

O'Dell Creek Revegetation Master Plan

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Contents

1 Introduction..... 1

 1.1 Objectives..... 4

2 Restoration Targets..... 4

 2.1 Reference Vegetation Community Structure..... 6

 2.1.1 South of Varney Road 6

 2.1.2 Granger and Longhorn Ranch Land..... 8

 2.1.3 Love Property..... 10

 2.2 Dominant Woody Species Descriptions 12

 2.2.1 Sandbar willow (*Salix exigua*) 12

 2.2.2 Yellow willow (*Salix Salix eriocephala v. watsonii*) 13

 2.2.3 Bebb’s willow (*Salix bebbiana*) 13

 2.2.4 Booth’s willow (*Salix boothii*)..... 13

3 Revegetation Plan..... 14

 3.1 Limiting Factors 14

 3.1.1 Wildlife Browse 14

 3.1.2 Existing Vegetation Cover 15

 3.2 Revegetation Treatments..... 15

 3.2.1 Containerized Planting..... 16

 3.2.2 Planting Willow Cuttings 17

 3.2.3 Browse exclusion 18

 3.2.4 Weed Management 19

 3.3 Demonstration Revegetation Project 19

 3.3.1 Implications for Future Phases of Revegetation..... 19

4 Conclusion 20

5 References 21

Appendix A: O’Dell Creek Revegetation Master Plan Maps 23

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1 Introduction

O'Dell Creek and its spring creek tributaries are important ecological connections to the Madison River, providing a source of cool fresh water to the river as well as a variety of aquatic, riparian, and terrestrial habitats that are utilized by a host of plant and animal species. Located in southwest Montana, the O'Dell Creek headwaters complex is approximately seven miles south of the town of Ennis (Figure 1-1). Mainstem O'Dell Creek joins the Madison River just north of Ennis, and the Madison, Jefferson, and Gallatin Rivers converge in Three Forks, Montana, to form the Missouri River, the longest river in North America.

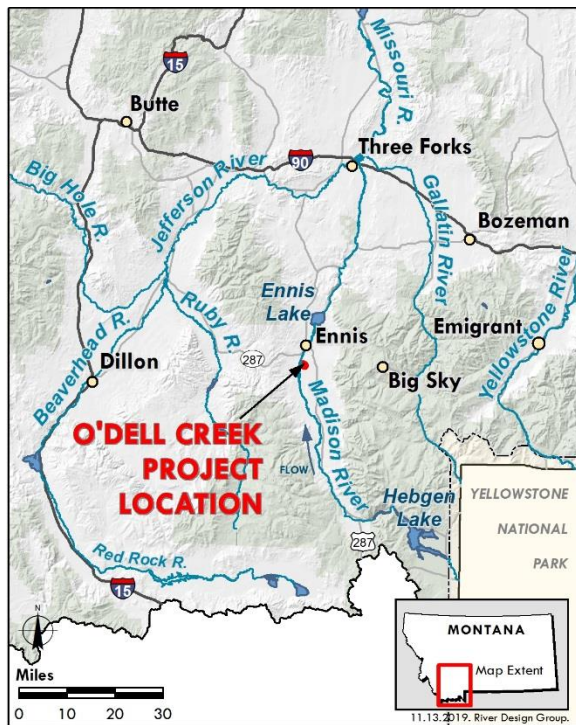


Figure 1-1. O'Dell Creek vicinity map.

The O'Dell Creek headwaters (Project Area) represents one of Montana's largest spring-fed wetland complexes and are unique and important wetland resources found in the greater Madison River Valley. Historically, this area supported a very rare, fully functioning mosaic and diverse complex of wetland and spring creek habitats. Since the late 1800's however, anthropogenic activities mainly due to ranching and agricultural activities have altered these habitats. Creek and wetland ditching, draining, over-grazing, and alteration of natural hydrology have resulted in a significant loss of wetlands and spring creeks in the system, as well as a loss of wetland and creek functions and values.

Recently, priorities have shifted towards the conservation of these important wildlife habitats while successfully integrating and balancing agricultural and grazing land-use practices. Along with conservation efforts, active restoration measures have been implemented to improve and restore fisheries and wetland habitat, as well as overall ecosystem functions and values. Since 2005, 13 major phases of work have culminated in the restoration of approximately 13.5 miles of spring creek, 700 acres of emergent wetland, and 35 acres of open water wetland. This stream and wetland restoration project has occurred on two actively-managed cattle ranches, the Granger Ranches and The Longhorn Ranch (Figure 1-2), which were established in the Madison River Valley in the early 1900's.

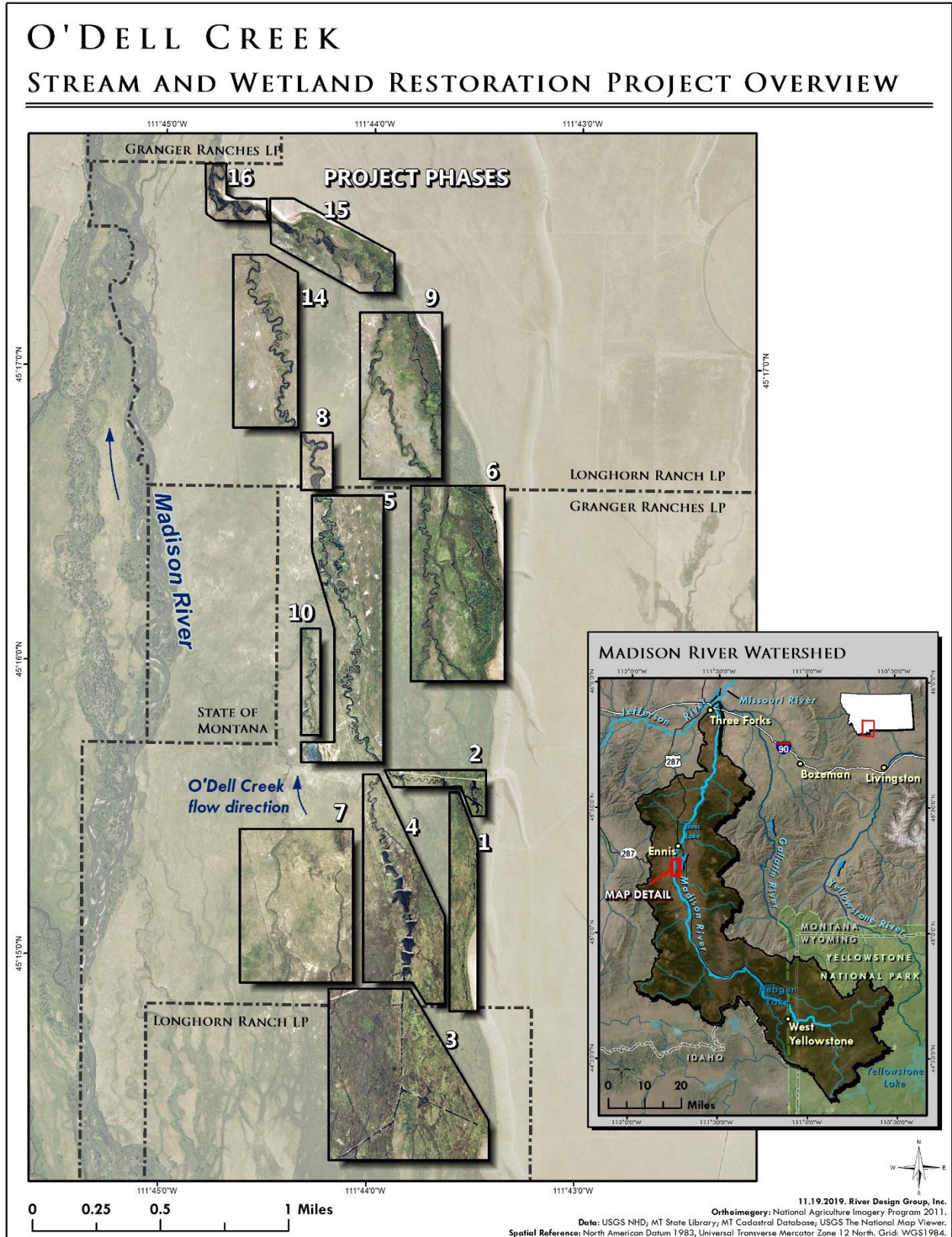


Figure 1-2. O'Dell Creek Stream and Wetland Restoration Project overview map. Phase 1 was implemented in 2005, Phase 16 was implemented in 2019.

Depending on the location in the O'Dell Creek headwaters complex, restoration techniques have focused on ditch filling, re-constructing stream channels on historical floodplain surfaces, lowering floodplains, shaping and narrowing over-widened channels, and creating complex in-stream fish habitat including riffle, run, pool, and glide habitat features. Open water and emergent wetlands have also been constructed. A key result of restoration actions to date has been a significant rise in the groundwater table throughout the Project Area, yielding improvements to stream and floodplain connectivity among other ecosystem enhancements. Furthermore, restoration work has resulted in more favorable conditions for native vegetation recruitment and success than existed prior to restoration.

Active vegetation restoration as part of the 13 phases of stream and wetland restoration has included planting herbaceous wetland sod on streambanks and seeding grasses in disturbed areas on floodplains. Passive vegetation restoration techniques have focused on the creation of appropriate floodplain habitat and microsites, resulting in natural vegetation recruitment throughout Project Area streambanks and floodplains. Significant increases in native plant species richness and diversity, including rare plant species, and substantial decreases in non-native weedy species have been documented (Luna 2014, 2016). This natural recruitment, however, has largely been limited to herbaceous plant species.

Where present, woody species that have naturally recruited to the Project Area include mostly dwarf carr species such as

sageleaf willow (*Salix candida*) that typically attain heights of less than 3 feet in calcareous fens and wet meadows. Very few larger woody species have naturally recruited to Project Area floodplains, and where present, are consistently browsed by wildlife to almost ground level (Figure 1-3).



Figure 1-3. Sageleaf willow in a calcareous fen along O'Dell Creek streambank. The river birch in the foreground is browsed to the ground.

Woody riparian vegetation on streambanks and floodplains provides stream shading and overhanging streambank vegetation, which reduces stream temperatures and improves cover for aquatic species. Over time, woody riparian vegetation also provides a source of large woody debris to streams, which improves fish habitat conditions by promoting pool formation and aquatic habitat heterogeneity. Woody vegetation also serves as a seed source for other floodplain areas and provides habitat for a wide range of bird species. An added benefit

of riparian vegetation along streams is streambank stability due to deep binding root masses, which is provided by both woody and herbaceous communities.

1.1 Objectives

The O'Dell Creek Revegetation Master Plan aims to restore woody vegetation to the O'Dell Creek headwaters system to its likely condition had habitat degradation not occurred. As seen in vegetation reference reaches upstream and downstream of the project area, woody vegetation was likely a component of the O'Dell Creek riparian system prior to anthropogenic modifications including land clearing for grazing and agriculture.

This Revegetation Master Plan builds upon the stream and wetland restoration foundation established in the O'Dell Creek headwaters system over the last 14 years. Appropriate shrub and tree planting sites have been selected throughout the restoration project phases to increase woody riparian vegetation habitat throughout the Project Area where appropriate. Vegetation community composition, stand structure, and density targets are outlined, and various site preparation, browse protection, and planting guidelines are presented. In addition, active planting measures are complemented by browse exclusion on the woody species, mainly willows, that have naturally recruited to streambanks and floodplains following restoration, but have their growth limited by yearly browsing.

2 Restoration Targets

Identification of vegetation reference sites within and in the vicinity of the O'Dell Creek headwaters area provide targets for vegetation composition throughout the Project Area. While the makeup of pre-disturbance vegetation communities in the Project Area is debatable due to a lack of historic records or photographs and varying personal accounts, the use of reference communities is useful and practical to shape our understanding of the potential vegetation communities that would have existed in the area if human-caused disturbances had not exerted influence in the system over the last century.

Reference sites with diverse structure that function well in the landscape provide modern analogs to pre-disturbance conditions with the added benefit of accounting for temporal shifts in ecological trajectories since the pre-disturbance era. As part of this project, five sites in the vicinity of the Project Area were chosen to represent the desired vegetation targets and account for spatial variation (Figure 2-1). Tall shrub communities were targeted, as these provide avian and other wildlife habitat that is largely absent from the restoration project phases, and that over time will provide: 1) overhanging cover for fish species; 2) streambank stability; and 3) reductions in stream temperature, crucial to maintaining a major cold-water source to the Madison River.

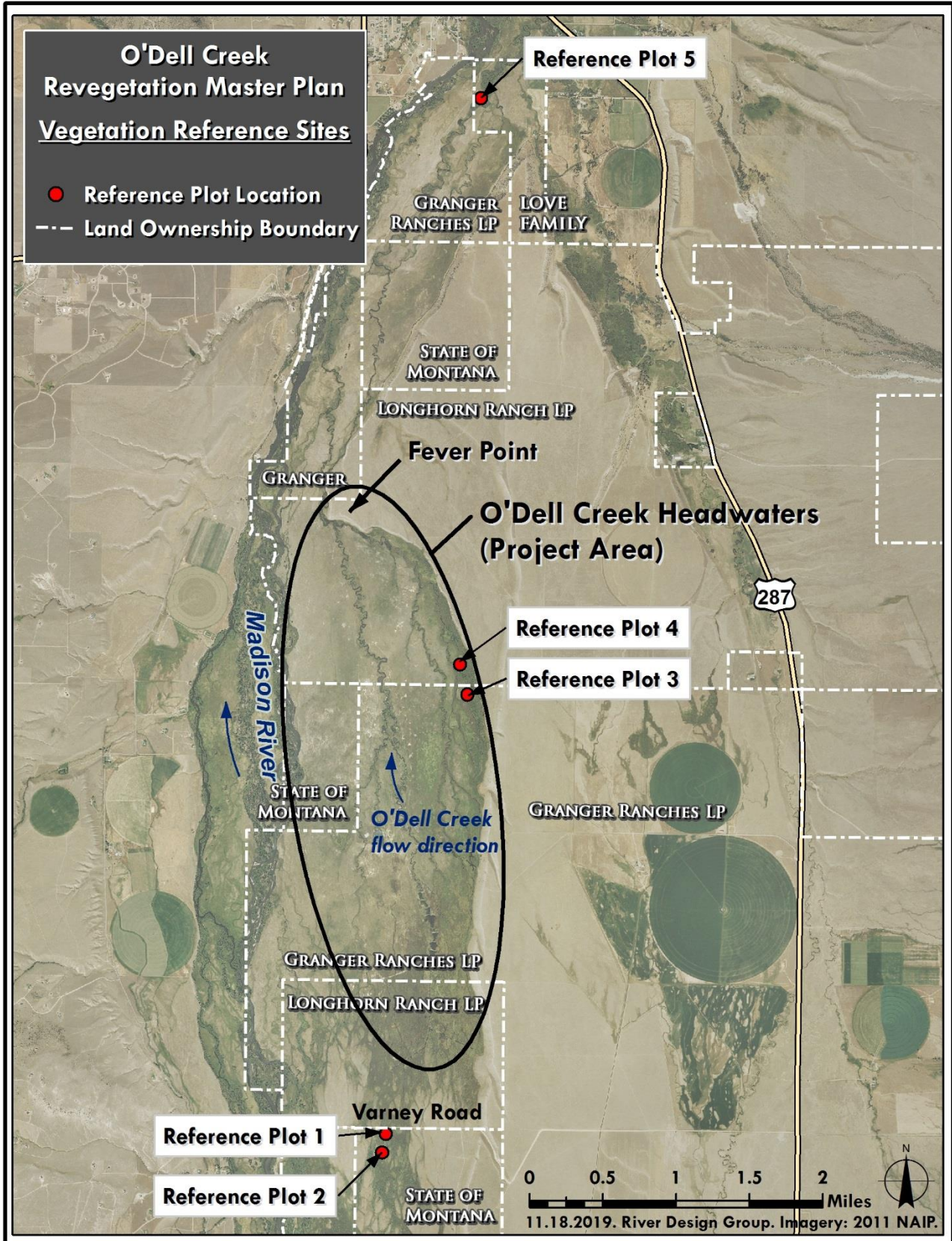


Figure 2-1. Vegetation Reference Plot Locations.

2.1 Reference Vegetation Community Structure

The following five reference plots are listed from south to north (upstream to downstream). Applicability of these reference conditions to project area sites varies by location, which is further detailed in Section 3 of this report.

2.1.1 South of Varney Road

Two reference plots are located on State of Montana land, south of Varney Road (Figure 2-1). The land contains a mosaic of willow shrubs and is dominated by sandbar willow (*Salix exigua*) punctuated by larger willow trees with the occasional black cottonwood (*Populus trichocarpa*). It is a sandbar willow/Baltic rush (*Juncus balticus*) community type with various age classes of willows present and consistent regeneration. It has been and is currently leased for cattle grazing on a rotational basis.

Reference Plot 1 is in a mature sandbar willow community with 70% absolute canopy cover of 6 to 10 feet tall shrubs, and intermediate to young patches actively recruiting into herbaceous meadow area (Figure 2-2). The herbaceous layer consists largely of Baltic rush (70% cover) and water sedge (*Carex aquatilis*) (30%) in low-lying depressions in open and closed canopy areas. The soil consists of sandy loam beneath a tightly bound organic layer of Baltic rush roots, overlying small to medium sized gravels. It was fully saturated during sampling in mid-July 2019. Consistent soil saturation in areas of low-lying topography creates conditions that allow sandbar willow

to remain stable in the canopy and subcanopy.



Figure 2-2. Vegetation and soil at Reference Plot 1.

Reference Plot 2 is further south on the State Land south of Varney Road, and exhibits similar characteristics to Plot 1. The sandbar willow overstory here occupies 80% of canopy cover and is 6 to 8 feet tall, and mature individuals of yellow willow (*Salix eriocephala v. watsonii*) are also present (Figure 2-3). A few saplings of Bebb's willow (*Salix bebbiana*) were found recruiting into open herbaceous meadow areas, where it tends to recruit into wet meadows on the margin of willow thickets or the outer perimeter of the wetland zone where soils tend to dry at the end of the season. Bebb's willow is absent in permanently saturated soils.



Figure 2-3. Vegetation at Reference Site 2. Note the taller yellow willow on the left, and single large black cottonwood tree in the background.

Lemmon's willow (*Salix lemmonii*) is also present in some patches in the vicinity of this site. The herbaceous understory at Plot 2 consists largely of Baltic rush, water sedge, woolly sedge (*Carex pellita*), and Kentucky bluegrass (*Poa pratensis*). Wetland hydrology is temporary to seasonal following snowmelt in late spring. Soils are sandy loams over gravels and cobbles.

Applicability to Restoration

A distinct break in vegetation community structure occurs at Varney Road, which defines the southern border of The Longhorn Ranch in the O'Dell Creek

headwaters area (Figure 2-4). In contrast to the State Land to the south, land directly to the north of Varney Road exhibits a diverse herbaceous plant community but is wholly devoid of the woody species that are present to the south of Varney Road.

The explanation for this discrepancy is a subject of debate, however first-hand accounts reveal that the State Land to the south of the road was completely devoid of willows and cottonwood in the early 1950's. Around 1952, water diversions from Madison River to the south were created and ditches delivered hydrology to the now-State Land, which became more favorable to the establishment of water-dependent riparian species, including sandbar willow.

Improved hydrological conditions for willow community establishment, coupled with disturbance and wind or water dispersal of seed, likely produced the environmental conditions that favored the establishment and spread of willow shrubs throughout this area. Personal accounts from landowners and land lessees in the area include a gradual shift from herbaceous communities to a dominance of woody vegetation over tens of years following the introduction of



Figure 2-4. Varney Road looking east. Longhorn Ranch property is north (left). State land is south (right).

hydrology. In addition, some beaver activity is likely to have further assisted the recruitment of willows in areas of introduced hydrology on the State Land.

That the willows did not spread north of Varney Road is likely due in large part to a break in surface water flow, as the roadbed is a few feet above the ground surface and water that is flowing north is intercepted by the road and routed west before entering a culvert below the road, and directed further west to where it flows into the Madison River. And as is described in further detail in Section 3 of this report, a major limiting factor to the successful natural recruitment of woody vegetation to the O'Dell Creek headwaters area is the presence of a thick grass, sedge, and rush sod mat with an extensive root system. This existing vegetation does not allow germinated seeds of woody species access to the water, nutrients, and the space they need to survive to seedlings or saplings.

Bare substrate does not occur on ranch land to the north of Varney Road, and the existing vegetation groundcover inhibits survival of any seedlings that may have dispersed to the area. One main difference here than at the State Land to the south may have been ground and vegetation conditions during the initial willow germination and establishment period. When hydrology was introduced to the State Land in the early 1950's, the area was likely dominated by more upland grasses and forbs instead of wetland species, and bare ground areas may have been available for willow recruitment.

Currently, Longhorn Ranch land directly to the north of Varney Road contains the same

herbaceous species as exist in the understory of the sandbar willow community to the south of the road, and soil properties were strikingly similar as well. With some disturbance to the existing vegetation groundcover and willow seed spread, it is expected that this area could naturally regenerate sandbar willow as well. Up until the very recent past, however, The Longhorn Ranch property to the north of Varney Road was heavily grazed and similar ground disturbance conditions would have been present as on State Land to the south.

The condition of the willow community on the State Land, coupled with the soil and hydrological conditions, suggest that this willow population would serve as a practical and successful donor source for the O'Dell Creek headwaters area. While the mature sandbar willow community here is likely not the historical pre-human condition of the entire Project Area, it provides a reference for the vegetation structure and composition that is possible and sustainable, given similar soil and hydrologic conditions.

2.1.2 Granger and Longhorn Ranch Land

Two vegetation reference plots are located near the O'Dell Creek Stream and Wetland Restoration Phase 6 project area on Granger Ranches and The Longhorn Ranch property (Figure 2-1).

Reference Plot 3 is in a mature sandbar willow/Booth's willow/Kentucky bluegrass community type with stands of water sedge (Figure 2-5). This site is similar to Plot 2, but with deeper, more fine-textured silty-clay loam soil. The community occurs on a level bench less than 30 feet from the stream

channel. Sandbar willow occupies 50% of the overstory canopy, while Booth's willow is present at 20% of the canopy. Booth's willow tends to occupy these fine-textured soils whereas yellow willow is found on gravelly or cobbly soil substrates in mixed communities with sandbar willow.



Figure 2-5. Reference Plot 3 vegetation.

Understory composition is dominated by Kentucky bluegrass (80% absolute cover in the herbaceous stratum), with a mixture of mesic forbs restricted to woody thickets and hummocks at the base of mature shrubs. The site has been heavily grazed by wildlife and cattle. Plot 3 is an example of a disturbed, post-climax community of Booth's willow/mesic forbs and Booth's willow/water sedge community types.

Reference Plot 4 is located more central in the tall scrub-shrub wetland at the Phase 6 Restoration Project area than Reference Plot 3 (Figure 2-6). It is within a Bebb's willow (*Salix bebbiana*)/beaked sedge (*Carex utriculata*) early- to mid-seral stage community with a diversity of species in the herbaceous understory. As with all the woody vegetation communities on the O'Dell Creek headwaters area, this

community is heavily grazed by deer, elk, and moose, and is a major calving ground for deer. While mature individuals of willow and birch trees are common, regeneration and young age classes of these species are limited because of browse.



Figure 2-6. View looking west onto the Restoration Phase 6 Project Area, and Reference Plot 4.

Bebb's willow occupies 30% of the overstory canopy at Plot 4. River birch (*Betula occidentalis*) is present at 15% cover. River birch recruits and remains a stable, mid to late seral stage dominant in wetlands with well aerated, organic soils or mineral soils with extensive organic layers that remain permanently saturated. Mature shrubs of Bebb's willow occupy the perimeter of the birch thicket and are found on raised hummocks.

Typically, mixed communities of river birch and Bebb's willow contain a blend of low- to medium-sized shrubs. At this site, understory shrubs are found on raised hummocks and at the base of mature overstory shrubs, containing trace amounts of Woods' rose (*Rosa woodsii*), northern

black currant (*Ribes hudsonianum*), and shrubby cinquefoil (*Potentilla fruticosa*).

The herbaceous understory is dominated by beaked sedge at 65% absolute cover in the stratum. Slim-stem reed grass (*Calamagrostis stricta*) occupies 5-10% cover, and Baltic rush, Canada goldenrod (*Solidago canadensis*), meadow foxtail (*Alopecurus pratensis*), chives (*Allium schoenoprasum*), and field mint (*Mentha arvensis*) occupy approximately 5% each of the herbaceous stratum. Sixteen other graminoid (grass, sedge, or rush) and forb species are present at this reference community plot in trace amounts.

Soils exhibit large accumulations of organic material, indicating that this location is a well-established and long-standing wetland community. The wetlands were also influenced by past beaver activity, and multiple decaying beaver dams are still present in the area. The entire top 16+ inches of the soil is peat and classified as a histosol, with significant organic mottling and streaking in the sub-mineral layer, indicative of hydric soil conditions. Complete saturation of the peat was at the surface, and the water table was at maximum two inches below the surface during time of sampling.

Applicability to Restoration

It is likely that this community type was more prolific throughout the O'Dell Creek headwaters area than is currently present. While historic stream and wetland ditching for agricultural and grazing purposes lowered groundwater tables throughout most of the project area, this Restoration Phase 6 area intercepts groundwater from

the ancient river terrace on the eastern edge of the floodplain. Numerous springs are found at the base of the old river terrace. The groundwater table was not as affected by the historical land use practices here as it was in other areas, which also precluded more intensive cattle grazing in this area.

Because wetland hydrology likely persisted despite human alterations, the scrub-shrub and tall shrub wetland vegetation communities provide a reasonable target for vegetation community restoration in the Project Area. The stream and wetland restoration actions since 2005 have dramatically increased water tables, making the reference community type in the Phase 6 area more applicable to the other restoration phases.

2.1.3 Love Property

One vegetation reference plot is located to the north of the Restoration Project phases, south of Ennis on the Love family property. Here, willow communities are verdant along the connected stream and floodplain environment. The reference plot on the Love property is the only reference location affected by Madison River ice floes and gorging, as it is a major disturbance on O'Dell Creek from approximately 2,000 feet upstream of Fever Point down to the creek's confluence with Madison River. The location of Fever Point is provided on Figure 2-1 for reference.

Reference Plot 5 is in a mature sandbar willow/Booth's willow community type (Figure 2-7). Western snowberry (*Symphoricarpos occidentalis*) is frequently found along the streambanks, slightly raised

terraces, and open meadows adjacent to mature willow stands. Mature and sapling water birch is also present, and the reference location contains a diverse understory of woody and herbaceous species.



Figure 2-7. Vegetation in the Reference Plot 5 vicinity.

Sandbar willow occupies 20% absolute cover of the overstory canopy, and Booth's willow and river birch are at 15% and 2%, respectively. Western snowberry was documented at 5% cover in this reference plot, and other woody species include red-osier dogwood (*Cornus sericea*) at 3% canopy cover, and inland gooseberry (*Ribes setosum*) and Woods' rose, each at 2% cover, as well as a trace amount of red raspberry (*Rubus idaeus*). The herbaceous stratum is dominated by woolly sedge and water sedge at 25% and 20% of cover, respectively. Other herbaceous species present at Reference Plot 5 include silver cinquefoil (*Potentilla anserina*) (5% cover), water smartweed (*Polygonum amphibium*) (3%), Kentucky bluegrass (2%), Canada thistle (*Cirsium arvense*) (5%), and eight other species with trace amounts.

Soils consist of silty clay loams over gravels and cobbles. This reference site is an example of Booth's willow/mesic forbs and Booth's willow/water sedge community types. Booth's willow recruits on fine textured saturated soils and forms stable communities with red-osier dogwood at later stages of succession. Booth's willow communities tend to form in wide terraces or broad alluvial floodplains and are frequently found near old or existing beaver ponds. Sections of O'Dell Creek on the Love property also contain small patches of water birch/red-osier dogwood communities that recruit into sites with greater organic matter accumulation and lower stream velocity, forming a stable community at later stages of succession (Figure 2-8).



Figure 2-8. O'Dell Creek on the Love property.

Applicability to Restoration

The reference vegetation communities present on the Love property represent a practical and applicable target for restoration of vegetation communities throughout the O'Dell Creek headwaters area, given that soil substrate conditions are favorable for the development of these communities. The presence of the tall shrub willow communities along mainstem O'Dell

Creek on the Love property indicate a good likelihood of these communities existing upstream in the Project Area to some extent historically, prior to human modification to the system including ditching and land clearing.

The extent to which these communities may have been present upstream of the reference community in the Project Area is, again, debatable. A major disturbance that is present on Love property but absent from most of the O'Dell Creek headwaters project area is Madison River ice floes and gorging, which disturbs existing floodplain sod and deposits sand, creating a favorable substrate for seed bed establishment. In addition, large areas throughout the O'Dell Creek headwaters project area are characterized by clay soils, saline terraces and marl soil with high calcium carbonate concentrations and limited nitrogen and phosphorous availability due to localized water chemistry. These areas are not conducive to the development of tall willow shrub communities. Instead, extensive extremely rich to rich fen dwarf carr and herbaceous communities have formed on the eastern portion of the Project Area. Dwarf carr vegetation includes sage leaf willow (*Salix candida*), and dwarf forms of mountain willow (*Salix pseudomonticola*), plane-leaf willow (*Salix planifolia*), Booth's willow, and yellow willow that seldom reach heights greater than 1.5 feet in soils with high pH and limited available nutrients for optimal plant growth.

Soil sampling throughout the Project Area identified sporadic patches of silty clay loams over gravels and cobbles, especially along some mainstem O'Dell Creek

restoration areas, suggesting a patchy range of tall willow shrub communities would have been historically present. Alluvial mineral soils would support optimal growth of the same willow species found in dwarf fen carr communities and allow for early recruitment of sandbar willow and occasionally, cottonwood, on exposed mineral soils that experience periodic disturbance.

2.2 Dominant Woody Species Descriptions

Descriptions of the dominant willow species found throughout vegetation reference sites, and the most applicable willow species for restoration, are included in the following sub-sections.

2.2.1 Sandbar willow (*Salix exigua*)

Sandbar willow is an early seral colonizing species that has deep taproots that bind bare soils, and vigorous, spreading lateral roots capable of sprouting and re-sprouting when subjected to top removal, browsing and flooding. It is usually the first woody species to colonize disturbed, flood-prone sand and gravel bars and floodplains but also recruits into exposed peat soils. It is an aggressive spreading woody species under favorable conditions (NRCS 2002). It is often utilized for streambank stabilization and restoration projects, as it regenerates well from cuttings that are harvested and planted while dormant, without the need for root development or application of rooting hormones prior to installing directly on streambanks.

This species occupies a range of soil types on floodplains including on pure sands and exposed gravels below the water line on

streams, and raised sand and gravel bars along streambanks. It also occurs on moist meadows, terraces, and abandoned channels and oxbow meanders. It can occupy well-drained soils that are highly alkaline to saline. It is considered more tolerant to concentrated salt accumulations than other willow species, and its application to the O'Dell Creek headwaters environment may be preferred over some other species for that reason.

2.2.2 Yellow willow (*Salix Salix eriocephala v. watsonii*)

Yellow willow is a multi-stemmed willow shrub with a mature height of around 16 feet. It is commonly found in association with sandbar willow on gravelly streambanks or wet floodplain terraces with sandy or silty soils. Mature yellow willow stands are commonly found adjacent to Booth's willow stands with fine-textured soils and a semi-permanent to permanent hydroperiod. This species forms a minor to major component of willow communities at O'Dell Creek Vegetation Reference Plots and its inclusion on vegetation restoration areas throughout the O'Dell Creek headwaters area is suitable, given appropriate substrate and hydrologic conditions.

2.2.3 Bebb's willow (*Salix bebbiana*)

Bebb's willow is a large shrub to small tree, frequently reaching heights of 25 feet. It is fast growing but short-lived (NRCS 2003), which explains the often-decadent growth form where it occurs on the O'Dell Creek headwaters project area, as regeneration is hindered by wildlife browse.

The willow species is frequently found in mixed stands with sandbar willow, yellow willow, and Booth's willow. It occurs in a range of soil types and habitats including on fens, floodplains, and streambanks, and can be a common species in mature water birch/red-osier dogwood community types on level terraces and floodplain benches. It also frequently occurs on drier margins of wet meadows and streams. Cuttings of Bebb's willow perform best with application of rooting hormone prior to planting.

2.2.4 Booth's willow (*Salix boothii*)

Booth's willow is a large shrub to small tree reaching heights of 24 feet, with a rapid growth rate and moderate lifespan (NRCS 2019). It is adapted to a wide range of soil conditions but without tolerance to salinity. Booth's willow is commonly found in gravelly substrates near streambanks, or finer-textured silty soils on drier terraces and floodplain benches. It corresponds with high water tables. Mixed stands of sandbar willow and Booth's willow are typically found on disturbed sites or drier floodplain benches near streambanks. Both yellow willow and Booth's willow are highly tolerant of alkaline soils and water chemistry.

3 Revegetation Plan

Vegetation restoration targets identified in Section 2 can be applied to specific and suitable areas throughout the O'Dell Creek Stream and Wetland Restoration Project Phases 1 through 16 (Appendix A). As previously mentioned, the passive restoration of native and desirable herbaceous vegetation to project area floodplains has been successful. Stream and wetland restoration actions have resulted in a rise in groundwater levels resulting in restoration of wetland hydrology throughout a majority of the Project Area, and fresh substrate has promoted the natural colonization of a wide variety of graminoids and forbs including rare species. This revegetation plan outlines steps to colonize appropriate surfaces with woody shrubs and few trees to the restoration project.

Most land throughout the Project Area may not be appropriate for the development of tall shrub riparian communities. However, in patches along O'Dell Creek and spring creek tributaries where soil substrate does not include a predominance of clay or calcium carbonates, and where water tables have been restored to provide appropriate hydrological conditions, the promotion of tall willow shrub communities is appropriate. These willow communities along the banks of streams would be punctuated with few tall black cottonwood or water birch trees. Over time, these vegetation assemblages would provide not only overhanging cover for fish, streambank stability, stream shading to reduce temperatures, and woody debris to promote

aquatic habitat heterogeneity, but also would provide important bird habitat which is currently lacking from the vast majority of the project area (Figure 3-1).



Figure 3-1. Example revegetation location on outer meander bend of O'Dell Creek.

3.1 Limiting Factors

Two major limiting factors affect natural woody vegetation recruitment and success in the project area. The restoration strategies presented below address these factors, which include wildlife browse and existing vegetation cover.

3.1.1 Wildlife Browse

The O'Dell Creek headwaters project area is home to a large population of whitetail and mule deer, as well as elk, moose, and antelope. While antelope prefer uplands to use as forage ground, deer, elk, and moose frequent floodplain and wetland areas in the project area and strip woody vegetation of leaves and young shoots. Mature Bebb's willow and water birch in the Restoration Phase 6 project area, for example, are almost completely browsed from the soil surface up to six feet, implying that planted

shrubs and trees need to exceed that height to persist in the landscape (Figure 3-2).



Figure 3-2. Wildlife browse extending to six feet on mature river birch trees on the Restoration Phase 6 Project Area.

High wildlife browse pressure in riparian areas throughout southwest Montana, including in the greater Madison River Valley, is common. Whitetail and mule deer are especially prevalent, which may result from a combination of less severe winters resulting in less winter kill, and a lack of apex predators including wolves and mountain lions. In addition, while human hunters often heavily utilize state and federal lands, their hunting opportunities are somewhat more restricted on private lands such as the Granger and Longhorn Ranches which comprise the O'Dell Creek headwaters area. Large private landholdings may therefore provide safe havens for deer populations, which are hunted more on surrounding state and federal lands than on private land. Granger and Longhorn Ranches do, however, permit hunting on their grounds, but the pressure is less than on surrounding Forest Service and State land.

Another browse threat to restoration plantings include mice and vole girdling around the base stem of plants. If the small mammals chew through the bark and cambium layer at the base of a shrub or tree which moves water and nutrients throughout the plant, it will result in plant death. This is a concern especially in floodplain areas on O'Dell Creek that are not inundated or fully saturated throughout the growing and fall seasons, and that are dominated by dense pasture grasses or native meadow species which house mice and voles.

3.1.2 Existing Vegetation Cover

Within the project area, the existing herbaceous vegetation cover is usually dense and diverse, with thick above- and below-ground biomass. In the absence of natural disturbances such as large flood events and ice gorges which often result in bare substrate for plant recruitment and colonization, woody species survival from germination to seedlings or saplings is limited. Thick grass, sedge, and/or rush thatch belowground restricts seedling success as physical space, nutrients, and water is intercepted by the existing vegetation root structure, and light availability can be restricted from a thick above-ground biomass as well.

3.2 Revegetation Treatments

Methods of woody species restoration to the Project Area include planting and fencing. While seed distribution by broadcast, drill seeding, or hydroseeding is often used for revegetation of woody species, the existing graminoid layer would limit the success of

this method in the O'Dell Creek headwaters area. This is especially true given that the introduction of disturbance such as cattle grazing or mechanical sod removal is not recommended. Cattle grazing activity in wet floodplain and riparian areas often results in greater disturbance than advised, including the creation of deep furrows from repeated hoof trampling and a decrease in water quality. In addition, mechanically removing large areas of existing sod triggers invasive weedy species recruitment.

Planting both nursery-grown stock and cuttings harvested from native donor sites in the vicinity of the Project Area will jump-start woody species recolonization on appropriate surfaces. Planting will be supplemented with browse exclusion fencing in areas where willow shrubs have naturally recruited but that are browsed yearly and never reach maturity. In addition, all planted shrubs and trees will be accompanied by wildlife browse protection for a minimum of five years to allow the woody species enough time to grow without browse pressure in order to be able to withstand browse.

Revegetation planting of woody species will be focused on outer meander banks to provide for aquatic habitat benefits as well as bank stabilization. Some interior floodplain areas will also be targeted for planting, which will, over time, provide riparian habitat for a variety of bird species as well as large and small mammals.

3.2.1 Containerized Planting

Nursery-grown shrubs and trees planted in the Project Area have the advantage of

growing in a favorable plant nursery environment until the sapling growth stage, when both root and shoot development is adequate to sustain competition from existing vegetation in the Project Area. Utilizing plants grown to the size of a 1-gallon planting container (>2 years old) has been shown to provide a good compromise between plant size and cost. Supplementing 1-gallon plants with 5- and 10-gallon container sizes is also recommended where possible to introduce near-immediate vertical vegetation structure to the Project Area. However, a plant that is grown for too long in the nursery environment has a risk of high outplanting stress, where it cannot adapt as easily to the harsher field conditions as younger plants.

Table 3-1 provides a species list appropriate for planting throughout various regions in the project area. Appendix A includes an overview of planting locations.

Table 3-1. Recommended species, size of containers, and minimum spacing when planting.		
Species	Cutting/ Container Size	Min. Spacing (ft)
Sandbar willow <i>Salix exigua</i>	Cuttings, 1-gallon	0.2, 6
Bebb's willow <i>S. bebbiana</i>	1-gallon	6
Drummond's willow <i>S. Drummondiana</i>	1-gallon	6
Yellow willow <i>S. eriocephala v. Watsonii</i>	1 to 5-gallon	10
black cottonwood <i>Populus trichocarpa</i>	1 to 10-gallon	15
Water birch <i>Betula occidentalis</i>	1 to 10-gallon	15
Inland gooseberry <i>Ribes setosum</i>	1-gallon	6
Western snowberry <i>Symphoricarpos occidentalis</i>	1-gallon	6

Following planting, each shrub or tree should have a 3-foot x 3-foot weed mat installed around it, to minimize competition from weed species which grow well on disturbed soil, as well as the existing grasses, sedges, and rushes which surround the plant and will fill in the area around the plant within one growing season if no physical (weed mat) or chemical (herbicide) protection around the plant is afforded. Targeted herbicide application can also be used to reduce plant competition around planted stock.

However, if containerized plant stock roots and bottoms of cutting are installed below the existing sod mat they should reach soil and water and may not require herbicide treatment for optimal establishment. Furthermore, to avoid removing existing vegetation from large planting areas which would necessitate extensive weed management, it is recommended that the application of any aquatic-rated herbicide be limited to individual 3-foot x 3-foot shrub and tree planting areas.

3.2.2 Planting Willow Cuttings

The harvest of willow cuttings from the identified donor site on State Land to the south of Varney Road is recommended for appropriate streambank locations throughout the Project Area. Other donor sites in the Madison River Valley can also be used, given that elevation and environmental conditions do not significantly vary between the donor willow stand and Project Area.

Planting dormant willow cuttings is a preferred revegetation method in the O'Dell

Creek headwaters project area. Willows are easily established from direct cuttings when appropriate specifications are met (NRCS 2007). Timing of harvest should coincide with dormancy of the willows, and harvest of willow cuttings in the fall immediately following the onset of dormancy is preferred over harvesting during the winter, as cuttings harvested in the fall can be planted immediately to restoration sites without the need for storage, as would be the case with a winter harvest and spring planting timeline.

Cuttings should be 0.5 to 1 inch in diameter, or up to 1.5 inches if the donor stem tissue is not too old. The age class of 2 to 4 years is recommended, and care should be taken to avoid young whips-of-the-year. Cutting length should be between 6 and 8 feet. The donor site on State Land to the south of Varney Road contains mostly sandbar willow, which has extremely high establishment success when installed correctly.

Following harvest of the willows during the fall dormancy period, it is recommended to soak the bottoms of the willows between 24 hours and 5 days prior to planting. Sandbar willow, however, requires little to no pre-soaking for good success. Cutting stock should be placed in water the same day as harvest to avoid desiccation, and cuttings should be installed in restoration planting locations within one week of harvest. On streambank locations, four to six willow cuttings per lineal foot is recommended to provide adequate growth during the initial establishment period, while allowing for some natural mortality.

Installation of willow cuttings can occur manually utilizing small-diameter dibble bars or with a long trench shovel. A small excavator may also be used, such that the excavator bucket digs into the soil and moves the soil far enough for willow cuttings to be placed in the trench, then the bucket is slowly released and all soil material placed back over the willow cuttings. Good contact between the willow stem and soil, and minimal air pockets in planting holes are keys to success. After installation in the ground, the tops of the willow cuttings should be cut such that no more than half of the cutting extends above the ground surface, to promote energy allocation to root production. Where possible, the bottom of the cutting should reach the water table.

3.2.3 Browse exclusion

As wildlife browse is high in the Project Area, all plantings should be protected from browse to the greatest extent possible for at least five years following planting. Plant heights should exceed six feet if possible before browse protection is removed.

Fencing around entire planting areas is recommended, as it is cost-effective and works well to keep ungulates out of planting units. Where plantings are not concentrated in units, individual browse protection can be utilized around each shrub or tree. To balance cost and effectiveness, utilizing heavy-duty polypropylene mesh fence fabric is recommended, along with steel T-posts installed at 15-foot spacing. If widths of planting units are within 20 feet, a fence height of 6 feet is appropriate as deer are deterred from jumping into the narrow

areas. Planting areas that exceed 20 feet in width will require higher fencing (7.5 feet tall) to keep deer from jumping into the enclosure.

Steel T-posts should be installed with the bottom two feet in the ground to ensure long-term stability of the fence structure. Fence heights of 6 feet will utilize 8-foot tall T-posts, and fence heights of 7.5 feet will necessitate the use of 10-foot tall T-posts.

Ungulate exclusion fence will not protect plants from mice and voles. An added benefit of installing weed barrier fabric around each plant is protection from mice and vole girdling. While the fabric does not provide complete exclusion of the small mammals, it discourages them from traveling to the base of the plant, as the small mammals avoid traveling on open surfaces devoid of grass cover. If larger and more expensive 10-gallon containerized plant stock is planted, a rigid plastic tube is recommended to be installed around the shrub or tree to ensure that mice and voles do not girdle the base of the plant.

In addition to fencing revegetation plantings, browse exclusion fence will be erected in areas with natural willow recruitment subjected to repeated browsing and that do not attain desired height. Some appropriate locations for this treatment are provided on Sheet 1.2 in Appendix A, and additional areas may be identified by the project manager and landowners, depending on the natural recruitment conditions of the specific year of revegetation project implementation.

3.2.4 Weed Management

Most planting areas throughout the Project Area are relatively weed free as a result of Restoration Project implementation, but pre-revegetation weed management may be needed. All planting sites should be examined prior to planting to ensure minimal weed competition, and if large weed infestations do exist, targeted herbicide application or weed mowing may be warranted. More importantly in this Project Area, weeds should be monitored for the first two years following planting to ensure infestations on disturbed ground around plantings are controlled before they produce seed and contribute to the invasive species seedbank in the soil. This is especially true for Canada Thistle, a Category 1 Noxious Weed which has been documented in large patches throughout the Project Area. Post-planting weed control most often includes very target herbicide application, ensuring no herbicide contact with planted species or existing native vegetation in the area, or hand-pulling.

3.3 Demonstration Revegetation Project

A pilot project-scale revegetation project was designed to test various revegetation methods, and mostly implemented in October-November 2019. The revegetation methodology presented in this Revegetation Plan incorporates lessons learned from the demonstration project. Frozen ground conditions were encountered in late October 2019 due to an uncharacteristically freezing weather pattern, necessitating the over-wintering of containerized plants on-site and planting in Spring 2020. The live, dormant

willow cuttings were planted prior to ground freeze, and during a short thaw period after the ground freeze but before full winter onset.



Figure 3-3. Sandbar willow cutting installation on O'Dell Creek floodplain as part of the Demonstration Revegetation Project. Tops of cuttings are cut after planting as seen in foreground.

3.3.1 Implications for Future Phases of Revegetation

For future implementations of this Revegetation Master Plan, the project implementation timeframe will be accelerated to September-October. If willow cuttings are not dormant in September, all other project elements will be installed prior to willow cutting harvest, including containerized plants, weed exclusion, and browse exclusion fence installation.

Location of planting units will consider fishing access and aesthetics, especially as browse exclusion fencing is designed to be kept in place for five years following planting, and fishing access on O'Dell Creek is important for landowners in the Project Area.

In addition, a plan-in-hand walk through of the project with the landowner is

recommended in the summer prior to any project installation. This will ensure that the landowner is aware of all the proposed project elements and placement of planting units, before resources are expended on the ground.

4 Conclusion

Implementation of 13 phases of stream and wetland restoration in the O'Dell Creek headwaters project area has resulted in significant expansion and improvements to aquatic, wetland, and riparian habitat. Achievements include the creation of connected stream and floodplain environments, improvements to instream fish habitat, stream temperature decreases, restoration of wetland hydrology through increases in groundwater levels, expansion of wetland area, and increases in functions and values of pre-existing wetlands.

While the projects have resulted in active and passive restoration of diverse herbaceous native species assemblages throughout the Project Area, natural woody species recruitment has been limited or nonexistent. This Revegetation Master Plan presents the basis and justification for restoration of tall willow shrub communities in select patches throughout Project Area streambanks and floodplains. This plan also provides methods for active restoration of appropriate woody plant species communities that can be phased over multiple years.

Implementation of this Revegetation Master Plan would result in further reductions to O'Dell Creek stream temperatures, provision

of additional aquatic habitat for fish, and riparian and wetland wildlife habitat benefits. The outcome would be the restoration of vegetation structure and function to its likely pre-disturbance condition, and a riparian landscape characterized by resiliency and wildlife compatibility.



5 References

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USDA Natural Resources Conservation Service (NRCS). 2003. Plant Guide: Bebb Willow, *Salix bebbiana* Sarg. USDA NRCS Plant Materials Program.

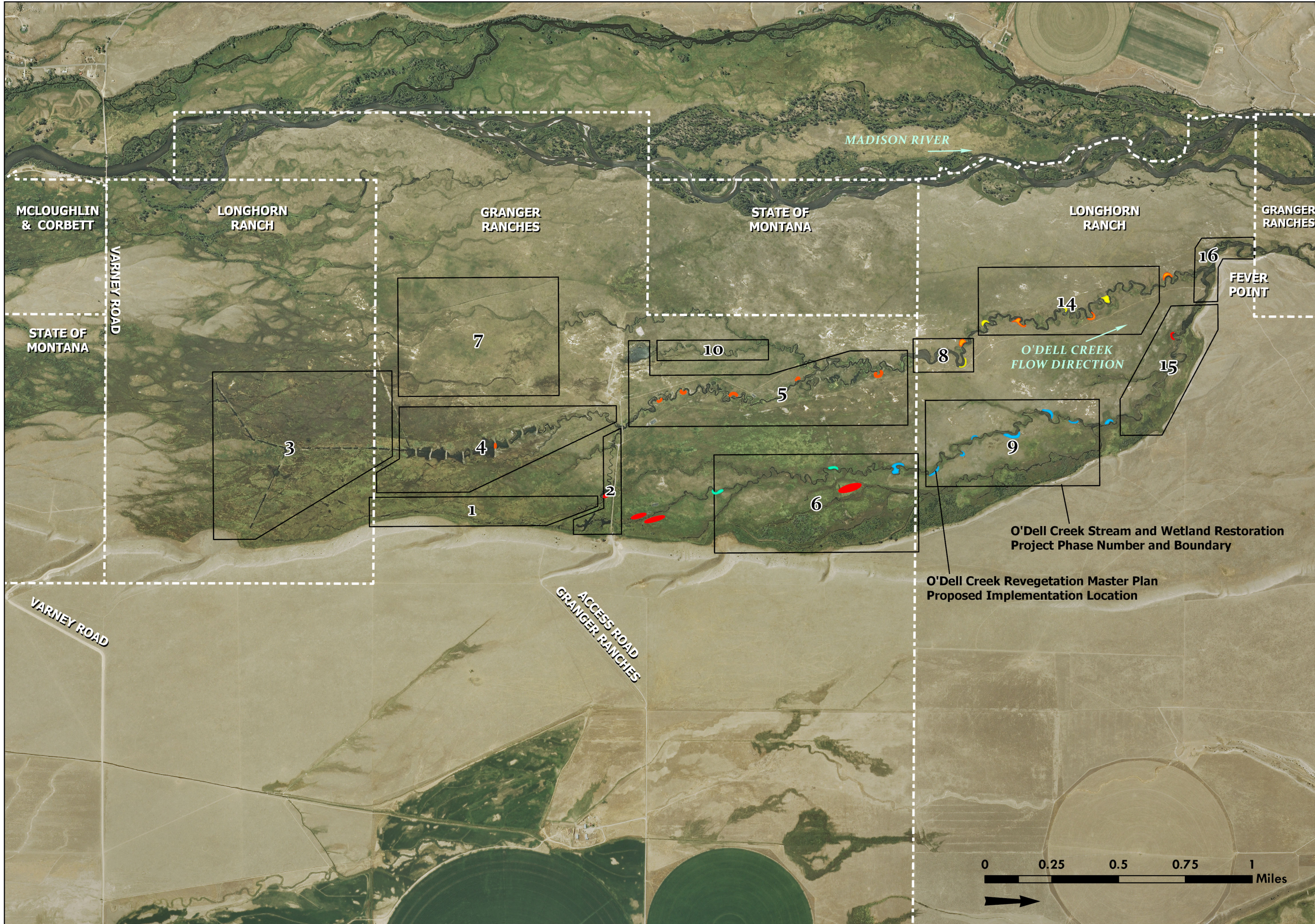
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Appendix A
O'Dell Creek Revegetation Plan Maps


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REVISIONS			
NO.	DATE	DESCRIPTION	BY/CHK
1	11.4.19	DESIGN	SA

PROJECT OVERVIEW

O'DELL CREEK REVEGETATION MASTER PLAN

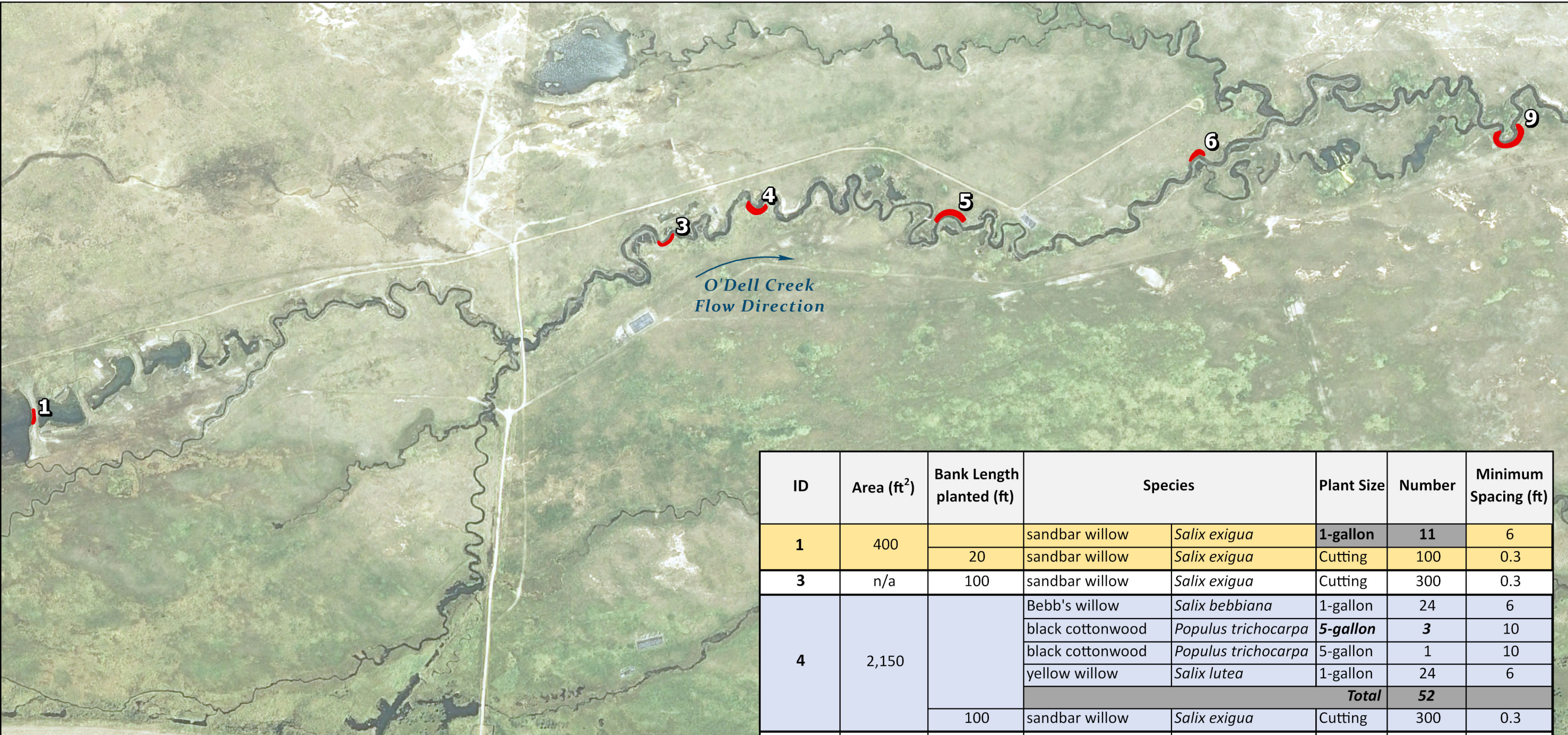


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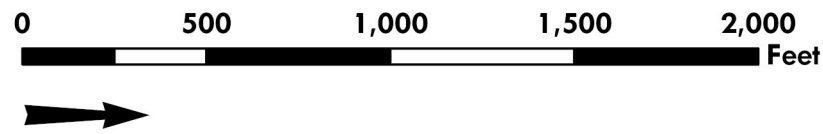
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PROJECT NUMBER
RDG-19-008

SHEET NUMBER
1.0



O'Dell Creek
Flow Direction



ID	Area (ft ²)	Bank Length planted (ft)	Species		Plant Size	Number	Minimum Spacing (ft)
1	400	20	sandbar willow	<i>Salix exigua</i>	1-gallon	11	6
			sandbar willow	<i>Salix exigua</i>	Cutting	100	0.3
3	n/a	100	sandbar willow	<i>Salix exigua</i>	Cutting	300	0.3
4	2,150	100	Bebb's willow	<i>Salix bebbiana</i>	1-gallon	24	6
			black cottonwood	<i>Populus trichocarpa</i>	5-gallon	3	10
			black cottonwood	<i>Populus trichocarpa</i>	5-gallon	1	10
			yellow willow	<i>Salix lutea</i>	1-gallon	24	6
			Total				
5	2,874	120	sandbar willow	<i>Salix exigua</i>	Cutting	300	0.3
			Bebb's willow	<i>Salix bebbiana</i>	1-gallon	32	6
			Inland gooseberry	<i>Ribes setosum</i>	1-gallon	13	8
Total					45		
6	973	50	sandbar willow	<i>Salix exigua</i>	Cutting	150	0.3
			water birch	<i>Betula occidentalis</i>	5-gallon	4	10
			Inland gooseberry	<i>Ribes setosum</i>	1-gallon	6	8
Total					10		
9	3,833	200	sandbar willow	<i>Salix exigua</i>	Cutting	600	0.3
			Bebb's willow	<i>Salix bebbiana</i>	1-gallon	32	6
			yellow willow	<i>Salix lutea</i>	1-gallon	32	6
			water birch	<i>Betula occidentalis</i>	1-gallon	4	10
			water birch	<i>Betula occidentalis</i>	5-gallon	4	10
			Inland gooseberry	<i>Ribes setosum</i>	1-gallon	21	6
Total					93		

REVISIONS				
NO.	DATE	DESCRIPTION	BY/CHK	
1	8.9.19	CONCEPT DESIGN	SA	
2	9.7.19	REVISION	SA	
3	10.1.19	FINAL DESIGN	SA	

DEMONSTRATION REVEGETATION PROJECT

O'DELL CREEK REVEGETATION MASTER PLAN

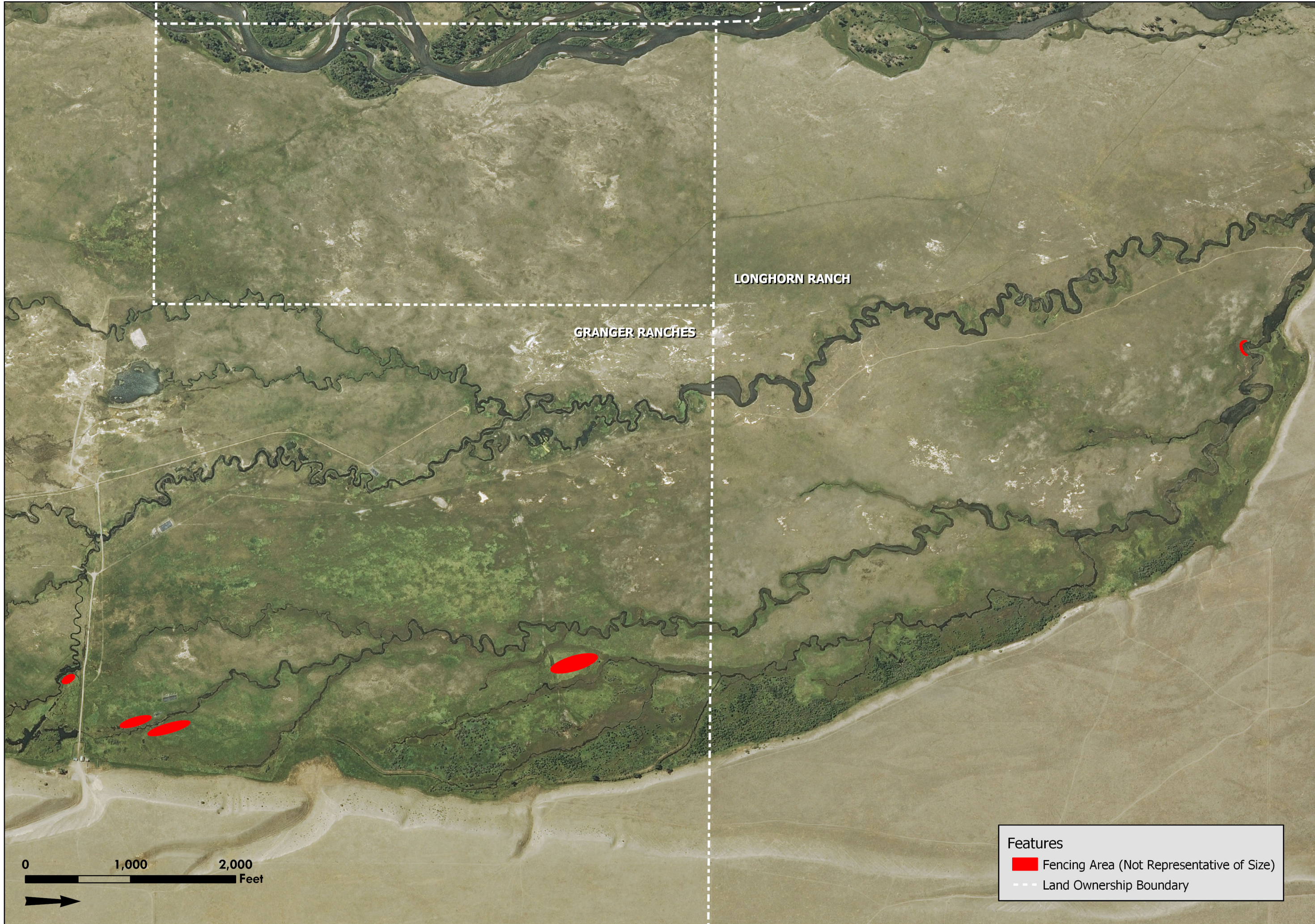
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Features

- Fencing Area (Not Representative of Size)
- - - Land Ownership Boundary

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1	7.11.19	CONCEPT DESIGN	SA

BROWSE EXCLUSION FENCE AROUND EXISTING WILLOWS

O'DELL CREEK REVEGETATION MASTER PLAN



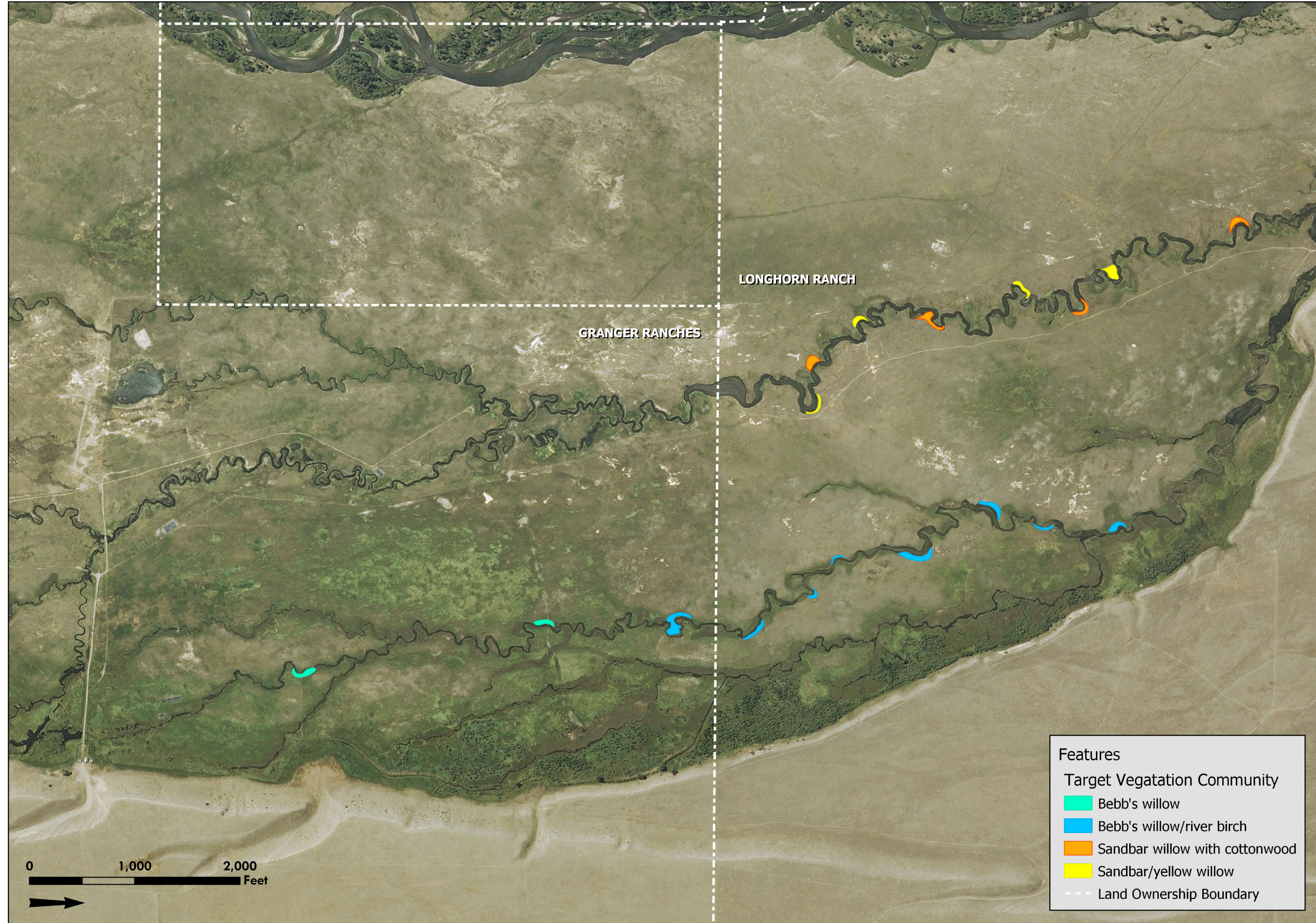
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GRANGER RANCHES

LONGHORN RANCH

Features

Target Vegetation Community

- █ Bebb's willow
- █ Bebb's willow/river birch
- █ Sandbar willow with cottonwood
- █ Sandbar/yellow willow
- - - Land Ownership Boundary

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FUTURE PLANTING PHASES

O'DELL CREEK REVEGETATION MASTER PLAN



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