vole predation and competition from grasses and weeds to the extent possible.

Figure 2. Bebb willow plant community along Therriault Creek at upstream end of project reach. Plant community occurs directly along channel (photo right and center) on floodplain benches.

Pasture Grasses

Drier Pasture Grasses

The 'Drier Pasture Grasses' plant community occurs near the upstream end of the project reach. The plant community is characterized by non-native pasture grasses such as quackgrass (*Agropyron repens*), common timothy (*Phleum pratense*), redtop (*Agrostis stolonifera*), meadow foxtail (*Alopecurus pratensis*) and smooth brome (*Bromus inermis*) (Figure 3). A wide range of weedy species are also present such as Canada thistle, common mullein (*Verbascum thapsus*) and yellow toadflax (*Linaria vulgaris*). In addition to aggressive grasses and forbs, small numbers of shrubs are present from initial revegetation efforts; however, these shrubs are threatened by competition from aggressive pasture grasses, weedy species and browse by both deer and voles.

The channel through this plant community is steeper and the water table may be slightly lower resulting in a drier species composition in general compared with downstream reaches. There is a chance more desirable species such as sedges and rushes will begin to colonize this plant community naturally in response to the restored channel elevation. However, the site is currently dominated by aggressive grasses that form dense root mats, and other invasive species are present. Therefore, it is not likely the site will transition to a riparian plant community consisting of shrubs or trees because there are few available niches where these species can colonize and establish. Restoring this plant community to a native riparian shrub community will require using herbicide to aggressively treat invasive species during the first few years. Herbicide is the most cost effective initial control method when targeting a variety of species over relatively large areas.

Residual surviving shrubs that were planted in the reach during initial restoration should be protected from browse and vole predation and competition from grasses and weeds to the extent possible. No additional containerized planting is proposed for this plant community; however, if weed control is effective, containerized planting focused on floodplain swales and outer meanders should be implemented in 2008.

In addition to these treatments, two outer meander bends were identified where high flows in spring 2006 left the constructed channel and accessed the former channel resulting in significant down-cutting of channel plugs. For this reason, these sites are considered high risk for channel avulsion during large flows and more aggressive revegetation is recommended at these sites to quickly establish dense woody vegetation. To achieve immediate bank stability, vegetated soil lifts are proposed at these sites.

Wetter pasture grasses

The 'Wetter Pasture Grasses' plant community occupies lower elevation sites, such as low benches along the channel and floodplain swales, within the 'Drier Pasture Grasses' plant community described above (Figure 4). Species comprising this plant community are similar to the 'Drier Pasture Grasses' plant community, but include sedge (*Carex*) species, Baltic rush (*Juncus balticus*) and wetland forbs such as common willow-herb (*Epilobium ciliatum*).

Wetter species within this plant community indicate a closer connection with groundwater than in the 'Drier Pasture Grasses' community. In general, the 'Wetter Pasture Grasses' plant community consists of desirable species. It is possible that riparian shrubs may naturally colonize isolated sites within this plant

Figure 3. Pasture grass plant community along Therriault Creek at upstream end of project reach. Photo shows drier pasture grasses and invasive species that occur on the higher terrace elevation.

community due to its occurrence in lower elevation areas of the floodplain where seed may be deposited during overbank flows. However, the majority of this site may not shift to native woody vegetation due to the vigorous, stable grasses currently occupying most of the sites. Treatments for this plant community are similar to those described above for 'Drier Pasture Grasses,' and include herbicide application and residual shrub protection. In addition to these treatments, containerized plants will be installed along some outer meander bends in conjunction with mulch mats, and deer and vole browse protection.

Coir logs and willow fascines will also be installed directly along the stream channel to establish woody riparian shrubs. This bioengineering technique will allow woody vegetation to establish within the bankfull channel where there is less competition from grasses, and in closer proximity to the water table and stream flows.

Figure 4. Pasture grass plant community along Therriault Creek at upstream end of project reach. Photo shows wetter pasture grass plant community that occurs in floodplain depressions and along the channel.

Quackgrass

The 'Quackgrass' plant community occurs along much of the project reach and consists primarily of quackgrass (*Agropyron repens*), with lesser amounts of other non-native pasture grasses and weedy species such as common timothy (*Phleum pretense*), smooth brome (*Bromus inermis*) and Canada thistle (Figure 5). Quackgrass develops a dense mat of interconnected lateral roots (rhizomes), which form a heavy sod making natural colonization of native shrubs or even desirable grasses, forbs or sedges difficult. New infestations of quackgrass arise from seeds or rhizomes making this species very difficult to control. Small numbers of shrubs, planted during initial revegetation efforts, are present in this plant community. Some shrubs occur at the channel margin below the quackgrass root depth and are mostly willows. Due to these shrubs' location directly on stream banks, browse protection is not practical and weed protection is not necessary. All other residual shrubs, not immediately adjacent to the stream bank within this plant community, will receive treatment to protect them from competition and deer and vole browse.

In this plant community, the primary revegetation techniques are: increase roughness and woody vegetation along the channel by installing coir logs and willow fascines; limit competition from invasive grasses; and planting woody vegetation in key areas along the channel. Herbicide application and solarization weed control treatments will reduce grass and weed cover and increase ecological niches where native shrubs and herbaceous plants can grow.

Figure 5. Quackgrass plant community along Therriault Creek at upstream end of project reach.

Pond associated plant communities

Various plant communities are associated with the former channel location that has been abandoned and plugged at various intervals, resulting in seasonally and perennially ponded water (Figure 6). The hydroperiod resulting from fluctuations in water levels will determine if these plant communities persist overtime. Plant species occurring in pond plant communities include American mannagrass (*Glyceria grandis*), common cattail (*Typha latifolia*) and softstem bulrush (*Scirpus validus*). Species such as smartweed (*Polygonum spp.*) and common willow-herb were observed growing on downed logs

within the ponded areas. Some weedy species, such as Canada thistle, are present in small amounts.

In general, these plant communities are wetlands consisting of native species that provide good habitat for waterfowl. In this plant community, the primary revegetation recommendation is to monitor for new weed infestations and response of plant communities to water level fluctuations over time.

Figure 6. Pond plant communities associated with former Therriault Creek channel location.

Wetter Quackgrass

The 'Wetter Quackgrass' plant community occurs down valley from the 'Quackgrass' plant community where the valley gradient is less, and where soils have more hydric characteristics. The transition between the two plant communities occurs near the valley gradient and soil type break described earlier. The 'Wetter Quackgrass' plant community consists primarily of quackgrass and other non-native pastures grasses, but also includes native sedges and forbs such as Bebb sedge (*Carex bebbii*) and small-winged sedge (*Carex microptera*) (Figure 7). Reed canarygrass is also present within the plant community, primarily in small clumps (Figure 10).

Within this plant community low topography depressions (swales) are generally wetter than the rest of the plant community. These swales are located in sod excavation and pond overflow areas (Figures 8 and 9). These swales support a diverse mix of sedges and rushes, and include aquatic plant species such as pale smartweed (*Polygonum lapathifolium*), common watercress (*Rorippa nasturtium-aquaticum*) and water speedwell (*Veronica anaqallis-aquatica*).

Conditions in the 'Wetter Quackgrass' plant community lend themselves to natural colonization by desired woody plant species more so than upstream drier reaches. Moister site hydrology is probably due to finer soil textures, so techniques will focus on giving sedges a competitive advantage over the more aggressive quackgrass. The channel and floodplain are generally well connected in this plant community, but shifting the hydrology in this reach to promote localized areas of extended overbank flows may

promote natural recruitment of woody vegetation and conversion from grasses to sedges and rushes. Revegetation treatments for this plant community include placement of large woody debris in the channel and floodplain to promote floodplain inundation and create areas of deposition for seed recruitment, and microsites for shrub establishment. No additional containerized planting is proposed within this plant community. The area should be monitored for natural recruitment of desired vegetation.

Figure 7. Wetter quackgrass plant community along Therriault Creek.

Figure 8. Sod excavation area within 'Wetter Quackgrass' plant community observed in winter 2005.

Figure 9. Sod excavation area within 'Wetter Quackgrass' plant community where native wet species are colonizing observed in summer 2006.

Figure 10. Overview of lower portion of reach showing primarily 'Wetter Quackgrass' plant community with inclusions of 'Drier pasture grass' (dull brown) and reed canarygrass (brighter green and slightly taller clumps).

Sedge/Rush

The 'Sedge/Rush' plant community occurs at the downstream end of the project reach. This area is wetter than the 'Wet Quackgrass' plant community. The 'Sedge/Rush' plant community receives return flow from a pond located along the toe of the slope at the southern end of the property. The species composition is similar to the 'Wetter Quackgrass' plant community, but cover of sedges and rushes is higher and wetter species such as tufted hairgrass (*Deschampsia cespitosa*), common willow-herb and American managrass are present. A dense stand of reed canarygrass occurs along the toe of the slope running east/west along this plant community.

The 'Sedge/Rush' plant community consists primarily of native wetland species. Reed canarygrass and Canada thistle within this area should be controlled using herbicide treatments. No other revegetation treatments are proposed. The plant community should be monitored for natural woody vegetation recruitment and additional weed infestations.

Spruce/Red-osier dogwood

The 'Spruce/Red-osier dogwood' plant community occurs downstream of the project reach where the valley width narrows. This community is a common riparian type in northwestern Montana occurring on gently sloping alluvial terraces or benches (Hansen et al. 1995). The overstory canopy is dominated by Englemann spruce (*Picea engelmannii*). A diverse understory of shrubs is present including willow, red-osier dogwood (*Cornus stolonifera*), mountain alder (*Alnus incana*), and western serviceberry (*Amelanchier alnifolia*). A diverse herbaceous community is also present including native wetland species such as beaked sedge (*Carex utriculata*), tufted hairgrass and large-leaved avens (*Geum macrophyllum*). Dense patches of reed canarygrass are present along the channel, but do not appear to be limiting overall riparian function. This plant community is likely a potential natural community for the lower portion of Therriault Creek within the project reach (from the point where the channel turns northwest extending downstream to the end of the reach) and other similar valley types along Therriault Creek.

Figure 11. Spruce/red-osier dogwood plant community downstream of the project reach.

Weed Control

Weed control will be an important tool for restoring desired native riparian plant communities throughout the project reach. This will require active, aggressive management for the first couple of years or longer to reduce weed density, thereby reducing competition for light, water, and nutrient resources that desired species will need to become established. Weed control techniques like herbicide and solarization are intended to reduce weed density and create openings where desirable native plants can become established. For weed control to be effective long-term it is necessary for a native plant community to establish that can naturally resist competition from invasive species, making it important to take a long-term approach to restoration of this site. This only works if openings created by weed control activities are colonized by desired species and not by other weeds; therefore, it will be important to monitoring these sites closely. Based on monitoring results, it may be determined that additional revegetation actions are necessary such as seeding or planting. If containerized shrubs become established, the shade from the shrub canopy will help suppress aggressive grasses.

Within the project reach, Canada thistle, yellow toadflax (*Linaria vulgaris*) and reed canarygrass are the primary species targeted for weed control actions. Numerous other non-native, invasive or weedy species are present within the project reach. These will either be indirectly controlled by targeting other species or are not feasible for control. For example, quackgrass is so prevalent that eliminating it would also eliminate desirable plant species and potentially destabilize the floodplain. Figure A-2 in Appendix A shows the distribution of weeds that should be targeted. At the time of field surveys, approximately 10 acres of Canada thistle, 0.15 acres of yellow toadflax (two sites identified near upstream end of project reach) and 4.5 acres of reed canarygrass were recorded. The areas identified in Figure A-2 should be targeted for weed control beginning in 2007. Additional details describing herbicide effectiveness and application are provided in Appendix B.

Project Phasing

To successfully convert the riparian vegetation along Therriault Creek within the project reach to native shrubs and trees will require a multi-year phased approach. Plant

community response to revegetation treatments should be monitored frequently, and later project phases should be adjusted based on monitoring results. A commitment by the land owner and KRN to maintain the project and monitor progress along the reach will be key to achieving project objectives. This revegetation plan provides detailed recommendations for implementing the first year of a multi-year effort. As described earlier, the intention of this initial phase is to provide a basis for determining what treatments will be most effective at the site to control weedy species and support native shrub growth and establishment. Effectiveness monitoring results should guide future years' efforts. Appendix D provides a table describing the monitoring recommendations for each year and how the results of that monitoring should guide additional revegetation treatments implemented through 2009. Achieving project objectives may require activities past 2009. Appendix D also provides a timeline for implementing treatments recommended for the initial phase, monitoring and maintenance activity timing and an extended timeline for revegetation efforts through 2009. Appendix E provides a cost estimate for Phase I (2007) activities and Phase II (2008) and Phase III (2009) monitoring and maintenance costs. Effectiveness monitoring is described in more detail below.

Monitoring

To achieve project objectives over time, it will be necessary to observe how the strategies and techniques applied on the ground influence ecological processes at the site. By observing and documenting natural recruitment, invasive species colonization and any shifts in species composition that reflect positive changes in hydrology and soil nutrient regimes, it will be possible to determine which revegetation actions are appropriate for future phases. The following table (Table 2) provides details on monitoring recommendations for the project reach. Appendix C provides guidance on how results of monitoring should be used to determine additional revegetation treatments.

Table 2. Summary of effectiveness monitoring to determine response of the site to revegetation treatments.

Monitoring Parameter	Metrics
Herbicide	Monitor species composition and relative abundance (focusing on detecting new infestations and reduction of infestation size of target species)
Containerized shrubs & protected residual shrubs	Survival of planted shrubs Effectiveness of deer and vole protection
Temporary solarization	Observe transition in species composition and relative abundance
Bioengineering	Willow cutting survival Structural stability
Large woody debris structures	Observe shifts in species composition in adjacent floodplain areas Observe deposition and colonization of woody species around structures
Species composition transition	Observe natural shifts in species composition particularly in wetter plant communities
Natural recruitment	Observe natural shifts in species composition particularly in wetter plant communities

Maintenance

It is necessary to maintain planted material and bioengineering structures during at least the first two years after initial project implementation. The most common maintenance needs are described below.

Watering

Watering is necessary to improve survival of planted material. Planted material should be deep watered (watering 1-2 minutes with constant stream or 5 to 10 gallons of water per plant) three to four times between July and September for a minimum of two years as roots establish. Results of monitoring will dictate if additional years of watering or more frequent watering are necessary.

Weeding

Weed control (brush) blankets will be installed with each containerized shrub, but hand weeding may be necessary if weeds, particularly aggressive grass species, grow up through slits or holes in the brush blanket.

Repair

If stream bank bioengineering structures (vegetated soil lifts and coir fascines) are damaged before vegetation becomes established, they may require repair. Repairs may include re-staking fabric, mending tears or adding additional willow cuttings. In addition, browse protectors, brush blankets, and solarization fabric may need to be adjusted or replaced.

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List of Appendices

Appendix A: Plant Community Locations and Species Lists

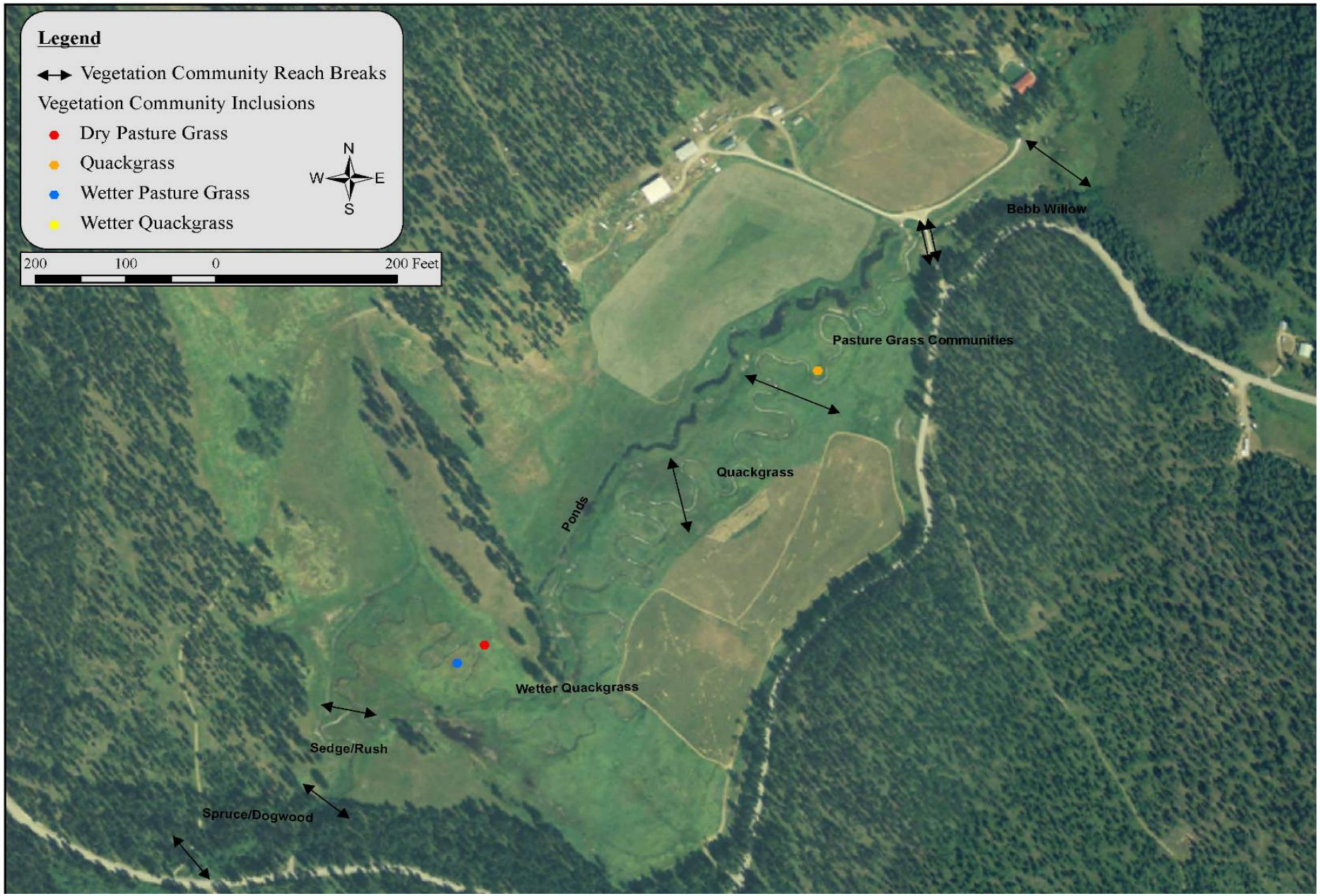

Figure A-1. Overview of Therriault Creek project reach showing approximate locations of vegetation community breaks. Colored dots represent inclusions of a different plant community within an areas predominantly another plant community.

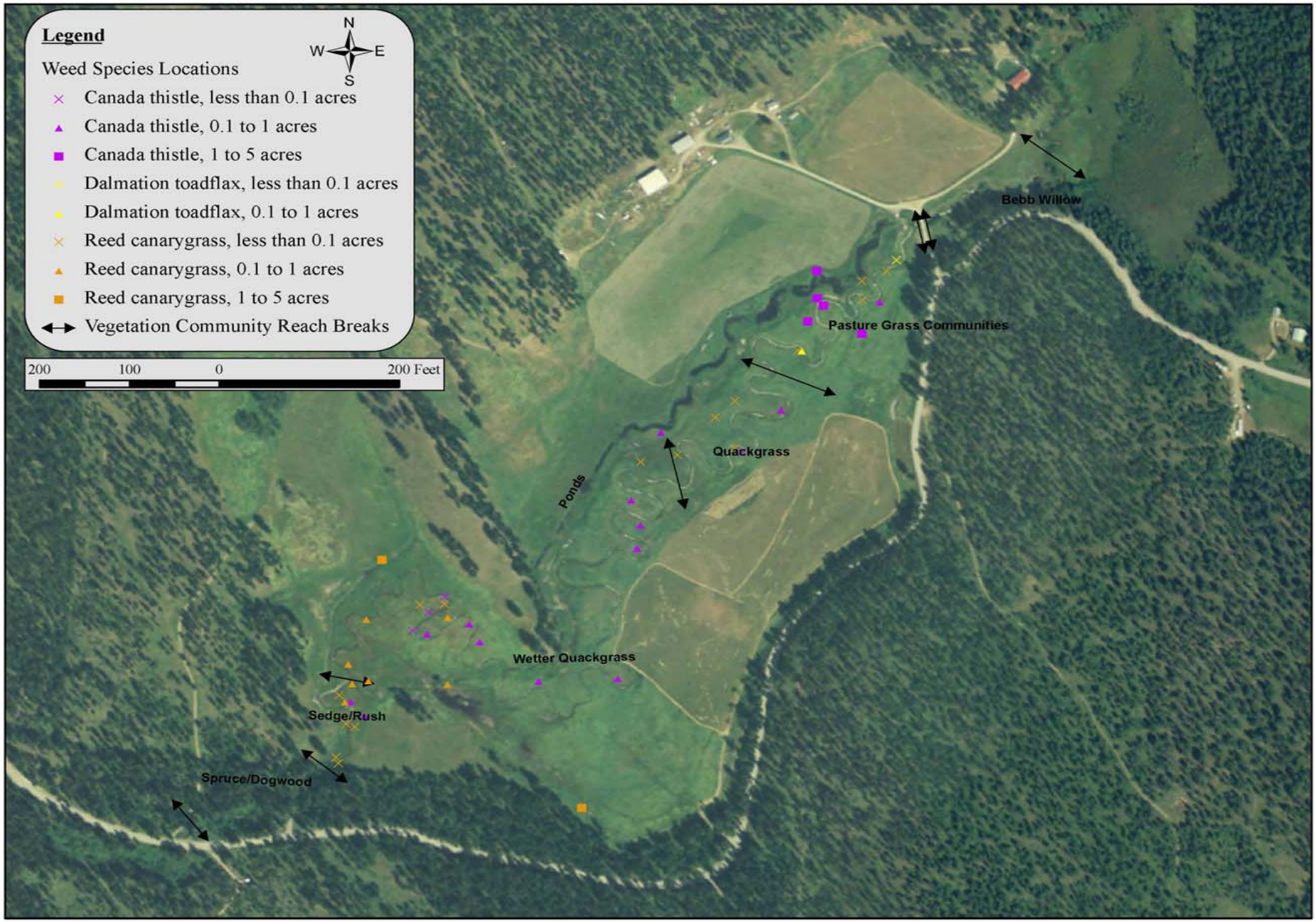

Figure A-2. Overview of Therriault Creek project reach showing approximate locations of weed infestations to target with herbicide application.

Table A-1. Therriault Creek Bebb Willow Community Species List

	Scientific Name	Common Name
Trees		
	Picea engelmanii	Engelmann spruce
	Populus tremuloides	Quaking aspen
Shrubs		
	Alnus incana	Mountain alder
	Cornus canadensis	Bunchberry dogwood
	Cornus stolonifera	Red-osier dogwood
	Crataegus douglasii	Black hawthorne
	Prunus virginiana	Common chokecherry
	Rosa woodsii	Wood's rose
	Rubus idaeus	American red raspberry
	Salix bebbii	Bebb's willow
	Salix exigua	Sandbar willow
	Salix geyeriana	Geyer willow
	Symphoricarpos occidentalis	Western snowberry
Graminoids		
	Achillea millefolium	Common yarrow
	Agrostis stolonifera	Redtop**
	Aster laevis	Smooth aster
	Calamagrostis canadensis	Bluejoint reedgrass
	Carex flava	Yellow sedge
	Carex stipata	Sawbeak sedge
	Carex utriculata	Beaked sedge
	Carex vesicaria	Blister sedge
	Cicuta douglasii	Western water hemlock
	Deschampsia cespitosa	Tufted hairgrass
	Equisetum arvense	Field horsetail
	Geum macrophyllum	Large-leaved avens
	Heracleum lanatum	Common cowparsnip
	Juncus ensifolius	Swordleaf rush
	Poa palustris	Fowl bluegrass
	Polygonum lapathifolium	Pale smartweed
	Solidago canedensis	Canada goldenrod
	Toxicodendron radicans	Western posion ivy*
	Veronica anagallis-aquatica	Water speedwell

[P] =planted
*=weedy or invasive
**=non-native pasture grasses

Table A-2. Therriault Creek Dry Pasture Grass Community Species List

	Scientific Name	Common Name
Shrubs		
	Alnus incana	Mountain alder[P]
	Amelanchier alnifolia	Serviceberry[P]
	Cornus stolonifera	Red-osier dogwood[P]
	Crataegus douglasii	Black hawthorne[P]
	Salix bebbii	Bebb's willow[P]
	Salix exigua	Sandbar willow[P]
	Salix geyeriana	Geyer willow[P]
Graminoids		
	Agropyron repens	Quackgrass*
	Agrostis stolonifera	Redtop**
	Alopecurus pratensis	Meadow foxtail**
	Brassica spp.	Mustard species*
	Bromus inermis	Smooth brome**
	Carex bebbii	Bebb's sedge
	Carex stipata	Sawbeak sedge
	Cirsium arvense	Canada thistle*
	Cirsium vulgare	Bull thistle*
	Cynoglossum officinale	Hound's tounge*
	Dactylis glomerata	Orchard grass**
	Equisetum arvense	Field horsetail
	Heracleum lanatum	Common cowparsnip
	Linaria vulgaris	Yellow toadflax*
	Medicago lupulina	Black medick*
	Mentha arvense	Filed mint
	Thlaspi perfoliatum	Pennycress*
	Phalaris arundinacea	Reed canarygrass*
	Phleum pratense	Common timothy**
	Poa pratensis	Kentucky Bluegrass**
	Rumex crispus	Curly doc
	Silene alba	Bladder campion*
	Verbascum thapsus	Common mullien*
	Viola spp.	Violet species

[P] =planted
*=weedy or invasive
**=non-native pasture grasses

Table A-3. Therriault Creek Wet Pasture Grass Community Species List

	Scientific Name	Common Name
Shrubs		
	Cornus stolonifera	Red-osier dogwood[P]
	Crataegus douglasii	Black hawthorne[P]
	Salix exigua	Sandbar willow[P]
Graminoids		
	Agropyron repens	Quackgrass*
	Agrostis stolonifera	Redtop**
	Carex bebbii	Bebb sedge
	Carex microptera	Small winged sedge
	Carex stipata	Sawbeak sedge
	Cirsium arvense	Canada thistle*
	Epilobium ciliatum	Common willow herb
	Juncus balticus	Baltic rush
	Poa pratensis	Kentucky bluegrass**
	Polygonum lapathifolium	Curlytop knotweed
	Scirpus microcarpus	Panicled bulrush

[P]=planted
*=weedy or invasive
**=non-native pasture grasses

Tables A-4 and A-5. Therriault Creek Quackgrass Community Species List

	Scientific Name	Common Name
Graminoids		
	Agropyron repens	Quackgrass*
	Agrostis stolonifera	Redtop**
	Alopecurus pratensis	Meadow foxtail**
	Bromus inermis	Smooth brome**
	Cirsium arvense	Canada thistle*
	Phleum pratense	Common timothy**

*=weedy or invasive
**=non-native pasture grasses

Near the downstream extent of this plant community within the project reach, there are some sod excavation areas that have colonized with a slightly different species composition than the rest of the plant community. The species occurring within this plant community are listed in the table below.

	Scientific Name	Common Name
Graminoids		
	Juncus spp.	Rush species
	Elymus spp.	Wheatgrass species
	Agrostis stolonifera	Redtop**
	Carex stipata	Sawbeak sedge
	Deschampsia cespitosa	Tufted hairgrass
	Epilobium ciliatum	Common willow-herb
	Equisetum arvense	Field horsetail
	Mentha arvensis	Field mint
	Phleum pratense	Common timothy**
	Plantago major	Common plantain*
	Polygonum lapathifolium	Pale smartweed
	Rorippa nasturtium-aquaticum	Common watercress

*=weedy or invasive
**=non-native pasture grasses

Tables A-6 and A-7. Therriault Creek Pond Associated Community Species List

	Scientific Name	Common Name
Graminoids		
	Elymus spp.	Wheatgrass species**
	Agropyron repens	Quackgrass*
	Agrostis stolonifera	Redtop**
	Cirsium arvense	Canada thistle*
	Epilobium ciliatum	Common willow-herb
	Equisetum arvense	Field horsetail
	Juncus articulatus	Jointed rush
	Plantago major	Common plantain*
	Poa pratensis	Kentucky bluegrass**
	Rorippa nasturtium-aquaticum	Common watercress*
	Rumex crispus	Curly dock*

*=weedy or invasive
**=non-native pasture grass

A second plant community is also associated with the ponds created from the abandoned, plugged channel. This plant community occurs as a transition between the ponds and the 'Wetter Quackgrass' plant community. Species within the community are listed in the table below.

	Scientific Name	Common Name
Graminoids		
	Lemna minor	Lesser duckweed
	Glyceria grandis	American mannagrass
	Scirpus validus	Softstem bulrush
	Typha latifolia	Common cattail

Tables A-8 and A-9. Therriault Creek Wetter Quackgrass Community Species List

	Scientific Name	Common Name
Graminoids		
	Brassica spp.	Mustard species*
	Agropyron repens	Quackgrass*
	Agrostis stolonifera	Redtop**
	Bromus inermis	Smooth brome**
	Carex bebbii	Bebb sedge
	Carex microptera	Smallwing sedge
	Carex stipata	Sawbeak sedge
	Cirsium vulgare	Bull thistle*
	Epilobium cilatum	Common willow-herb
	Phleum pratense	Common timothy**
	Poa pratensis	Kentucky bluegrass**

*=weedy or invasive
**=non-native pasture grasses

Swales within this plant community have a slightly different plant species composition. Species within this plant community are listed in the table below.

	Scientific Name	Common Name
Graminoids		
	Chrysanthemum leucanthemum	Oxeye daisy*
	Juncus spp.	Rush species
	Alopecurus pratensis	Meadow foxtail**
	Carex bebbii	Bebb sedge
	Carex microptera	Smallwing sedge
	Carex stipata	Sawbeak sedge
	Eleocharis palustris	Common spikerush
	Epilobium cilatum	Common willow-herb
	Juncus balticus	Baltic rush
	Poa palustris	Fowl bluegrass**
	Polygonum lapathifolium	Pale smartweed

*=weedy or invasive
**=non-native pasture grasses

Table A-10. Therriault Creek Sedge/Rush Community Species List

	Scientific Name	Common Name
Graminoids		
	Agropyron repens	Quackgrass*
	Agrostis stolonifera	Redtop**
	Alopecurus pratensis	Meadow foxtail
	Carex bebbii	Bebb sedge
	Carex utriculata	Beaked sedge
	Cirsium arvense	Canada thistle*
	Deschampsia cespitosa	Tufted hairgrass
	Epilobium ciliatum	Common willow-herb
	Glyceria grandis	American mannagrass
	Mentha arvensis	Field mint
	Phalaris arundinacea	Reed canarygrass*
	Polygonum lapathifolium	Pale smartweed
	Potentilla anserina	Common silverweed
	Rumex crispus	Curly dock*
	Scirpus microcarpus	Panicled bulrush
	Veronica anagallis-aquatica	Water speedwell

*=weedy or invasive
**=non-native pasture grass

Table A-11. Therriault Creek Spruce/Red-Osier Dogwood Plant Community Species List

	Scientific Name	Common Name
Trees		
	Picea engelmanii	Engelmann spruce
Shrubs		
	Alnus incana	Mountain alder
	Amelanchier alnifolia	Western serviceberry
	Cornus stolonifera	Red-osier dogwood
	Salix bebbiana	Bebb's willow
	Symphoricarpos occidentalis	Western snowberry
Graminoids		
	Arctium minus	Lesser burdock*
	Aster laevis	Smooth aster
	Cirsium arvense	Canada thistle*
	Carex utriculata	Beaked sedge
	Deschampsia cespitosa	Tufted hairgrass
	Geum macrophyllum	Large-leaved avens
	Mentha arvensis	Field mint
	Phalaris arundinacea	Reed canarygrass*
	Phleum pratense	Common timothy*
	Potentilla anserina	Common silverweed
	Sagittaria spp.	Sagittaria species
	Scirpus microcarpus	Panicled bulrush
	Smilacena spp.	Arrowhead species
	Solidago canedensis	Canada goldenrod

*=weedy or invasive

Appendix B. Revegetation Treatment Descriptions

Residual Shrub Protection

This treatment includes protecting surviving shrubs planted during initial restoration activities at the site. Many of these surviving shrubs show signs of heavy browse by ungulates (Figure B-1) or girdling by voles. In addition, most shrubs are subject to high levels of competition from aggressive grasses or other invasive species. All residual shrubs that can be located will be protected from browse by securing rigid plastic mesh browse protectors and vole protectors around each plant. In addition, plants will be protected from competition by installing 2' x 2' brush blankets around the base of each plant (Figures B-2 and B-3). These techniques are described in more detailed in the *Containerized Planting* section below. Some containerized willow plants and willow cuttings installed in 2004 and 2005 are exhibiting vigorous growth, and exhibit minimal impact from browse and girdling. These individuals do not need to be protected. All other shrubs and trees that can be located (estimated to be approximately 500) will be protected.

Figure B-1. Ungulate browse and grass competition on residual planted shrub.

Containerized Planting

This treatment includes planting containerized native shrubs in select locations along the channel. Containerized plant materials will include primarily one gallon native shrubs and some five gallon native plant material if available. Plant materials will be selected based on availability of appropriate species and seed sources. A list of appropriate species is provided in Table B-1, but species used in 2007 treatments will ultimately depend on availability. A total of 1,000, one-gallon shrubs and 50, five-gallon shrubs or trees are proposed for 2007 treatments. Additional plantings in later years will depend on survival of these plants. Planting will be concentrated in 'islands' along outer meander bends where woody vegetation is not establishing naturally. Islands of plants will be installed throughout the project reach, primarily within the 'Pasture Grass' and 'Quackgrass' plant community types. Planting will include a mix of early-successional species, such as willows, alder, snowberry and rose, that may be better suited for the high light environment. The species mix also includes later-successional species, such as spruce, in anticipation of the time when site conditions will favor these species.

Each one-gallon shrub will receive a rigid plastic mesh browse protector and Tubex® vole guard to protect the shrub from browse and girdling. Browse protectors are 4 feet in height and constructed from rigid plastic netting. Netting is secured in place with 2-inch square by 4-foot tall wooden posts and UV stabilized zip ties (Photo 2). Tubex® vole guards are solid rigid plastic tubes that are approximately 8 inches high and whose diameter can be adjusted. Vole guards are pushed or trenched into the ground to ensure that rodents cannot burrow under them. Vole guards will be placed inside of each larger browse protector (Figure B-3). Due to the aggressive grasses present throughout the project reach, approximately 3 inches of bark mulch will be placed within each vole guard to provide protection from weeds at the base of the plant. Bark mulch will also function to create a favorable microclimate for plant growth by retaining soil moisture, moderating soil temperature, and providing organic material which may be lacking in upper layers of the soil due to the agricultural history of the site. In addition to browse protection, a two-foot by two-foot plastic mulch mat will be installed around the base of each one gallon shrub to reduce competition from aggressive grasses and other invasive species (Figure B-2). Five gallon plants should be large enough to resist browse and competition so these plants will not require protection.

Photo B-2. Photo illustrating one gallon shrub installed with mulch mat and browse protection.

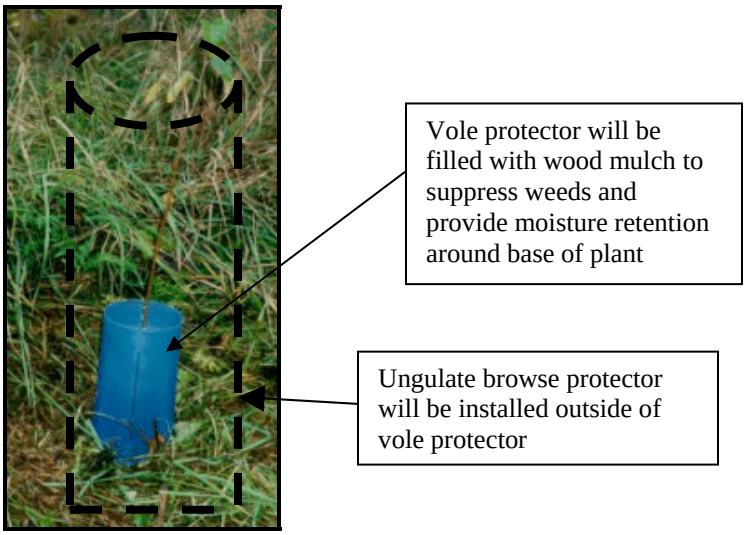

Figure B-3. Vole guard protecting base of plant installed inside of a larger ungulate browse protector.

Figure B-4. Larger sized plant material, such as this Red-osier dogwood, will be used in select areas along the channel if plant material is available.

Table B-1. Species mix for Therriault Creek 2007 containerized planting sites.

Genus	Species	Common Name	Size	Percent	Total Each
Alnus	*incana*	Thinleaf alder	10x10x36 cm	5%	50
Betula	*occidenatalis*	Water birch	10x10x36 cm	5%	50
Cornus	*stolonifera*	Red-osier dogwood	10x10x36 cm	10%	100
Crataegus	*douglasii*	Douglas hawthorne	10x10x36 cm	15%	150
Prunus	*virginiana*	Common chokecherry	10x10x36 cm	5%	50
Rosa	*woodsii*	Wood's rose	10x10x36 cm	5%	50
Salix	*bebbiana*	Bebb's willow	10x10x36 cm	10%	100
Salix	*boothii*	Booth's willow	10x10x36 cm	5%	50
Salix	*drummondiana*	Drummond willow	10x10x36 cm	5%	50
Salix	*exigua*	Sandbar willow	10x10x36 cm	15%	150
Salix	*geyeriana*	Geyer's willow	10x10x36 cm	10%	100
Symphoricarpos	*occidentalis*	Common snowberry	10x10x36 cm	10%	100
TOTAL ONE GALLON CONTAINERIZED PLANTS					**1000**
Alnus	*incana*	Thinleaf alder	5 gallon grow bag	N/A	20
Cornus	*stolonifera*	Red-osier dogwood	5 gallon grow bag	N/A	10
Salix	*bebbiana*	Bebb's willow	5 gallon grow bag	N/A	10
Salix	*geyeriana*	Geyer willow	5 gallon grow bag	N/A	10
TOTAL FIVE GALLON GROW BAG PLANTS					**50**

Solarization Treatments

The purpose of this treatment is to suppress invasive plant species, particularly grasses, and create site conditions more suitable for supporting desired plant species. This treatment will be used in floodplain areas dominated by exotic grasses, specifically targeting reed canary grass. Solarization eliminates light and increases soil temperature, using a black, tightly woven geotextile material (shade cloth) that is installed directly on the floodplain surface over existing vegetation. The increased soil temperature kills grass and weed seeds that have thin seed coats and can stimulate germination, or speed stratification, of thicker-coated native seeds. Prior to laying the shade cloth, depending on the length of treatment (see below) the area should be seeded with hard-coated

wetland and riparian species. An appropriate seed mix for supplementing the seed bank to use in conjunction with this treatment is provided in Table B-2.

The treatment will be used as either a pre-planting treatment (temporary) or as barrier treatment where plants will be installed through the material (long-term) (Figure B-5). A total of 0.5 acres (0.4 acres temporary and 0.1 acres long-term) within the project reach will be treated with solarization. Long-term solarization planting sites, functioning as a weed barrier treatment, will be located on outer meanders and planted through using one-gallon shrubs. Within long-term solarization areas, shade cloth should remain for up to three growing seasons or until shrubs have become established. When shade cloth is removed, the area should be seeded with the seed mix provided in Table B-2. Five temporary and two long-term solarization areas will be installed as a pre-planting treatment or as a weed barrier treatment to completely eradicate small areas of invasive species. If used as a pre-planting treatment, the fabric should be left on the ground for at least half of the growing season before removing the fabric. Only temporary solarization sites should be seeded with native wetland forbs and grasses prior to placement of shade cloth.

Treatment sites should be covered with two side-by-side strips of 15-foot wide fabric laid out on the floodplain, with three feet of the fabric overlapping. Each strip will be approximately 50 feet long. It may be necessary to mow the sites prior to placing the fabric to ensure the fabric can be effectively secured to the ground. Fabric is typically secured using eight inch by two inch metal staples. For long-term, planted, sites, the outside edges of the fabric will need to be buried or trenched into the ground with at least one foot of the fabric buried or trenched. For temporary sites, the fabric should not be trenched to make moving fabric to new locations easier.

Figure B-5. Example of long-term solarization weed barrier treatment planted with containerized shrubs.

Table B-2. Seed species mix for Therriault Creek 2007 solarization sites.

Genus	Species	Common Name	Percent of Mix
Agropyron	*riparium*	Streambank wheatgrass	15%
Calamagrostis	*canadensis*	Bluejoint reedgrass	15%
Carex	*nebrascensis*	Nebraska sedge	10%
Carex	*stipata*	Sawbeak sedge	5%
Deschampsia	*cespitosa*	Tufted hairgrass	20%
Elymus	*trachycaulus*	Slender wheatgrass	10%
Juncus	*balticus*	Baltic rush	11%
Juncus	*tenuis*	Poverty rush	9%
Achillea	*millefolium*	Common yarrow	5%

Solarization has been shown to be effective in eliminating dense areas of patchy reed canarygrass. If effective, this treatment may be more desirable than herbicide for controlling reed canarygrass and quackgrass because treating these species would require a non-selective herbicide that would kill all species and in areas where reed canarygrass or quackgrass is mixed-in with desirable species, eliminating desirable species may not be an option.

Vegetated Soil Lifts

Vegetated soil lifts are proposed at two sites along outer meander bends near the upstream end of the project where there is risk of channel avulsion into the abandoned Therriault Creek channel. Vegetated soil lifts are a revegetation and bank construction technique that combines layers of dormant willow cuttings with fabric-wrapped soil to revegetate and stabilize stream banks (Figures B-6 and B-7). Soil is wrapped within two layers of biodegradable coconut fiber (coir) fabric, to hold the soil in place while vegetation becomes established in the relatively high stress land/water interface. Soil lifts, combined with a bankfull bench, will result in near bank areas where native woody vegetation can become established. To increase success, the face of the bottom soil lift should be reinforced with an aspen excelsior log or other suitable material to help maintain the lift shape, keep fine soil particles from filtering out through the lift face, and maintain surface tension. The uppermost soil lift should be filled with salvaged sod or seeded with the seed mix developed for the site.

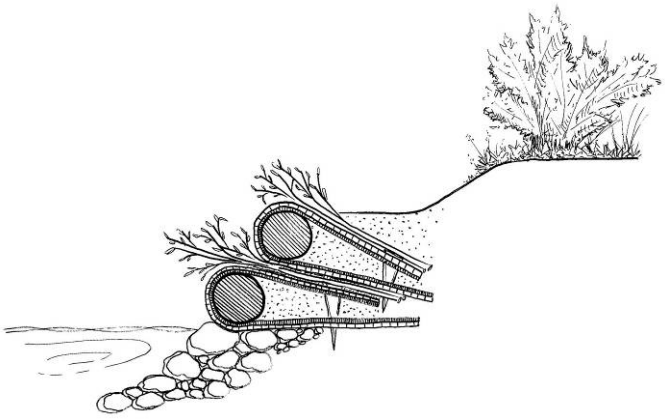

Figure B-6. Profile view drawing of vegetated soil lift treatment.

Figure B-7. Photograph showing vegetated soil lift treatment immediately after installation.

Coir Logs

This technique includes placement of coir logs, combined with dormant willow cuttings, at the toe of stream banks along selected outer meander bends. The purpose of this treatment is to establish woody vegetation along the channel in areas where competition from invasive species is less; in this case, below the bankfull water elevation. Coir log fascines are pre-constructed bioengineering components designed for use at the land/water interface (Figures B-8 and B-9). Coir log fascines have a synthetic (polyethylene) mesh or natural fiber netting that contains high-density coir (coconut fiber) bales. Coir is used for bioengineering because it stores water for long periods, and its durable fibers trap sediment and mimic soil matrices formed by living roots. Coir biodegrades over approximately five to seven years, thus providing a stable growing medium while native riparian plants become established. Coir log fascines can be placed within the existing channel to create the toe of new channel banks and allow a narrower channel to be created. New banks are created behind the coir log fascines by filling the area with cobble and soil. These areas can then be planted with woody vegetation.

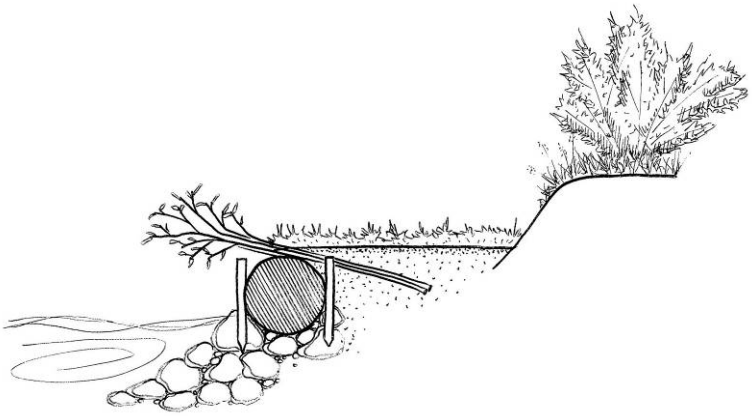

Figure B-8. Profile view drawing of coir log treatment.

Figure B-9. Photo of installed coir log installed at the toe of a slope in conjunction with willow fascines (bottom).

Live Willow Fascines

Live willow fascines are willow cuttings tied together to form a linear bundle. This treatment is proposed for recent depositional areas within the channel. Due to the mobility of sediments in these areas, it will be necessary to bury or otherwise anchor the fascines. Live willow fascines can be buried parallel to the stream in depositional areas (Figure B-10), perpendicular to the stream in floodplain areas, or used in conjunction with coir log treatments.

Cuttings from native willow species will be collected for use in live willow fascines, vegetated soil lifts and coir log fascines. The best species to use for willow cuttings, in order of preference, are sandbar willow (*Salix exigua)*, Drummond Willow (*Salix drummondiana*), Booth willow (*Salix boothii*), and yellow willow (*Salix lutea*). Bebb willow (*Salix bebbiana*) and Geyer's willow (*Salix geyeriana*) may be used if collected as part of a multi-species collection. Source(s) of willows need to be identified prior to beginning revegetation activities.

Figure B-10. Example of live willow fascines buried in the floodplain parallel to the stream. The ends of the fascines hang over the newly constructed bank.

In general, the following guidelines will increase success of willow cuttings:

- Willow cuttings should be collected locally, within the same drainage if possible and from areas have a similar elevation to the project area;
- Cuttings should be collected as close to the installation date as possible. The ideal time to collect cuttings is between late February and early April;
- Willow cuttings should be collected from second-year stems taken from healthy plants;
- Cuttings should be 6 feet (2 meters) in length for use in vegetated soil lifts and willow fascines and 16-24 inches in length and a minimum of ¼ inch thick for use in direct installation along banks;
- If cuttings must be stored temporarily, they should be wrapped in burlap and staged in a shady, wet, cool area.

Large Woody Debris Structures

This technique includes placing large woody debris in select locations of the channel to enhance habitat and provide roughness features to encourage over-bank flooding and retention of flood waters in adjacent floodplain and riparian areas. This technique can be used as a method to restore riparian and wetland hydrology, thereby creating conditions that will better support native riparian vegetation (Figures B-11 and B-12). Ideal materials for this project are whole logs and trees with limbs, branches and root wads attached. Only portions of the whole trees are placed in the channel, mimicking the natural process of trees falling into a stream, and reducing the need to either anchor or bury trees to keep them in place. This will also maximize habitat benefits because portions of each structure will interact with all stages of streamflow and extend into adjacent riparian habitat.

Multiple trees are typically placed at each site, forming a large wood complex that traps and retains organic matter transported through the system. Trees are kept in place through a combination of methods: selection of appropriate stream location; selection of appropriate sized trees; and proper placement and orientation of trees. Anchoring of logs is done passively either by tying into existing vegetation or by designing structures to

'naturally' anchor themselves. Within a properly constructed large woody debris structure, as wood is lifted and moved by water, the individual logs should move into, rather than disengage from, one another. For structures to function most effectively, the logs must rise and fall with water levels to absorb energy, maximize debris-trapping potential and create maximum complexity. If available, small and medium diameter 'slash' material should also be incorporated into each structure. This highly branching material functions to catch most forms of organic and inorganic material being transported through the system during spring flows, and encourages ponding behind structures during high flows and recession of high flows. Incorporating smaller materials into structures will also increase silt deposition and potential bar creation, which in turn provides substrate for natural willow establishment from seed.

Trees can be placed using heavy equipment such as tracked vehicles or excavators, but other low impact techniques can be employed which virtually eliminate any damage to stream banks, soils or vegetation in adjacent riparian and wetland areas. Low impact techniques include using a system of blocks and cables (traditional block and tackle approach to moving heavy objects) to place trees. Block and tackle can be used in combination with draft horses, working from upland locations to pull cables, to further minimize impacts within the riparian area.

Between three and five woody debris structures, with four to six trees each, are proposed for Therriault Creek. Approximate structure locations are shown on Figure C-1 in Appendix C. Structures will be placed between 50 and 100 feet apart in a short reach near the downstream end of the project. This reach is located within the 'Wetter Quackgrass' plant community. Within this reach, small patches of reed canarygrass and other invasive species are colonizing drier microsites, and desirable species, such as sedges and rushes, are colonizing wetter microsites within the floodplain. At the same time, very little natural recruitment of woody plants is occurring. The purpose of this technique will be to increase floodplain wetness to encourage establishment of sedge and rush communities and create conditions within and along the channel for natural recruitment of desirable woody shrubs.

Figure B-11. Example of large woody debris placed in stream channel resulting in increased inundation of adjacent floodplain during high flows (left) to stimulate natural riparian revegetation processes and during low flows (right) to provide habitat. Willow seedlings recruited naturally into high flow side channel after one spring.

Figure B-12. Example of conversion from agricultural grasses and invasive species including timothy, Red top, tansy and Canada thistle to diverse sedge and rush meadow in response to placement of large woody debris in the channel (photo right) and resulting increased floodplain inundation.

Herbicide Application

Herbicide should be used as the primary method of weed control in the project reach because it is most cost effective over large areas. Three species will be targeted: Canada thistle, Yellow toadflax and reed canarygrass. Canada thistle and Yellow toadflax can be treated using a selective herbicide at similar rates, described below. Reed canarygrass requires a non-selective herbicide which should be applied carefully to spot treat canarygrass and not negatively impact desirable species. Locations of areas to target for herbicide application are shown on Figure A-2 in Appendix A.

Canada thistle

Canada thistle is listed as a Category 1 noxious weeds in Montana (Weed Management Task Force 2005). Canada thistle can spread rapidly and compete with native vegetation. The species should be controlled aggressively to prevent continued spread. For Canada thistle, herbicide has been shown to effectively control large infestations; however, single herbicide applications do not provide long-term control because the root system is difficult to kill, and can survive even though above-ground shoots have been killed. Therefore, effective chemical control of Canada thistle typically requires multiple applications (Sheley and Petroff 1999). Several herbicides are registered for control of Canada thistle; however, because open water and shallow ground water are present in the project reach, only aquatic approved herbicides should be used. Due to the widespread distribution of Canada thistle through the project reach, a selective herbicide, is recommended to prevent impacting other desirable species such as sedges and rushes. We recommend the selective herbicide Milestone®, which has been shown to be effective for Canada thistle control in areas similar to Therriault Creek. Milestone should be applied at a rate of 2 to 3 lb ai/acre (2.24 to 3.36 kg ai/ha). It is best to apply herbicide to Canada thistle when the plant is in the rosette or bolt stage (Sheley and Petroff 1999).

Yellow toadflax

Yellow toadflax are listed as Category 1 noxious weeds in Montana (Weed Management Task Force 2005). The species can spread rapidly and compete with native vegetation. Only a few small clumps of yellow toadflax are present in the project reach, therefore the

species should be aggressively control to prevent further spread. Effectiveness of herbicide on yellow toadflax is highly variable (Sheley and Petroff 1999). Because the infestation was very small in 2006 (less than 20 total plants), hand pulling of the species is recommended to control toadflax in the project reach. Toadflax is extremely difficult to manage once infestations become established; therefore, removing individual plants and controlling further spread of toadflax through equipment or other means should be a high priority.

Reed canarygrass

Reed canarygrass is a highly aggressive grass that can spread rapidly along stream systems, effectively compete with native species and prevent natural colonization of desired shrubs. Reed canarygrass is thought to be native to some river systems in Montana (Merigliano and Lesica 1998), but non-native varieties have been widely established due to their agronomic value for pasture and erosion control. Therefore, it is likely that what is now abundant and invasive throughout western Montana are cultivars specifically bred for high rates of growth, vigor, and adaptability to a range of environmental conditions. A study by Merigliano and Lesica (1998) determined that canarygrass can reproduce vegetatively by its rhizomes and rhizome fragments, as well as sexually by its abundantly produced seed. Although each inflorescence can produce approximately 600 seeds, it probably has a low successful establishment rate from seeds, especially within dense infestations. Because reed canarygrass forms dense root mats, it provides channel stability but grows too densely to provide adequate cover for small mammals and waterfowl (Alaska Natural Heritage Program 2006). Over the long term, sustaining a mosaic of microtopographies and creating and maintaining complex riparian canopies will be the most effective methods to reduce and prevent reed canarygrass infestations, because seed germination is dependent on high amounts of light penetration. Reed canarygrass control in the project reach will rely on a combination of techniques including herbicide, solarization and altering site conditions to favor desirable native species.

Reed canarygrass can be successfully controlled by the proper use of herbicide. The following information is adapted from Tu (2004). Small stands or clumps of canarygrass can be effectively killed with one application, but large infestations will likely require several applications over several years to be effective. Because canarygrass frequently grows in wet areas, only aquatic approved herbicides are allowed in many situations. Aquatic approved herbicides include Glyphosate (Rodeo®, Aquamaster®, or Glypro® among others). Glyphosate is a non-selective herbicide that kills or injures nearly all plant species. Glyphosate applied in a 2% solution (1.08% active ingredient (a.i.) with a nonionic surfactant works well to kill canarygrass. Continued monitoring and follow-up treatments will be necessary for 5 to 10 years to prevent reinvasion, and to exhaust the seedbank. Monitoring should include observing how the native seed bank responds to control efforts; if a native seed bank is still viable, desirable species may colonize the site. If native species do not colonize from the existing seed bank, supplemental seeding or planting will be required.

Appendix C. Revegetation Treatment Locations

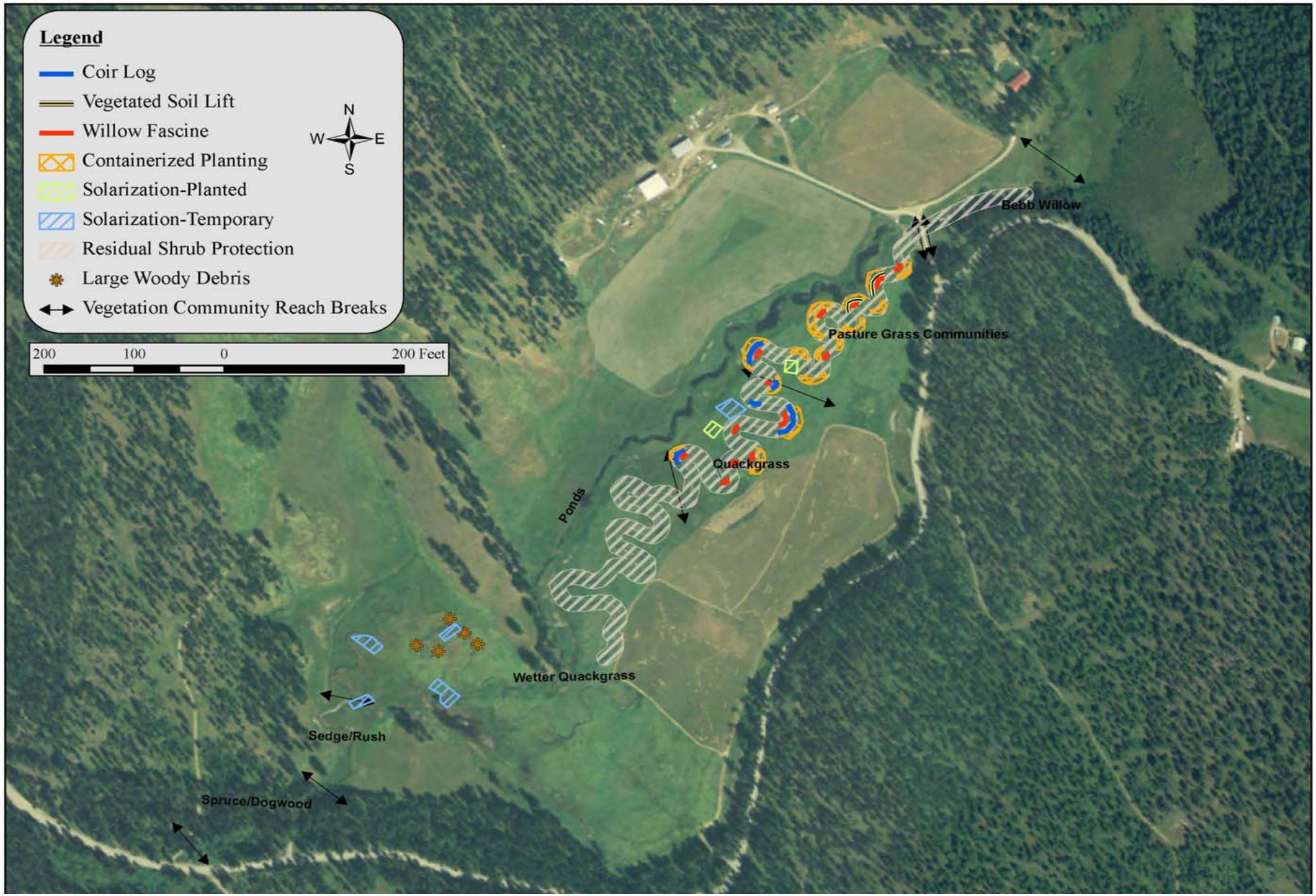

Figure C-1. Overview of Therriault Creek project reach showing locations of revegetation treatment.

Appendix D. Project Phasing & Schedule of Treatments

Table D-1. Therriault Creek riparian revegetation treatments, monitoring and maintenance recommendations for years 2007 through 2009.

Therriault Creek Riparian Revegetation Treatment Summary for 2007-2009						
	PHASE I REVEGETATION			**PHASE II REVEGETATION**		**PHASE III REVEGETATION**
Plant Community	**2007 Treatments**	**Target function or process (Project objective)**	**Monitoring & Maintenance 2007**	**2008 Treatments**	**Monitoring & Maintenance 2008**	**2009 Treatments**
Bebb willow	Protect surviving containerized plants	Woody vegetation establishment for channel stability	Irrigation and browse protection maintenance; Monitor for natural recruitment of desired woody species; Monitor weed infestations on adjacent upland terrace; Monitor survival	If no natural recruitment is occurring, consider additional planting with native species	Same as 2007	Monitor for natural recruitment; if no natural recruitment is occurring, consider supplemental planting with native species; Continue herbicide as needed
Drier pasture grasses	Protect surviving containerized plants	Woody vegetation establishment for channel and floodplain stability	Irrigation and browse protector maintenance; Monitor natural recruitment of desired woody species along channel margins; Monitor survival	If browse protection and mulch mats are effective, but natural recruitment is not occurring, consider additional shrub planting; Planting should be done in small 'islands' to facilitate maintenance and allow weed control to continue	Same as 2007	If browse protection and mulch mats are effective for planted shrubs, but natural recruitment is still not occurring, consider additional containerized plantings in this reach
	Herbicide application (Canada thistle target species)	Limit invasion and spread of weeds to reduce competition for establishing shrubs	Monitor for effectiveness and new thistle infestations	Follow up herbicide application for original infestations and any new infestations	Same as 2007	Follow up herbicide application (Note: it may be necessary for herbicide application to continue for 5 or more additional years)
	Vegetated soil lifts	Provide short term bank stability and establish dense woody vegetation at high risk outer meander bends to enhance fish habitat	Monitor for willow survival and maintenance needs	If willow survival is poor, add additional willow cuttings	Same as 2007	If willow survival is poor, add additional willow cuttings; If treatment is effective at establishing woody vegetation in desired areas, consider installing short sections in other areas throughout this plant community
	Coir logs	Provide stable site within or directly along channel capable of supporting, recruiting and retaining sediment and seed; Retain moisture to support woody vegetation establishment directly along bankfull channel to enhance fish habitat	Monitor for willow survival and maintenance needs	If willow survival is poor, add additional willow cuttings; If scour occurs around log, re-staking or burying may be necessary	Same as 2007	If willow survival is poor, add additional willow cuttings (Note: if survival was poor in 2007 and 2008 consider changing time of year willows are collected or installed or find new willow source; if treatment is effective at establishing woody vegetation in desired areas, consider installing additional short sections of treatment throughout this plant community

Plant Community	2007 Treatments	Target function or process	Monitoring & Maintenance 2007	2008 Treatments	Monitoring & Maintenance 2008	2009 Treatments
Wetter pasture grasses	Protect surviving containerized plants	Woody vegetation establishment for channel and floodplain stability	Irrigation and browse protector maintenance; Monitor survival	If browse protectors and mulch mats are effective, monitor natural recruitment in the plant community prior to planting additional shrubs; If browse protectors are not effective, additional measures will need to be evaluated based on observing browsed plants and animal use patterns (exclosures may be necessary, but only if the situation warrants); If mulch mats are not effective, either concentrated herbicide application or larger, heavier duty weed barriers, may be necessary	Same as 2007	If plant survival is on a downward trend, irrigation and site maintenance has been adequate, and competition has been relatively controlled near residual planted shrubs, it is possible that other site conditions, such as soil pH or nutrients are limiting plant survival; If plants appear to be stressed but are surviving, continue irrigation of surviving plants into 2010 and repeat suppression of competitive species near planting sites
	Herbicide application (Canada thistle and reed canarygrass target species)	Limit invasion and spread of weeds to reduce competition with establishing shrubs	Monitor for effectiveness and new infestations	Follow up herbicide application for original and new infestations	Same as 2007	Follow up herbicide application (Note: it may be necessary for herbicide application to continue for 5 or more additional years)
	Containerized planting (includes browse, weed and vole protection)	Woody vegetation establishment for channel stability; Improve biodiversity and available seed source	Irrigation and browse protector maintenance; Monitor survival of planted shrubs; Monitor for natural recruitment of desired trees and shrubs	If browse protection and mulch mats are effective, but no natural recruitment is occurring, consider additional shrub plantings; If survival is low, determine if irrigation and control of competition with other species was sufficient	Same as 2007	If plant survival is on a downward trend, irrigation and site maintenance has been adequate, and competition has been relatively controlled near residual planted shrubs, it is possible that other site conditions, such as soil pH or nutrients are limiting plant survival; If plants appear to be stressed but are surviving, continue irrigation of surviving plants into 2010 and repeat suppression of competitive species near planting sites
	Solarization + planting	Suppress reed canarygrass to create conditions to support woody vegetation; Woody vegetation establishment for channel stability; Improve biodiversity and available seed source	Monitor survival of plants and compare with containerized plans with only mulch mats; Irrigation and maintenance of browse protection and solarization fabric	If survival is good, continue to monitor and maintain; if survival is poor, investigate why and potentially re-plant or modify technique	Same as 2007	If treatment appears to be more effective than containerized plantings using individual mulch mats continue this treatment over larger areas
	Willow fascines	Establish woody vegetation in natural deposition areas within the channel and provide willow seed source for reach	Monitor for stability and contact with soil; Monitor survival and shoot growth	If treatment appears to be effective, continue treatment in other depositional areas of the channel	Same as 2007	If treatment appears to be effective, continue treatment in other depositional areas of the channel; Also, consider direct staking along channel margins below grass rooting depth

Plant Community	2007 Treatments	Target function or process	Monitoring & Maintenance Summer 2008	2008 Treatments	Monitoring & Maintenance Summer 2009	2009 Treatments
Wetter pasture grass continued	Coir logs	Provide sites directly along channel capable of supporting, recruiting and retaining sediment and seed; Retain moisture to support woody vegetation establishment directly along channel to enhance fish habitat	Monitor for willow survival and maintenance needs	If willow survival is poor, add additional willow cuttings; If scour occurs around log, re-staking or burying may be necessary	Same as 2007	If willow survival is poor, add additional willow cuttings (Note: if survival was poor in 2007 and 2008 consider changing time of year willows are collected or installed or find new willow source; if treatment is effective at establishing woody vegetation in desired areas, consider installing additional short sections of treatment throughout this plant community
Quackgrass	Protect surviving containerized plants	Woody vegetation establishment for channel and floodplain stability	Irrigation and browse protection maintenance; Monitor survival	If browse protectors and mulch mats are effective, monitor natural recruitment in the plant community prior to planting additional shrubs; If browse protectors are not effective, additional measures will need to be evaluated based on observing browsed plants and animal use patterns (exclosures may be necessary, but only if the situation warrants); If mulch mats are not effective, either concentrated herbicide application or larger, heavier duty weed barriers, may be necessary	Same as 2007	If plant survival is on a downward trend, irrigation and site maintenance has been adequate, and competition has been relatively controlled near residual planted shrubs, it is possible that other site conditions, such as soil pH or nutrients are limiting plant survival; If plants appear to be stressed but are surviving, continue irrigation of surviving plants into 2010 and repeat suppression of competitive species near planting sites
	Herbicide application (Canada thistle and reed canarygrass target species)	Limit invasion and spread of weeds to reduce competition with establishing shrubs	Monitor for effectiveness and new infestations	Follow up herbicide application for original and new infestations	Same as 2007	Follow up herbicide application, including new infestations; If herbicide does not appear to be effectively suppressing reed canarygrass consider other weed treatments such as mowing followed by herbicide, multiple herbicide applications over the growing season or solarization
	Solarization (temporary)	Suppress quackgrass and exhaust seed source to reduce competition for native species establishment	Monitor for reduced cover of quackgrass and establishment of native species	Monitor in early spring 2008; If species shift has occurred, relocate solarization treatment to another site and plant or seed previously treated site with desired native species; If species shift has not occurred, leave treatment in place and monitor again in Fall 2008	Monitor for reduced cover of quackgrass and establishment of native species at new locations and original locations; Irrigation and browse protector maintenance will be required for any additional shrubs planted in solarization plots in 2008	Continue to relocate solarization treatments if treatment is effective; Spot treatments using herbicide may be necessary to control invasive species colonizing sites treated in 2007 and relocated in 2008; Additional planting and seeding may also be required

Plant Community	2007 Treatments	Target function or process	Monitoring & Maintenance Summer 2008	2008 Treatments	Monitoring & Maintenance Summer 2009	2009 Treatments
Quackgrass continued	Containerized planting (includes browse, weed and vole protection)	Woody vegetation establishment for channel stability; Improve biodiversity and available seed source	Irrigation and browse protection maintenance; Monitor survival; Monitor for natural recruitment of desired woody species	If browse protection and mulch mats are effective, but no natural recruitment is occurring, consider additional shrub plantings; If survival is low, determine if irrigation and control of competition with other species was sufficient	Same as 2007	If plant survival is on a downward trend, irrigation and site maintenance has been adequate, and competition has been relatively controlled near residual planted shrubs, it is possible that other site conditions, such as soil pH or nutrients are limiting plant survival; If plants appear to be stressed but are surviving, continue irrigation of surviving plants into 2010 and repeat suppression of competitive species near planting sites
	Solarization + Planting	Suppress reed canarygrass and create conditions to support woody vegetation for channel stability, fish habitat, improve biodiversity and provide seed source	Monitor survival of plants and compare with survival of plants with only mulch mats; Irrigation and maintenance of browse protection and solarization fabric	If survival is good continue to monitor and maintain; If survival is poor investigate why and potentially re-plant or modify technique	Same as 2007	If treatment appears to be more effective than plantings using individual mulch mats continue this treatment over larger areas; If treatment does not appear to be effective leave in place for weed suppression for planted shrubs but do not repeat treatment; Once shrubs have reached a height where they are less susceptible to competition with grasses (between 5 and 8 feet depending on species)
	Coir logs/willow fascines	Provide stable site within or directly along channel capable of supporting, recruiting and retaining sediment and seed; Retain moisture to support woody vegetation establishment directly along bankfull channel to enhance fish habitat; Establish woody vegetation in natural deposition areas within the channel and provide willow seed source for reach	Monitor for willow survival and maintenance needs	If willow survival is poor, add additional willow cuttings; If scour occurs around log, re-staking or burying may be necessary; If treatment appears to be effective, continue treatment in other depositional areas of the channel	Same as 2007	If willow survival is poor, add additional willow cuttings (Note: if survival was poor in 2007 and 2008 consider changing time of year willows are collected or installed or find new willow source; if treatment is effective at establishing woody vegetation in desired areas, consider installing additional short sections of treatment throughout this plant community

Plant Community	2007 Treatments	Target function or process	Monitoring & Maintenance Summer 2008	2008 Treatments	Monitoring & Maintenance Summer 2009	2009 Treatments
Pond plant communities	None	Functioning-will adjust in response to water level fluctuations	Monitor for weed infestations and changes in plant community composition that may help make decisions for other areas along the channel	Weed control if new infestations are detected	Same as 2007	Weed control if new infestations are detected; Depending on vegetation community response to water levels, some planting may be desired, but would be a low priority for project objectives
Wetter quackgrass	Protect surviving containerized plants	Woody vegetation establishment for channel and floodplain stability	Irrigation and browse protection maintenance; Monitor survival	If browse protectors and mulch mats are effective, monitor natural recruitment in the plant community prior to planting additional shrubs; If browse protectors are not effective, additional measures will need to be evaluated based on observing browsed plants and animal use patterns (exclosures may be necessary, but only if the situation warrants); If mulch mats are not effective, either concentrated herbicide application or larger, heavier duty weed barriers, may be necessary	Same as 2007	If plant survival is on a downward trend, irrigation and site maintenance has been adequate, and competition has been relatively controlled near residual planted shrubs, it is possible that other site conditions, such as soil pH or nutrients are limiting plant survival; If plants appear to be stressed but are surviving, continue irrigation of surviving plants into 2010 and repeat suppression of competitive species near planting sites
	Herbicide application (Canada thistle and reed canarygrass target species)	Limit invasion and spread of weeds to reduce competition with establishing shrubs	Monitor for effectiveness and new infestations	Follow up herbicide application for original and new infestations	Same as 2007	Follow up herbicide application, including new infestations; If herbicide does not appear to be effectively suppressing reed canarygrass consider other weed treatments such as mowing followed by herbicide, multiple herbicide applications over the growing season or solarization
	Large woody debris	Enhance floodplain hydrology to increase hydroperiod and create conditions to support transition to wetter species create channel and floodplain microsites for shrub establishment	Monitor changes in floodplain plant community composition; Monitor willow and other shrub recruitment along the channel and floodplain	If natural recruitment of shrubs and transition to wetter species occurs, continue to monitor site; If natural recruitment does not occur, consider planting small amounts of containerized shrubs or installing dormant willow cutting around woody debris structures and in wetter areas of the floodplain	Same as 2007	If natural recruitment does not occur, consider planting small amounts of containerized shrubs; Planting should be tailored to observed changes in the floodplain, particularly taking advantage of new depositional areas
	Solarization (temporary)	Suppress quackgrass and exhaust seed source to reduce competition for native species establishment	Monitor for reduced cover of quackgrass and establishment of native species	Monitor in early spring 2008; If species shift has occurred, relocate solarization treatment to another site and plant or seed previously treated site with desired native species; If species shift has not occurred, leave treatment in place and monitor again in Fall 2008	Monitor for reduced cover of quackgrass and establishment of native species at new locations and original locations; Irrigation and browse protector maintenance will be required for any additional shrubs planted in solarization plots in 2008	Continue to relocate solarization treatments if treatment is effective; Spot treatments using herbicide may be necessary to control invasive species colonizing sites treated in 2007 and relocated in 2008; Additional planting and seeding may also be required

Plant Community	2007 Treatments	Target function or process	Monitoring & Maintenance Summer 2008	2008 Treatments	Monitoring & Maintenance Summer 2009	2009 Treatments
Sedge/rush	Herbicide (Canada thistle and reed canarygrass)	Limit invasion and spread of weeds to reduce competition with establishing shrubs	Monitor for effectiveness and new infestations	Follow up herbicide application	Same as 2007	Follow up herbicide application, including new infestations; If herbicide does not appear to be effectively suppressing reed canarygrass consider other treatments such as mowing followed by herbicide, multiple herbicide applications over the growing season or solarization
Spruce/red-osier dogwood	None	Functioning	None	None	None	None

Table D-2. Therriault Creek riparian revegetation implementation, monitoring and maintenance schedule.

Therriault Creek Riparian Revegetation Schedule															
	2007			2008						2009					
Plant Community	Sp	Su	F	Sp	Su		F			Sp		Su		F	
Bebb Willow															
Pasture Grasses: Drier															
Pasture Grasses: Wetter															
Quackgrass															
Pond Associated Plant Communities															
Wetter Quackgrass															
Spruce/Red-osier dogwood															

Implement 2007 Treatments
Herbicide applications
Monitor
Implement treatments based on results of Summer 2008 monitoring
Implement treatments based on results of Summer 2009 monitoring
Maintenance

Appendix E. Cost Estimate

Table E-1. Therriault Creek riparian revegetation cost estimate for 2007 through 2009.

Therriault Creek Riparian Revegetation Cost Estimate		
2007 Treatments	**Units**	**Cost**
Design lay-out, logistics and project management	1	$5,030.00
Vegetated soil lifts	100 feet	$3,150.00
Coir fascine	400 feet	$9,040.00
Live willow fascines	800 feet	$4,491.28
Containerized shrubs (including weed, deer and vole protection)	1,050	$20,410.00
Residual shrub protection	500	$4,325.50
Herbicide	5 acres	$600.00
Solarization	5 acres	$2,580.00
Large woody debris	3-5 structures	$3,800.00
		$53,883.78
2008 Maintenance, Monitoring & Treatments*		
Maintenance	1	$5,000.00
Monitoring	1	$2,500.00
Coir fascine	0	$0.00
Live willow fascines	0	$0.00
Containerized shrubs (including weed, deer and vole protection)	0	$0.00
Residual shrub protection	0	$0.00
Herbicide	5 acres	$600.00
Solarization	0	$0.00
Large woody debris	0	$0.00
		$8,100.00
2009 Maintenance, Monitoring & Treatments*		
Maintenance	1	$5,000.00
Monitoring	1	$2,500.00
Coir fascine	0	$0.00
Live willow fascines	0	$0.00
Containerized shrubs (including weed, deer and vole protection)	0	$0.00
Residual shrub protection	0	$0.00
Herbicide	5 acres	$600.00
Solarization	0	$0.00
Large woody debris	0	$0.00
		$8,100.00

*Costs of treatments implemented in 2008 and 2009 will depend on actual treatments and lengths or quantities of treatments installed. Treatments should be determined based on results of summer 2008 and 2009 monitoring.