Qualitative Rapid Assessment
2015-2017 Status Report

Milltown Reservoir / Clark Fork River NPL Site Clark Fork River Operable Unit, Reach A, Phase 1, Phase 2 and Phases 5 and 6

Prepared for:

Montana Department of Justice, Natural Resource Damage Program

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Executive Summary

This document provides a summary of the current geomorphic and vegetation status of remediation projects completed in Reach A of the Clark Fork River Operable Unit (CFROU Reach A) of the Clark Fork Site between 2011 and 2016. Project status for Phase 1, Phase 2 and Phases 5 and 6 is reported in terms of progress toward meeting objectives, maintenance needs, and effectiveness of the monitoring program itself including identifying data gaps where more information is needed to draw conclusions. The framework for monitoring is a Qualitative Rapid Assessment (QRA), which is described in detail in the Clark Fork River Reach A Vegetation and Geomorphology Monitoring Plan (Geum and AGI, 2016). The reason for using a QRA approach is to generate timely and useful information from monitoring given finite funding and an ever-increasing acreage of completed projects that need to be evaluated in a practical manner.

The QRA methods are based on the idea that geomorphic conditions and vegetation can be described in terms of broad categories through direct observation in the field by a team of knowledgeable experts. This is in contrast to collecting large quantities of data using time-consuming measurements, and then analyzing the data to determine which category a site or plot falls into. When category breaks are set to match performance target threshold values, observations directly translate to project objectives.

Geomorphic attributes that are measured as part of the QRA process include: channel stability, floodplain stability, and floodplain inundation/connectivity, and physical bank condition. Vegetation attributes include: streambank woody vegetation cover, floodplain woody vegetation cover, floodplain herbaceous vegetation cover, and survival of woody species. In combination, these attributes are referred to as metrics throughout the document, and each metric has an associated time frame when it is relevant, and threshold values that change over time and serve as indicators of project performance.

While this document includes detailed descriptions of observations and results made in completed phases between 2015 and 2017, this Executive Summary focuses on current status as of September 2017 when the most recent QRA was completed. Current status of completed projects is reported in terms of progress toward meeting performance targets, key observations and lessons learned, and maintenance needs. The QRA process has identified several factors that should be considered in designing future phases of work. This Executive Summary also provides a list of the future design recommendations.

Geomorphology

Phase 1

In 2017, the QRA assessment team identified the following geomorphic site trends in Phase 1. These trends are described in more detail in the main body of this document.

- Similar to 2015 and 2016, channel stability is meeting performance targets.

- During high flows in 2017 (approximately 350 cfs above the design Qbf or 2-year return interval), high water marks indicated up to a foot of overbank flow that caused wood and microtopography to be mobilized and reworked. The high flows did not result in any floodplain destabilization or avulsion.

Phase 2

In 2017, the QRA assessment team identified the following geomorphic site trends in Phase 2. These trends are described in more detail in the main body of the document.

- Channel stability is meeting performance targets.
- During high flows in 2017 (approximately 300 cfs above the design Qbf), high water marks indicate up to 0.5 feet of overbank flow that caused wood and microtopography to be mobilized and reworked. The high flows did not result in any floodplain destabilization or avulsion.

Phases 5 and 6

In 2017, the QRA assessment team identified the following geomorphic site trends in Phases 5 and 6. These trends are described in greater detail in following sections.

- Channel stability is meeting performance targets.
- Floodplain inundation indicators were notably rare in Phases 5 and 6 considering the magnitude of 2017 spring flows. This should be considered in relation to both bankfull design hydrologic calculations as well as bank construction techniques that may inadvertently expand the channel cross section during implementation.
- Numerous brush matrix banks that had been previously identified as having no to poor willow sprouting now show substantial or even robust expansion of willows.

The 2017 QRA results indicated that no additional monitoring and data collection is necessary for Phase 1, Phase 2 or Phases 5 and 6 until the scheduled Year 5 monitoring cycle unless flows exceed bankfull or a significant ice event occurs.

Geomorphology Management Actions

Based on the 2017 QRA, no management or maintenance actions were recommended to address issues related to geomorphology in Phase 1, Phase 2, or Phases 5 and 6.

Vegetation

Phase 1

In 2017, the QRA team identified the following vegetation trends in Phase 1. These trends are described in more detail in the main body of the document.

- Woody vegetation cover on streambanks continues to increase and willows are expanding towards the floodplain. This trend is particularly noticeable in areas where out of bank flows occurred in 2017 or in previous years.
- Survival of planted shrubs and trees has decreased in several planting units, particularly swale units and units planted in 2014 (compared to units planted in

2013), due to dry conditions and browse. Browse pressure is particularly high within the 4-ft beaver protection fences installed along streambanks in 2014 (2013 streambanks had individual protectors) which are doing little to prevent deer browse.

- Despite a decrease in survival, woody vegetation cover overall is increasing in most planting units as surviving shrubs and trees grow and expand.
- Floodplain herbaceous vegetation continues to increase and be dominated by seeded species; however, an increase in exotic species was observed in 2017. Alfalfa cover did not appear to increase in 2017 compared to 2016.
- Reed canarygrass was observed on more streambanks and point bars compared to 2016.
- The drop in woody vegetation survival along the left streambank could result in not achieving floodplain woody vegetation performance targets long-term. For this reason, the QRA should be repeated in Phase 1 in 2018 and management actions should be considered. No additional data collection is needed to document this trend.

Phase 2

In 2017, the QRA team identified the following vegetation trends in Phase 2. This phase was planted in 2016 and vegetation trends reflect Year 1 assessment. These trends are described in more detail in the main body of the document.

- Woody vegetation cover on streambanks was high for Year 1 and is expected to continue to increase over time.
- Survival of planted shrubs and trees was high. Survival was noticeably low on the west side of the floodplain between planting unit wl01 and sb01 and is attributed to dry conditions in this area.
- Browse protection measures installed in Phase 2 are functioning. The 4-ft wire fences had more sign of deer browse compared with the 8-ft net exclosures, but browse levels were moderate to low overall. Little sign of deer browse was observed in the 8-ft wire fence.
- Floodplain herbaceous vegetation cover was high overall but species composition varied greatly with some areas covered predominantly by seeded grasses and others almost entirely by annual/biennial exotic species. The main factors influencing species composition appeared to be: soil source (on site or imported) and soil moisture.
- There was less evidence of out of bank flows observed in Phase 2 compared to Phase 1, resulting in minimal expansion of woody vegetation from streambanks and streambank planting units.
- Floodplain features designed to maximize floodplain connectivity functioned very well and were activated during high flows resulting in high cover and diversity of wetland vegetation, expansion of woody vegetation, and mobilization and deposition of woody debris.

- Vegetative cover in irrigated hayfields is high. There was some evidence of slope erosion from irrigation which resulted in fine sediment deposition in the floodplain near planting unit om02b and om26.

Phases 5 and 6

In 2017, the QRA assessment team identified the following vegetation site trends in Phases 5 and 6. These trends are described in greater detail in the main body of the document.

- Woody vegetation cover on streambanks continues to increase.
- Plants installed in 2016 met the Year 1 survival performance target of greater than 80% survival; however, survival for planting units installed in 2015 has decreased since the 2016 assessment.
- Despite a decrease in survival, woody vegetation cover overall is increasing in most planting units as surviving shrubs and trees grow and expand.
- Herbaceous cover is increasing; however, many areas have high cover of exotic species. High elevation areas where conditions are driest have the highest cover of exotic species. Lower elevation floodplain surfaces with higher moisture have the highest cover of seeded species.
- There are several locations where deer can enter the 8-ft wire fence. Deer numbers are not high enough to affect establishing woody vegetation, but deer are having problems leaving the fenced area once they enter it.

Vegetation Management Actions

Based on the 2017 QRA results, the following management actions are recommended to support progress toward performance targets. Referenced locations are shown on maps Attachment A.

<u>Phase 1</u>

- Remove individual browse protectors where plants have out-grown them and re-use on surviving plants in fall 2014 streambank planting units.
    - Specifically, units where individual protectors should be removed include: OM06, OM10, OM13, OM16, OM18, OM21, OM22, OM19 (2013), OM20, and OM23.
    - Individual protectors should be placed on the surviving plants in OM-19 2014.
- Remove 8-ft net exclosure fencing where it is no longer needed or not functioning (i.e. can't be effectively maintained), including:
    - Island/planting unit SW04 (no longer needed).
    - Large exclosure on east side towards the downstream end of Phase 1 (no longer needed and difficult to maintain due to size).
    - Large exclosure on the west side at the downstream end of Phase 1 (no longer needed and difficult to maintain due to size).
    - Large exclosure on west side in the middle of Phase 1 (browse protection is still needed in this area but the exclosure is too large to effectively

maintain). Smaller fences or individual protectors should be installed in locations with surviving woody vegetation in this area.

- Maintain 8-ft net exclosure where it is still needed or where exclosures are small enough that maintenance is effective, including:
    - Exclosures upstream of bridge. A gap was left along the utility corridor in this area that is allowing deer to move through without damaging netting.
    - Exclosure east of river immediately downstream of bridge.
- Inter-plant select streambank and swale planting units with 10 cubic inch shrubs at a high planting density.
- Continue selective control of noxious weeds and selectively treat reed canarygrass on point bars during annual weed control.

Phase 2

- Repair downed sections of 8-ft net exclosure fences.
- Continue selective control of noxious weeds and isolated patches of reed canarygrass.
- Implement adaptive management for the west floodplain area where vegetation establishment is minimal. This area should be observed earlier in the growing season (July) in 2018 to determine if the conditions observed during the QRA are still present. If conditions are the same, aggressive management actions such as discing or plowing and re-seeding the area may need to be considered. The sandy soils and high elevation of this area will make it difficult for woody vegetation to establish or for high flows to inundate and allow natural revegetation processes to occur.

Phases 5 and 6

- Continue selective control of noxious weeds and include selective treatment of reed canarygrass along the channel.
- Consider installing deer jump-outs so deer inside the fence can exit.
- Continue to allow beaver activity in Galen Creek to occur as it is increasing the water table in the floodplain in these areas.
- Implement adaptive management for the dry floodplain areas. Options for increasing floodplain connectivity should be explored, including lowering floodplain surfaces and construction of additional floodplain features including side channels and wetlands.

Future Design Recommendations

The QRA process has included members of design teams from several phases of the CFROU Reach A project. This has allowed designers to evaluate the effectiveness of the various methods and treatments implemented to date. These evaluations and the resulting discussions have led to several future design considerations that could improve project performance. The following table provides a summary of the main future design considerations that have resulted from the QRA process.

Project Component	Future Design Considerations
Design Bankfull (2-year) Verification	1) Consider asynchronicity of tributaries and mainstem CFR (i.e. tributaries may not contribute to downstream CFR bankfull flows). 2) Consider irrigation withdrawals. 3) Consider potential effect of channel becoming enlarged during construction of streambank treatments that place the new streambank further back compared to the existing streambank.
Streambank Toe Construction	1) Incorporate areas of local high shear in design and implement specific localized treatments as necessary. 2) Identify criteria that lead to ice build-up. 3) Incorporate sacrificial toe in front of DVSL structures to prevent slumping. 4) Consider addition of woody debris in toe to prevent ice build-up and reduce toe scour and slumping. 5) Ensure toe is constructed in a location that allows the top of the streambank to stay in the same location as the existing streambank.
Avulsion Paths	1) In areas of high avulsion risk, construct the elevated meander cores with floodplain alluvium or floodplain alluvium mixed with some vegetative backfill (3:1 ratio). 2) Carry the super-elevated bank (0.5 feet high) through the entire upstream avulsion path length before returning to the bankfull (2-year) water-surface elevation. The super-elevated bank should cover the range of expected avulsion paths. 3) Construct wider, flatter point bars on bends that feed high risk avulsion paths to reduce high water super-elevation on the opposite bank. 4) If floods at a 10-year recurrence interval or greater occur after the channel survey and before construction, resurvey the sections to accurately define bank locations. 5) Install higher density woody debris in areas of higher avulsion risk (i.e., 2 x the density of coarse wood). 6) Consider incorporating willow plantings or cedar stakes with willows in all return flow areas to trap debris and decrease return flow velocities. 7) Reduce vegetative backfill depths from 1 foot to 6 inches. 8) Note that 2017 vegetation observations indicated that avulsion path risk minimization measures reduced woody vegetation survival in these areas which may increase long-term risk.
Brush Matrix Treatments	1) Increase density of brush used in treatment. 2) Consider ways to phase clearing and grubbing activities to increase viability of willows used in construction of these treatments. 3) Integrate live, dormant willow cuttings into the brush (rather than in a trench behind the brush. 4) Alternate the direction of placed brush to increase roughness.
DVSL Maintenance Requirements	1) Consider condition of woody vegetation in treated streambank – will vegetation establish over time? 2) Consider consequence of streambank failure and if there is low risk of failure having a negative effect then maintenance actions may not be warranted. 3) Consider new disturbance associated with potential maintenance action.
Vegetation	1) As resources allow, install the set-back trench of willows behind DVSL treatments 2) Browse control measures are necessary. 3) Consider the effects of floodplain elevation on vegetation establishment and if elevated areas (>1ft above design bankfull) are to be planted, supplemental irrigation will be required. 4) Maximize floodplain connectivity features, such as side channels and connected wetland features, to the extent possible. 5) Consider the effects of soil texture (sandy) and residual seed bank composition (invasive species) on long-term vegetation establishment when considering using vegetative backfill sources other than Beck Borrow. 6) Restrict the use of any non-native species in seed mixes.

[1]DVSL = double vegetated soil lift streambank treatment

Introduction

The Clark Fork River Reach A Vegetation and Geomorphology Monitoring Plan (Monitoring Plan) (Geum and AGI, 2015) describes the Qualitative Rapid Assessment (QRA) procedures that support adaptive management of the Clark Fork River Operable Unit Reach A (CFROU Reach A) Remedial Action Project. The QRA is a tool that allows a rapid evaluation of overall project performance and project maintenance needs as well as providing an initial screening of monitoring metrics to guide effectiveness monitoring. The QRA process will: 1) determine if a project phase is meeting goals or objectives; 2) determine the level of effectiveness monitoring required; and 3) identify maintenance actions. The QRA is conducted using the monitoring framework described in the Monitoring Plan.

This report was originally submitted in April, 2017 to the Montana Department of Environmental Quality (Geum and AGI, 2017). That version of the report described the results of QRAs that had been conducted to date including two in Phase 1 and one in Phases 5 and 6. A QRA was conducted in Phase 1 on July 8, 2015 and again on July 11, 2016 by members of the design team, agency personnel, and members of the Clark Fork monitoring team (QRA team). A QRA of Phases 5 and 6 was completed on July 12, 2016 by the QRA team. Phase 6 remediation and restoration work was not complete at that time; however, streambanks were complete in Phase 6 and were evaluated by the QRA team.

This version of the report provides an update to the April, 2017 version and includes the results of QRAs completed in Phase 1, Phase 2, and Phases 5 and 6 in 2017. A modified QRA was completed in Phase 1 and Phase 2 on September 11, 2017 and in Phases 5 and 6 on September 12, 2017. This report also documents maintenance actions recommended after each QRA and maintenance actions that have been completed. This document is organized by project phase, discipline (geomorphology/vegetation) and assessment year.

The vegetation and geomorphology monitoring described in this report is part of a broader monitoring program being implemented by the State of Montana along CFROU Reach A. Other monitoring efforts evaluate water quality, sediment, biological communities, nutrients and food web, and fish populations. The most recent results from these other monitoring efforts were reported at an August 3, 2017 meeting in Helena.

Methods and field forms for conducting the QRA for Reach A of the Clark Fork River (CFR) are provided in the Monitoring Plan. The four geomorphic metrics observed as part of the QRA include: channel stability, floodplain stability, floodplain inundation/connectivity, and physical bank condition (Table 1). All four of these geomorphic metrics were evaluated in 2017. Table 1 also identifies how the QRA geomorphology metrics relate to the Phase 1 Monitoring Plan metrics and performance targets. The four vegetation metrics observed as part of the QRA include: streambank woody vegetation cover, floodplain woody vegetation cover, floodplain herbaceous

vegetation cover, and survival of woody species (Table 2). All of these metrics were evaluated in 2017; however, the method for evaluating floodplain herbaceous vegetation differed in 2017. The results of QRA's completed to date are summarized in Table 3 and detailed summaries and results follow.

Table 1. Phase 1 geomorphology monitoring metrics and performance targets.

QRA Metric Category	Related Monitoring Plan Metrics	Performance Targets	
		Short-term (0-15 years)	Long-term (+15) years
Channel Stability	Channel dimensions	As-built conditions +/- 20%	As-built conditions +/- 25%
	Slope and Sinuosity	Existing condition +/- 5%	Existing condition +/- 20%
	Bedform complexity	Reference condition	Reference condition
	Bank erosion and channel migration	Treated banks: 0 feet per year Unmodified banks: 0.8 feet per year All banks if 10-year discharge is exceeded: 1.3 feet per year	0.6 feet/year
Floodplain and Secondary Channel Stability	Floodplain stability and secondary channel stability	No new channels form in the floodplain that convey flow at or below bankfull stage	No performance target
Floodplain Connectivity	Floodplain connectivity	No performance target; provides feedback to design engineers	No performance target

Table 2. Phase 1 vegetation monitoring metrics and performance targets.

QRA Metric Category (Monitoring Plan Metric)	Performance Targets		
	Short-term (0-5 years)	Mid-term (5-15 years)	Long-term (15+) years
Canopy cover woody vegetation on streambanks	40% (by year 5)	60% (by year 10)	Greater than 80%
Canopy cover floodplain woody vegetation	30% (by year 5)	50% (by year 10)	No performance target
Canopy cover of herbaceous vegetation	Native species are present in greater than 80% of project area	Native species are present in greater than 80% of project area	No performance target
	20% total canopy cover of native species (by year 1)	Greater than 80% total canopy cover of native species	
	20% total canopy cover of native species (by year 5)		
Woody vegetation survival	80% or higher (year 1)	No performance target	No performance target

Table 3. Status of completed CFROU Remedial Action Project phases based on monitoring metrics and short-term performance targets presented in the Reach A Vegetation and Geomorphology Monitoring Plan. Green cells indicate metrics that are meeting the short-term performance targets, blue cells indicate metrics where it is uncertain if the short-term performance target is being met, and orange cells indicate metrics that are not meeting the short-term performance target.

Related Monitoring Plan Metrics	Phase 1			Phase 2	Phases 5 and 6	
	2015 (Year 2)	2016 (Year 3)	2017 (Year 4)	2017 (Year 1)	2016 (Year 1[1])	2017 (Year 1, 2)
GEOMORPHOLOGY						
Channel stability						
Channel dimensions						
Slope and Sinuosity						
Bedform complexity						
Bank erosion and channel migration						
Floodplain stability and secondary channel stability[2]						
Floodplain connectivity[2]						
VEGETATION						
Canopy cover woody vegetation on streambanks						
Canopy cover floodplain woody vegetation						
Canopy cover of herbaceous vegetation						
Woody vegetation survival		N/A[3]	N/A[3]			N/A[4]

[1]At the time of the 2016 QRA, all streambanks had been constructed, all of the Phase 5 floodplain, including revegetation activities, most of the Phase 6 floodplain and only approximately 10% of Phase 6 revegetation had been completed.

[2]These metrics were not met in 2014 according to geomorphology monitoring – floodplain connectivity exceeded design criteria and one meander bend had significant floodplain erosion. In fall 2014, management actions were taken to restore floodplain erosion and subsequent observations of these metrics indicate they are meeting short-term performance targets.

[3]Survival did not meet Year 1 performance targets in these years; however, survival is a short-term target that is not intended to be used past Year 1. Cover becomes the applicable target at that point. Results for this metric are reported to document site trends.

[4]Survival met the Year 1 performance target for plants installed in 2016. Survival did not meet Year 1 performance targets in 2017 for plants installed in 2015; however, survival is a short-term target that is not intended to be used past Year 1.

2017 Hydrologic Context

In mid-June of 2017, a 1.3-inch rainfall event (as measured at Deer Lodge) caused flows at the USGS Galen Gage (USGS 12323800) to exceed the design bankfull (2-year return interval) flow for all phases evaluated in the QRA (Figure 1). The Galen Gage is considered an accurate representation of flows in Phases 1 and 2 because the gage is located at the Perkins Lane Bridge at the downstream end of Phase 2. Downstream of the Galen Gage, Lost Creek enters the Clark Fork River in Phase 3, Galen Creek enters the Clark Fork River in Phase 5 and Modesty Creek enters in Phase 6. The tributary contributions during the peak runoff in 2017 are unknown, although they are typically small during irrigation season and there is no evidence they were at flood stage during the Clark Fork River peak event. Discounting those potential inflows, both the amount and duration of June 2017 water overflowing onto the constructed floodplain decreases substantially in the downstream direction (Figure 2). This is consistent with 2017 QRA field observations and may have some implications for channel capacity design criteria in future phases.

Based on the observed reduction in floodplain inundation in the downstream direction, the following should be considered in the future to verify the bankfull (2-year return interval) design criteria values:

- The potential for overly conservative design bankfull calculations due to the non-synchronous nature of CFR flows and tributary inflows.
- The potential for overly conservative design bankfull calculations due to irrigation withdrawals.
- The potential for cross section expansion as a result of double vegetated soil lift structures (DVSL) being set back on constructed or preserved toes which may result in a larger cross section area or other morphological changes not accounted for in the hydraulic model.

Little precipitation occurred during the growing season after the June 2017 rainfall event. These hot, dry conditions influenced vegetation conditions observed during the 2017 QRA.

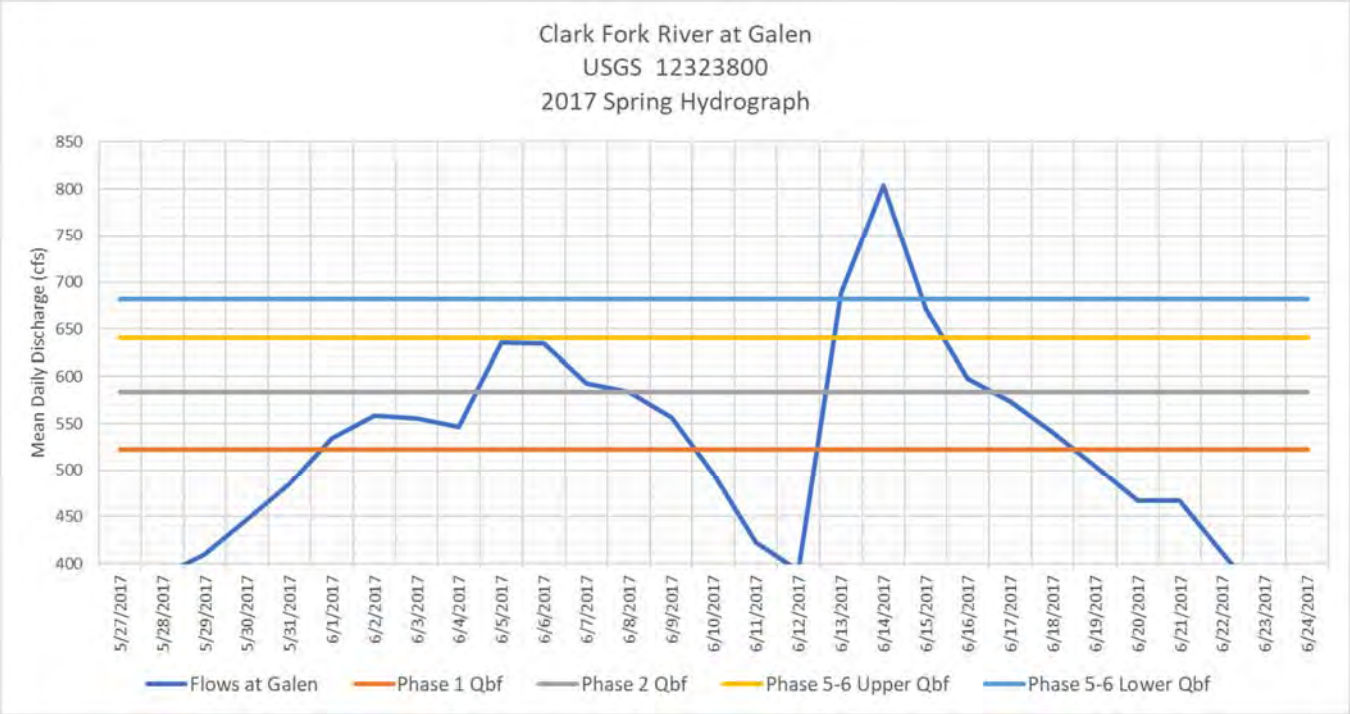

Figure 1. Spring 2017 hydrograph at Galen (USGS 12323800) showing design bankfull flow (horizontal lines) for each Phase evaluated in QRA.

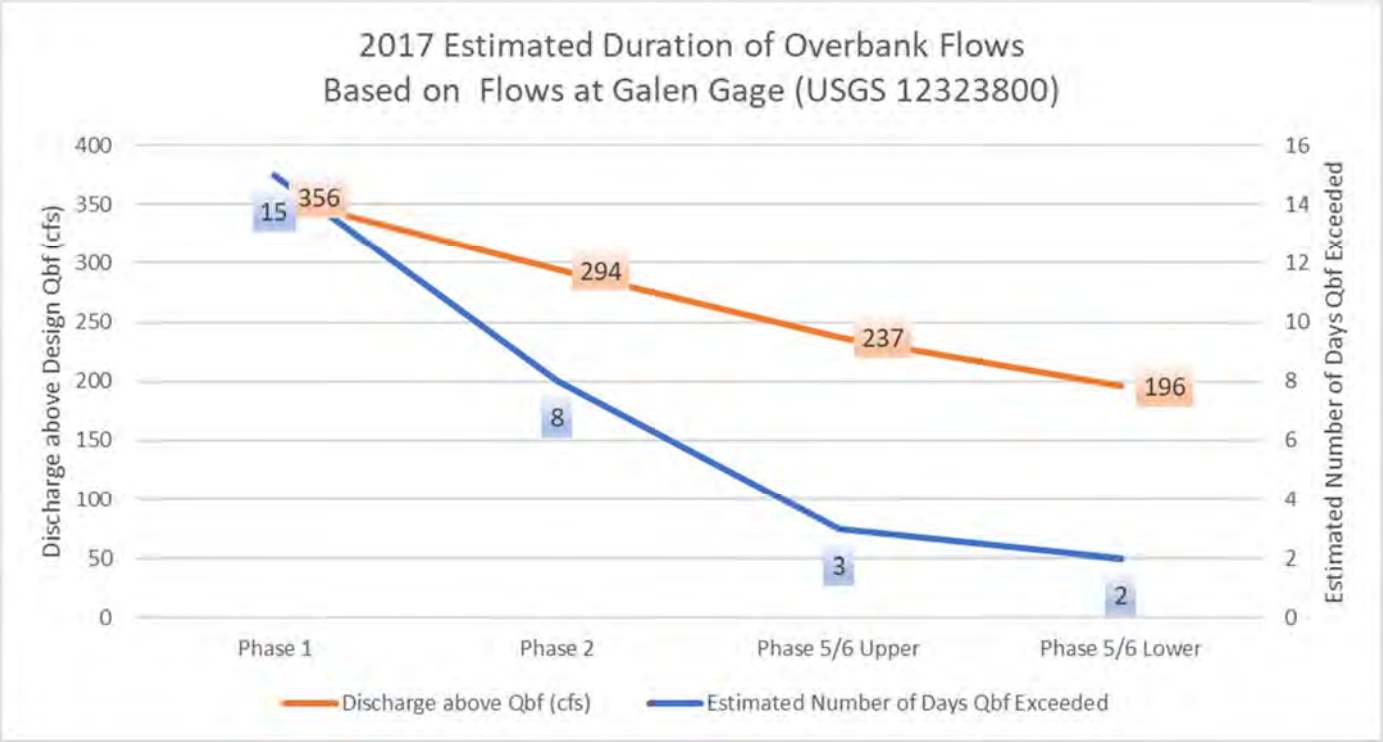

Figure 2. Estimated amount and duration of overbank flow in QRA phases during June 2017; estimates are based on Galen Gage record and do not include Lost Creek or Modesty Creek inflows.

Monitoring Schedule

This section provides a summary of the effectiveness monitoring schedule for the next five years for phases completed to date based on the CFROU Reach A Vegetation and Geomorphology Monitoring Plan (Geum and AGI, 2015). Table 4 summarizes monitoring conducted and planned for completed phases.

Table 4. Vegetation and geomorphology monitoring schedule for the next five years in completed phases of CFROU Reach A.

Phase	Construction Completed	Monitoring Completed	Recommended Future Geomorphology Monitoring	Recommended Future Vegetation Monitoring
Phase 1	2013	Year 1 Geomorphology (2014) Year 1 Vegetation (2014, 2015) QRA: 2015, 2016, 2017	**2019** scheduled 5-year effectiveness monitoring; **annually** spot-check individual streambanks identified as having issues during past QRAs and repeat QRA in the event of out of bank flows or ice.	**2019** scheduled 5-year effectiveness monitoring; **2018** QRA and repeated **annually** as needed.
Phase 2	2016	QRA: 2017	**2021** scheduled 5-year effectiveness monitoring; **annually** spot-check individual streambanks identified as having issues during past QRA and repeat QRA in the event of out of bank flows or ice.	**2021** scheduled 5-year effectiveness monitoring; **2018** QRA and repeated **annually** as needed.
Phase 5	Winter 2015: *Streambanks, Floodplain* Fall 2016: *Revegetation*	QRA: 2016, 2017	**2021** scheduled 5-year effectiveness monitoring; **annually** spot-check individual streambanks identified as having issues during past QRAs and repeat QRA in the event of out of bank flows or ice. Consider a winter streambank evaluation to observe ice effects.	**2021** scheduled 5-year effectiveness monitoring; **2018** QRA and repeated **annually** as needed.
Phase 6	Winter 2015: *Streambanks* Summer 2016: *Floodplain* Fall 2016: *Revegetation*	QRA: 2016 (streambanks only), 2017	**2021** scheduled Geomorphology monitoring (5-year); **annually** spot-check individual streambanks identified as having issues during QRA and repeat QRA in the event of out of bank flows or ice. Consider a winter streambank evaluation to observe ice effects.	**2021** scheduled 5-year effectiveness monitoring; **2018** QRA and repeated **annually** as needed.

Phase 1

This section describes the results of QRAs completed at the Phase 1 Project Site. QRA's were completed in Phase 1 in summer 2015 (Year 2), summer 2016 (Year 3), and late summer 2017 (Year 4). This section provides a summary of observations made for geomorphology and vegetation in each year, recommended management actions resulting from the QRA, and management actions completed. Map 1 in Attachment A provides the locations of geomorphology monitoring cross sections. Map 2 in Attachment A provides an overview of streambank treatments constructed in Phase 1, floodplain monitoring transect locations, and woody vegetation survival monitoring plot locations. As described in the QRA methods in the Monitoring Plan, the effectiveness monitoring locations are used to guide the QRA data collection process.

Floodplain and streambank construction was completed in Phase 1 in December, 2013. Year 1 geomorphology effectiveness monitoring at the Phase 1 Project Site occurred during the summer of 2014. Geomorphology monitoring included an evaluation of floodplain connectivity, cross section dimensions, pool density, residual pool depth, floodplain stability, and secondary channel stability. The results of this monitoring showed that performance targets related to cross section dimensions, secondary channel stability, and pool depths/frequencies were met. Results also indicated a higher level of floodplain inundation than anticipated (RESPEC, 2016a).

Revegetation activities were completed in Phase 1 in July, 2014. Year 1 vegetation effectiveness monitoring at the Phase 1 Project Site occurred during the summer of 2014 and summer of 2015. Vegetation monitoring in 2014 included woody streambank vegetation cover and survival of planted woody vegetation. Vegetation monitoring in 2015 included survival of planted woody vegetation and herbaceous and woody vegetation cover in the floodplain. Results of vegetation monitoring indicated that the short-term woody plant survival performance target of 80% was exceeded (85.5%) and herbaceous cover performance target of 20% was also exceeded (51.0% total cover, 31.0% native cover) for Year 1. Mean woody cover in planted areas in the floodplain was 14.8% and mean woody cover on streambanks averaged 15.2% (RESPEC, 2016a).

Geomorphology

Year 2015

This section describes the results of the geomorphology QRA completed at the Phase 1 Project Site in 2015. The 2015 geomorphic QRA field team included Karin Boyd (Applied Geomorphology), Joe Naughton (RESPEC), Karin Mainzhausen (CDM Smith), Randy English (Tetra Tech), Tom Mostad (NRDP) and Ben Quiñones (DEQ). The QRA took place on July 8, 2015. Since Phase 1 had been monitored for geomorphology in the summer of 2014, the 2015 QRA assessment focused on testing and evaluating

QRA procedures. In addition, the QRA process was used to further evaluate trends since 2014, determine if additional monitoring was necessary, and identify any new management actions. The QRA included walking the entire length of channel in Phase 1. Visual observations and photographs were recorded during the site review and information recorded on the *Floodplain Connectivity, Channel Stability,* and *Secondary Channel and Floodplain Stability* forms included as part of the QRA protocols. At the end of the review, the QRA teamed assigned a score to each of the characteristics on the *Channel Stability* form and recorded an overall stability score to the Phase 1 Project Site reach. Table 5 provides an overall summary of the results of the 2015 Phase 1 geomorphic QRA. Detailed results of the 2015 Phase 1 geomorphology QRA are provided in Attachment C. Supporting photos taken during the 2015 Phase 1 geomorphology QRA are provided in Attachment B.

In 2015, the QRA team identified the following geomorphic site trends in Phase 1. These trends are described in more detail in the following sections.

- Channel stability ratings indicated geomorphically stable channel conditions.
- During out of bank flows in 2014 (approximately 40 cfs above the design Qbf), a few rills formed across the core of one tightly compressed meander bend; this area was re-graded in fall 2014 and the subsequent 2015 field review indicated no elevated risk of avulsion in this location.
- The floodplain inundation/connectivity assessment identified numerous indicators of floodplain inundation as a result of 2014 high flows including floodplain deposition and erosion, and reworking of microtopography and floodplain woody debris.
- There were some areas of localized toe erosion on constructed streambanks. No immediate actions were determined necessary, but these streambanks should be re-visited during the 2016 QRA.
- The forms developed to document geomorphic site trends were considered effective by the QRA team, although the reworking of microtopography was considered to be a relatively poor indicator of floodplain inundation.
- In future QRA efforts, an additional form should be developed to map and characterize the physical condition of constructed streambanks, focusing on the identification of potential maintenance needs.
- Year 1 geomorphology effectiveness monitoring was completed in 2014 by RESPEC; the 2015 QRA did not identify the need for any additional or supplemental data collection to verify site trends prior to the scheduled 5-year effectiveness monitoring.

Table 5. Phase 1 2015 QRA geomorphology results and trends.

Metric	2015 QRA Results		Performance Trend
	Category	Results	
Channel Stability	Category 1 (Likely degrading) Category 2 (Largely stable with potential aggradational/ degradational trend) Category 3 (Likely aggrading)	Category 2: Largely Stable (avg score 3.2).	Some sediment deposition was indicated by weak gravel accumulation in riffles and fine bar deposition, however all indicators of channel morphology indicate a geomorphically stable condition.
Floodplain and Secondary Channel Stability	Category 1 (Low risk/consequence of avulsion) Category 2 (Moderate risk/consequence of avulsion) Category 3 (High risk/consequence of avulsion) Category 4 (Avulsion has occurred)	No floodplain channels creating elevated avulsion risk beyond Category 1.	Following repairs of fall 2014, no floodplain channels are present that pose a high avulsion risk.
Floodplain Connectivity	None	Clear evidence of floodplain inundation with wood mobilization and fine sediment deposition.	Positive—results provided to design engineers.
Streambank	None	Some localized areas of toe erosion, bank slumping and degradation of fabrics used to construct banks.	Toe erosion was localized to areas of high shear stress and typically only occurred along a small section of the treated bank - overall streambank trend is positive.

Channel Stability

Channel stability trends identified by the QRA team in 2015 indicated that the channel is trending towards meeting project goals and objectives and performance target values. The QRA channel stability form indicated an overall rating of 3.2, which is within the 'Largely Stable' category. A few indicators suggested some aggradation has occurred in the reach with some riffles showing weak gravels (pebble sized, relatively mobile), and in some cases the base of double vegetated soil lifts (DVSL) were inundated at low flow, suggesting potential channel deposition. Fine grained deposition was also observed on point bars and mid-channel bars. In general, however, the observed depositional trends were as expected and support willow and cottonwood recruitment on point bars. The inundation of bank treatments was also localized and likely a reflection of construction variability and local bank deposition rather than any systemic aggradational trend. Indicators of bar morphology, bank failure mechanisms, bar development, erosion extent, width to depth ratio, channel pattern, and sediment storage all indicate a stable condition.

Floodplain and Secondary Channel Stability

Prior to the 2015 QRA assessment, the Year 1 geomorphologic monitoring completed by RESPEC in 2014 showed that floodplain stability metrics were not met due to the formation of floodplain channels across one meander that posed an avulsion risk (Figure 3). The causes for the formation of these channels were evaluated by the design team and the site was repaired by filling in the largest floodplain channel and elevating the streambank where flows left the main channel and concentrated across the floodplain meander core shown in Figure 3. As a result of this, the design team developed the following design considerations to minimize the short-term risk of floodplain erosion across meander cores from occurring in the future (CDM, AGI and Geum, 2014):

1. In areas of high avulsion risk, construct the elevated meander cores with floodplain alluvium or floodplain alluvium mixed with some vegetative backfill (3:1 ratio).
2. Carry the super-elevated bank (0.5 feet high) through the entire upstream avulsion path length before returning to the bankfull (2-year) water-surface elevation. The super-elevated bank should cover the range of expected avulsion paths.
3. Construct wider, flatter point bars on bends that feed high risk avulsion paths to reduce high water super-elevation on the opposite bank.
4. If floods at a 10-year recurrence interval or greater occur after the channel survey and before construction, resurvey the sections to accurately define bank locations.
5. Install higher density woody debris in areas of higher avulsion risk (i.e., 2 x the density of coarse wood).
6. Consider incorporating willow plantings or cedar stakes with willows in all return flow areas to trap debris and decrease return flow velocities.
7. Reduce vegetative backfill depths from 1 foot to 6 inches.

For the 2015 QRA, the floodplain stability assessment focused on locating and characterizing any new floodplain channels or continuous rills (incipient channels) that appeared to convey flow at or near bankfull discharge. This effort confirmed that all floodplain stability goals and objectives were being met in July 2015. As the QRA identified no floodplain channels of concern, it was not necessary to fill out forms for floodplain stability. However, to determine if the QRA form for floodplain stability would sufficiently capture site conditions, a form was filled out in a moderately eroded floodplain area that had several discontinuous erosion features. The form was considered to be appropriate for capturing conditions in floodplain erosion areas. Each form identifies channels or rills by station, and records the length and width of the feature, the ratio of the river length to that of the eroded floodplain channel, the resistance of floodplain materials to continued erosion, a description of the return flow point, and various other descriptors.

Floodplain Connectivity

The onset of shallow floodplain inundation at the 2-year flow is a targeted design condition for Phase 1. The 2014 geomorphologic monitoring completed by RESPEC showed that performance values for the floodplain connectivity metric were not met because approximately 51% of the floodplain was inundated during the peak 2014 flow, whereas the target value was for between 18% and 38% of the area to be inundated (Figure 4). This may be due to a backwater effect caused by the constriction point leading into Phase 2 which is not yet constructed, thus the floodplain at the downstream end of Phase 1 remained high. Additionally, it may have been due to the difficulty in quantifying inundated area for a specific flow condition. The metric has since been revised from a quantitative performance target to a dataset that is provided to the design team to consider in hydraulic modeling validation (i.e. floodplain inundation extents verified through hydraulic modeling rather than field indicators).

During the 2015 QRA, the field team used the *Floodplain Connectivity* evaluation form to document signs of floodplain inundation such as high water marks, re-worked microtopography, mobilized wood, and fine sediment deposition (Figure 4). The indicators of inundation recorded during the 2015 QRA showed that areas of sediment deposition and wood mobilization correlated well to areas of mapped inundation. In contrast, field indicators of eroded microtopography were difficult to correlate to overbank flow and will continue to be evaluated as a potential parameter.

Streambanks

Streambank treatment locations are shown in Attachment A, Map 2. Although streambank condition was not originally included in the geomorphology component of the QRA (only in terms of observable bank erosion), it became clear in the field that there were specific areas where DVSL streambank treatments had experienced some toe erosion, which resulted in bank treatment undercutting and slumping. Several of these areas were mapped as part of the geomorphology QRA; however, because a bank characterization methodology had not been formalized prior to the 2015 QRA, a complete inventory of streambanks was not done in July 2015. In the fall of 2015, in response to observations made during the July QRA, DEQ completed a more comprehensive inventory of the condition of DVSL structures in Phase 1, and the results of this inventory are shown in Figure 5 (Attachment A provides as-built maps of constructed streambanks for Phase 1). Monitoring completed in 2014 by RESPEC identified nine streambank treatments with evidence of river undercutting (RESPEC 2016a).

Based on these observations, the QRA team decided to develop a form to use in future QRA efforts that would effectively capture the locations and extent of toe erosion and DVSL slumping to help identify potential management actions. Longer-term

geomorphic monitoring of streambanks will focus on rates of bankline movement on a broader spatial scale.

Phase 1 2015 Geomorphology Management Actions

The only potential management actions identified in 2015 were the potential to remedy the undercutting/slumping of DVSL structures (Figure 5). The general consensus regarding taking actions at bank treatments with signs of toe erosion was that no immediate action was necessary and that the decision to take actions should include the following considerations:

- *Condition of woody vegetation in treated bank*: In some cases, the DVSL had deformed; however, willows remained vigorous and as such the treatment may meet its intended function long-term regardless of deformation.
- *Consequence of bank failure*: Due to a combination of long treatments, design criteria that allow for long-term deformability, and materials/construction conditions, it is likely that localized bank deformation and failure may occur within five years of project completion (after which natural rates of channel movement are anticipated system-wide). The team discussed that the consequences of failure should be considered in determining maintenance needs. If the treatment is protecting infrastructure for example, maintenance priority would be substantially higher than for most treatments in relatively passive areas.
- *Disturbance associated with potential action:* In many cases, DVSL fabric may be tearing or slumping; however, local conditions show excellent resiliency overall with respect to vegetative vigor, fine grained deposition and site maturation (e.g. floodplain materials consolidation), so that the disturbance required to repair or maintain the streambank location may produce a net negative result.

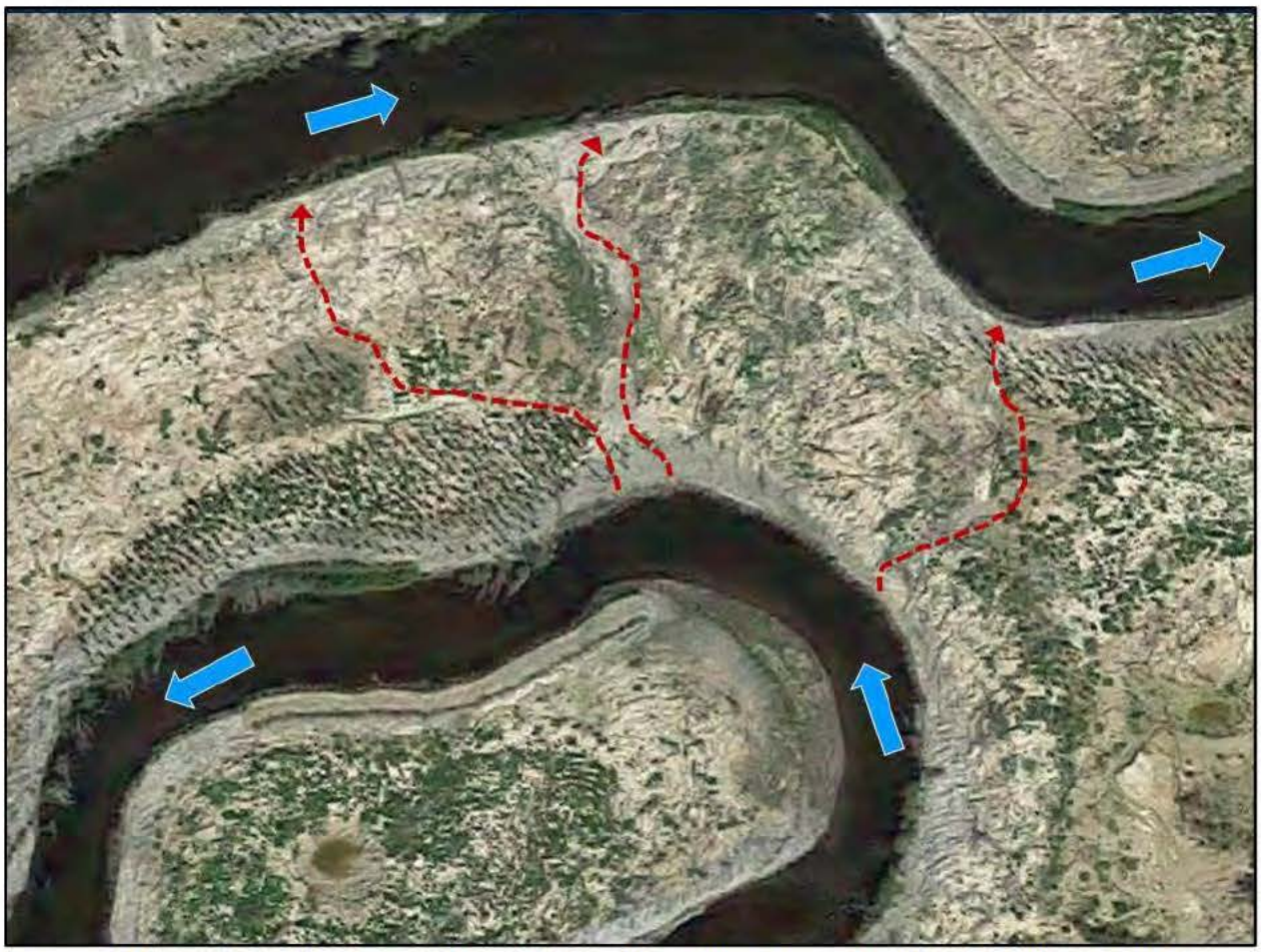

Figure 3. Mapped overflow channels (dashed red lines) that formed in Phase 1 following 2014 spring runoff.

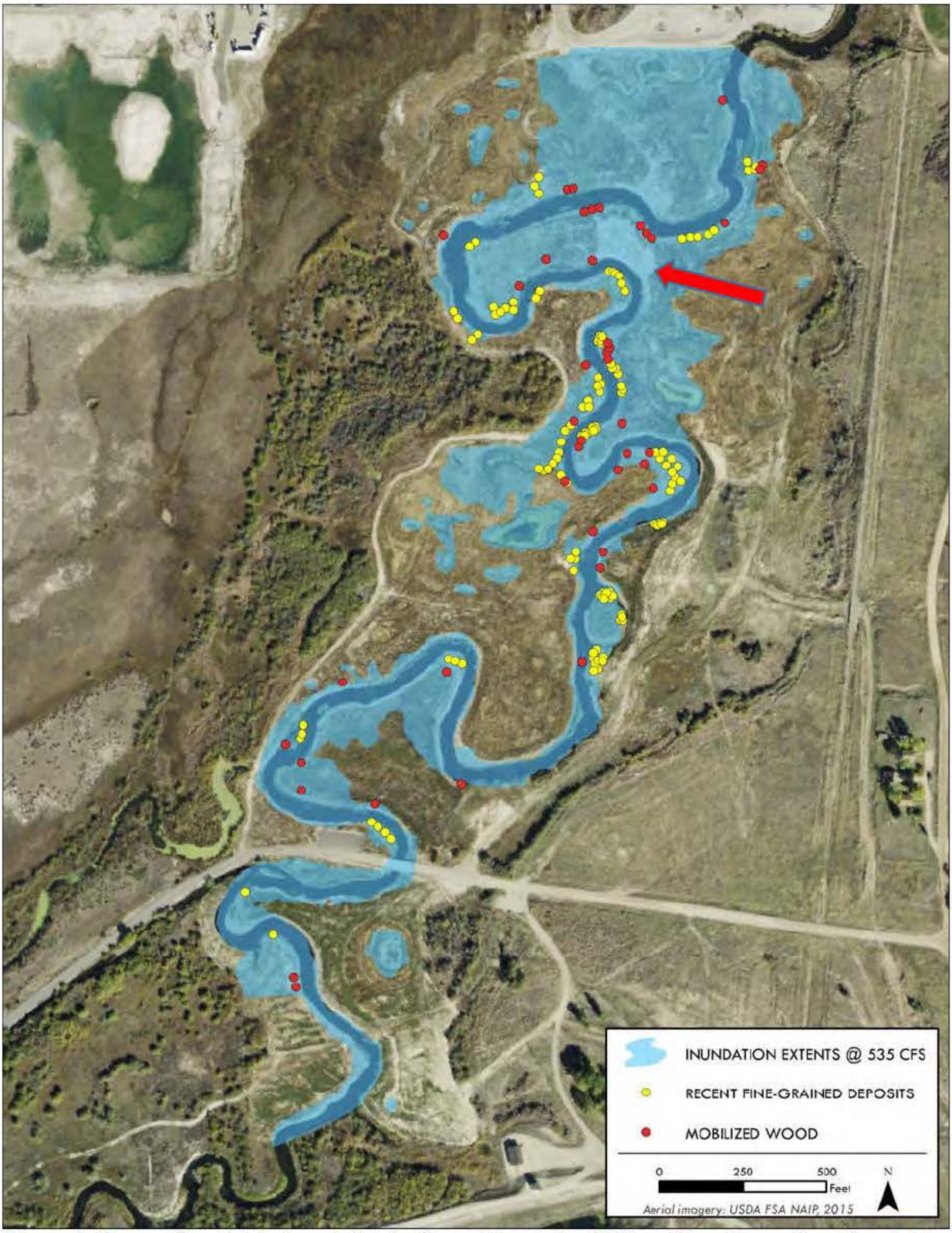

Figure 4. Mapped floodplain inundation in Phase 1 in spring 2014 and locations where floodplain inundation indicators were observed during the QRA. Red arrow indicates where the floodplain channel formed in spring 2014 and was repaired in fall 2014.

Figure 5. Results of DEQ inventory of all Phase 1 streambanks where structure degradation was observed in fall 2015 ('logs' in the legend refer to coir logs installed in DVSL treatments).

Year 2016

This section describes the results of the geomorphology QRA completed at the Phase 1 Project Site in 2016. The 2016 geomorphic QRA field team included Karin Boyd (Applied Geomorphology), Joe Naughton (RESPEC), Karin Mainzhausen (CDM Smith), Larry Cawlfield (Tetra Tech), Jeff Dunn (RESPEC), Tom Mostad (NRDP) and Josh Robino (DEQ). The QRA took place on July 11, 2016. The 2016 QRA assessment focused on evaluating any changes in geomorphic trends since 2015, determining if additional geomorphic monitoring was necessary, and identify any new management actions. The QRA included walking the entire length of channel in Phase 1. Visual observations and photographs were recorded during the site review and information recorded on the *Channel Stability* form included as part of the QRA protocols and *Streambank Condition* form. At the end of the review, the QRA team assigned a score to each of the characteristics on the *Channel Stability* form and recorded an overall stability score to the Phase 1 Project Site reach. All streambanks with observable altered conditions since construction were noted. For streambanks with considerable altered conditions, the more detailed *Streambank Condition* form was used. No flows exceeded design bankfull in 2016 so the team concentrated on channel conditions, including channel stability and streambanks; therefore, no *Floodplain Connectivity* or *Secondary Channel and Floodplain Stability* forms were completed in 2016.

Table 6 provides an overall summary of the results of the 2016 Phase 1 geomorphic QRA. Detailed results of the assessment are provided in Attachment C. For 2016 supporting photographs were integrated into the following section.

In 2016, the QRA assessment team identified the following geomorphic site trends in Phase 1. These trends are described in more detail in the following sections.

- Similar to 2015, channel stability was meeting performance targets.
- A new form was tested to evaluate streambank condition in 2016. A general log was kept to track all streambanks that showed notable damage (slumping, fabric loss, coir log loss, ice damage, etc.), and the more detailed form was used to evaluate those sites where maintenance was considered or where conditions could inform future bank design and implementation strategies.
- The condition of some streambanks had changed since construction. Most of these streambanks were also noted as having issues in 2015. Specific issues included: toe slumping and under-cutting, fabric degradation, and loss of coir logs. No maintenance actions were recommended but some future design considerations were documented, including; 1) document areas of localized high shear stress in the field during design; and 2) for areas of high shear stress, consider modifications to toe design based on modeled shear stresses at an individual bank, incorporating toe roughness, or constructing a bench or sacrificial toe in front of the bank to reduce short term risk of toe mobilization and slumping. Any new design measures should not cause reduced deformability of toes under the 10-year flow design criteria.

- Similar to 2015, the 2016 QRA did not identify the need for any additional or supplemental data collection to verify site trends prior to the scheduled 5-year effectiveness monitoring. The annual QRA should continue, but potentially at a reduced level of effort as described in the following bullet.
- The QRA team reiterated that Year 1 QRA monitoring should take place in all phases regardless of flows to evaluate streambanks and assess channel stability. If flows have not exceeded bankfull since the last QRA, the annual QRA assessment could potentially be performed by boat or limited to spot observations. The annual QRA could focus on re-visiting streambanks where issues were identified during the 2015 or 2016 QRA.

Table 6. Phase 1 2016 QRA geomorphology results and trends.

Metric	2016 QRA Results		Performance Trend
	Category	Results	
Channel Stability	Category 1 (Likely degrading) Category 2 (Largely stable with potential aggradational/ degradational trend) Category 3 (Likely aggrading)	Category 2: Largely Stable (avg score 3.6).	Some field indication of sediment aggradation relative to 2015.
Floodplain and Secondary Channel Stability	Category 1 (Low risk/consequence of avulsion) Category 2 (Moderate risk/consequence of avulsion) Category 3 (High risk/consequence of avulsion) Category 4 (Avulsion has occurred)	No out of bank flows in spring 2016 so not assessed.	No out of bank flows in spring 2016 so not assessed.
Floodplain Connectivity	None	No out of bank flows in spring 2016 so not assessed.	No out of bank flows in spring 2016 so not assessed.
Streambank	None	Twenty four streambank treatments were noted for continued observation regarding fabric condition, toe stability, and/or poor willow growth.	Uncertain – continued monitoring is recommended. No management actions are recommended at this time.

Channel Stability

Channel stability trends identified by the QRA team in 2016 indicated that the channel was trending towards meeting project goals and objectives and performance target values. The QRA channel stability form indicated an overall rating of 3.6, which is within the 'Largely Stable' category and a slightly higher rating than the one assigned in 2015. The overall stability rating reflects mild aggradational conditions, based on observed fine sediment deposition within the channel, mostly on point bars. These deposits were

providing natural woody and non-woody vegetation colonization (Figure 6). There was no evidence of systemic coarse grained aggradation nor systemic degradation, and riffles showed good mobility and general gradation variability. Point bar morphologies showed smooth transitions to the channel (Figure 7) and bank erosion was generally concentrated on outside banks or high shear stress areas.

Figure 6. Fine sediment deposition and natural recruitment of woody and non-woody vegetation on point bars and floodplain surfaces.

Figure 7. Point bar transition to main channel.

Floodplain and Secondary Channel Stability

There were no concerns observed with floodplain stability in 2016. Areas where floodplain scour occurred in spring 2014 (when discharge exceeded bankfull by about 40 cfs) hae been colonized by woody vegetation, primarily willows. The area of floodplain and bankline repair following 2014 runoff (Station 102+00) was functioning well (Figure 8). Fine sediment deposits on the floodplain from 2014 overbank flows were being colonized by willow seedlings and willow cover had increased in these areas.

Figure 8. Bankline that was repaired following the 2014 overflow event (photo is looking upstream).

Floodplain Connectivity

No flows had exceeded the design bankfull discharge since May 2014, and high water marks observed in July 2016 were low on point bars supporting the design objectives of minimal floodplain inundation under recent flow conditions. Remnant high water marks were still visible from the 2014 high flow event, mostly observed as floodplain deposits and reworking and stacking of coarse floodplain wood. Floodplain wood reworked during the 2014 event was observed to be oriented perpendicular to flow paths on the floodplain which helps disperse flow, prevent rilling and reduce the potential for headcut formation (Figure 9).

Figure 9. Floodplain wood that accumulated in 2014 high water flow paths, dispersing flows and reducing floodplain erosion.

Streambanks

In 2016, the QRA team noted all streambanks where conditions had changed since construction. For streambanks showing significant change since construction, a detailed maintenance inventory form was completed for the bank. These results are

provided in Attachment C. Streambank treatment locations are shown on Attachment A, Map 2.

The DVSL bank treatment had a substantial amount of fabric decay which was observed on both the upper and lower lifts of structures in 2016 (Figure 10). Some fabric decay, particularly on north-facing upper lifts, may have been from ice build up or movement. Where the lifts were constructed on steep clay banks, ice accumulation appeared to have displaced the toe alluvium causing slumping below the lifts. The QRA team discussed the potential to mitigate for this by adding coarse wood into the toe along the entire length of the treatment or at intervals along the treatment.

Figure 10. DVSL streambank with fabric decay and exposed coir log.

In a few areas, the coir fabric had degraded and the exposed coir logs were displaced (RB-N-5, RB-N-14, RB-N-19, RB-N-23, LB-N-33, RB-N-47). At streambank RB-N-14, the displaced coir log had deposited on a low bar just downstream (Figure 11). Due to the ability of coir fibers to retain high moisture, the displaced coir log was supporting wetland vegetation such as rushes and mint (Figure 11). The QRA team discussed whether displaced coir logs should be removed, and the consensus was that they should remain in place to support vegetation and naturally degrade with time.

Figure 11. Coir log displaced from bank RB-N-19 and deposited on floodplain surface immediately downstream. Herbaceous wetland vegetation is growing in the coir log (right photo).

In 2016, extensive moss had developed on the coir logs still in the DVSL structures. This is likely from trapping of fine sediment in the logs and high moisture content. Fine sediment accumulations were observed in coir logs at several sites. Further, where a bench was present in front of the DVSL treatment, colonization by willows and wetland vegetation was observed (Figure 12). Building a narrow, 6-inch, bench in front of DVSL treatments promotes fine sediment accumulation and wetland plant/willow colonization along the channel in front of the bank treatment and should continue to be repeated in future designs where DVSL structures are built.

Figure 12. Colonization of wetland vegetation on toe material in front of DVSL LB-N-35.

Willow growth in DVSL structures was more robust in 2016 compared to 2015. In 2015 it appeared that there was a high level of willow mortality in the bank treatments, but evidently there was substantial rebound in willow growth and vigor in the summer of 2016 (Figure 13). Beaver foraging was observed on willows in DVSL treatments in some areas.

Figure 13. Increased willow growth in DVSL structure LB-N-11.5.

In 2016, all brush trench treatments had high willow survival and growth (Figure 14). In Phase 1, brush trenches were installed at the top edge of point bars, behind preserve vegetation (PV) banks, and at the back edge of alluvium placed behind DVSL banks.

Figure 14. Willow growth in brush trench behind DVSL (LB-N-27) (photo is looking downstream).

In 2016, the geomorphology QRA team discussed adding vegetative backfill to the 10 feet of alluvium left bare behind streambanks because little vegetation was observed in this area (Figure 15). At a follow up meeting with the full QRA team, Amy Sacry with Geum described the intent behind leaving these areas bare alluvium as: 1) alluvium provides short-term erosion control (i.e. if soil is placed here prior to vegetation establishment it washes away and this increase risk to the streambank structure; and 2) bare alluvium allows for natural expansion and natural recruitment of woody vegetation; vegetative backfill would support herbaceous vegetation which is not as desirable as woody vegetation along streambanks. The placement of bare alluvium in this location creates the conditions needed for native willows and cottonwoods to colonize.

Figure 15. Bare alluvium placed behind streambank treatment.

The geomorphology QRA team also discussed the possibility of augmenting vegetation in streambanks that seemed to have poor willow survival, particularly where low survival was combined with toe scour and a loss of toe material. At a follow up meeting with the full QRA team, Amy Sacry with Geum indicated that based on her experience, if there is one willow still alive per every 5 linear feet of streambank there would still be sufficient willow cover and rooting in occurring in the next 3 to 4 years for the treatment to function as intended (i.e. performance targets of >40% cover by Year 5 should be met). The surviving willow cuttings should continue to expand through suckering into the bank and bare alluvium placed behind the bank. Further, most streambanks with poor willow survival have woody planting units behind the streambank and trees and shrubs installed in these areas will continue to grow and expand towards the bank over time. It is also difficult to successfully supplement the willows in these structures with additional dormant willow cuttings. Planting the top of the structures with small woody plants may be a more effective approach and the ten cubic inch woody plants installed in streambanks in Phase 1 have shown good initial survival, although poor growth (see Vegetation observations). Additionally, there is natural recruitment of both willow and cottonwood from 2014 overbank flows colonizing the alluvium placed behind these structures and initial survival of the seedlings is good.

In 2016, the QRA team noticed settling of the floodplain behind several DVSL structures and the team decided that if settling lowers the bank to the 1-year return interval (Q1) elevation it could be an issue that may need to be addressed. If this occurs, other factors, such as vegetation establishment, would need to be evaluated. The team noted that it would be good to follow up on this issue by comparing the as-built cross sections to the Year-5 effectiveness monitoring cross sections that are scheduled to be collected in 2019 to determine the extent to which streambanks may be settling.

In 2016, the QRA team completed detailed maintenance forms for four streambanks in Phase 1 (RB-N-5, LB-N-7A, RB-N-14, and RB-N-47). A summary of the inventory forms are provided in Attachment C and each streambank is described below. A common theme for streambanks where significant changes were observed was the loss of toe material and slumping of the structure. This led the team to conclude that the material used in the toe and the shape of the constructed toe are important considerations in future designs. Initial ideas on future design criteria for the toe to mitigate this effect is to construct a flat bench (approximately 12 inches) in front of the bottom lift. The other key observation was the size of the material in the toe needing to be adequate for specific shear stresses which may warrant larger toe material in some areas, but still not so coarse that the bank will never undercut. Hydraulic modeling may miss these localized areas of increased shear stress.

RB-N-5 (**DVSL with constructed toe**): Substantial toe loss and slumping (cantilever failure) were observed at this structure site. This structure is located across from an island in an area of locally high shear stress. The bank had undercut approximately 1.5 feet since construction, and some of the fabric was torn (Figure 16). Willow survival and cover was low so there was minimal rooting to slow down erosion and help stabilize the toe. The bench created by the slumped lower lift was trapping fine sediment. Specific future design considerations based on observations of this structure include: paying more careful attention to quantity and/or quality of constructed toe and adding sacrificial toe in areas where high shear stresses are anticipated to reduce the potential for short-term toe erosion that may lead to structure slumping that could compromise vegetative growth in the structure. There are no immediate risks from continued erosion at this location so no maintenance actions were recommended at the time of the 2016 QRA.

Figure 16. Streambank RB-N-5 with fabric degradation and toe material loss.

LB-N-7A (outer meander with no treatment along a 13.5 foot section): Bank erosion was observed at this site in a short section of bank where no streambank treatment was applied. Shear stress is relatively high at this location, creating some concern that continued streambank erosion will flank the next DVSL downstream (Figure 17). There were small willows growing in the streambank and in the absence of additional erosion these willows will grow and expand. Installing a gap treatment

(woody debris) in this short section would reduce the short-term risk of flanking the DVSL downstream. Access to this site is easy so it would be possible to install a gap treatment with minimal damage to other establishing vegetation. The QRA team ultimately decided that treating this streambank was not an imminent need, but because it would be an easy fix, it should be kept on the list to consider for future maintenance. As described in the next section, during the 2017 QRA conditions at this site were unchanged and no maintenance was recommended.

Figure 17. Streambank LB-N-7A (No Treatment) with scour at upstream end.

RB-N-14 (DVSL along an outer meander): At this DVSL structure site, both the top and bottom coir logs have been displaced and only the fabric of the top lift remains as a drape on the bank (Figure 18). The loss of coir logs and bank material is assumed to have been caused by loss of toe material. There is little risk associated with continued erosion at this location, so no action is recommended. Specific future design considerations include: paying closer attention to toe material size, noting locally high shear stress areas while in the field so that appropriate toe material, toe roughness such as wood, or sacrificial toe can be installed. Many of these areas of high shear stress are short sections where the thalweg impinges on the bank (often at high angles) that can't be quantified by planform parameters alone and requiring field identification.

Figure 18. Streambank RB-N-14 DVSL showing loss of coir logs and bank erosion.

RB-N-47 (DVSL on an outer meander with a high angle of thalweg impingement): Approximately 1 foot of under-cutting had occurred at this DVSL structure. Coir logs placed in the top lift had been displaced, and coir logs in approximately 15 feet of the bottom lift had also been lost (Figure 19). There was minimal woody vegetation cover on this structure. The cause of toe erosion appeared to be high shear caused by the direct angle at which the thalweg intersects this streambank. The toe erosion was located in a large eddy both at and just upstream of the point of intersection between the thalweg and the streambank. Specific future design considerations based on observations made at this site include: identifying locally high shear stress areas while in the field and assigning toe material and additional treatments (i.e. incorporating wood into the toe or constructing a sacrificial toe or bench) accordingly.

Figure 19. Streambank RB-N-47 DVSL showing fabric degradation and loss of coir logs.

Phase 1 2016 Geomorphology Management Actions

No immediate management actions were identified by the QRA team in 2016. The streambanks described above should continue to be re-visited annually. Similar to 2015, the general consensus regarding maintaining streambank treatments where localized scour and slumping had occurred is that the risk and consequence of bank failure is not great and vegetation will continue to establish and ultimately control

erosion rates. Some important future design considerations were identified in 2016 that should be considered as designs progress in other phases. These include:

- Localized areas of high shear stress should be identified during the design process and evaluated for potential design modifications.
- Potential design modifications to constructed streambank toes include: larger sized material (not to exceed deformability design criteria), incorporate woody debris and/or construct a flat bench or sacrificial toe in front of the structure.

Year 2017

This section describes the results of the geomorphology QRA completed at the Phase 1 Project Site in 2017. The 2017 geomorphic QRA field team included Karin Boyd (Applied Geomorphology) and Karin Mainzhausen (CDM Smith). The QRA took place on September 11, 2017. The 2017 QRA assessment focused on evaluating any changes in geomorphic trends since 2016 and identifying any new management actions. The QRA included walking the entire length of channel in Phase 1. Visual observations and photographs were recorded during the assessment and information recorded on the *Channel Stability* form and *Streambank Condition* form included as part of the QRA protocols. At the end of the assessment, the QRA teamed assigned a score to each of the characteristics on the *Channel Stability* form and recorded an overall stability score to the Phase 1 Project Site reach. All streambanks with observable altered conditions since construction were noted. For streambanks with considerable altered conditions, the more detailed *Streambank Condition* form was used. Flows exceeded design bankfull in 2017 so the team also completed a *Floodplain Connectivity* or *Secondary Channel and Floodplain Stability* form.

Table 7 provides an overall summary of the results of the 2017 Phase 1 geomorphic QRA. Detailed results of the assessment are provided in Attachment C. Supporting photos taken during the 2017 QRA are provided in Attachment B.

In 2017, the QRA assessment team identified the following geomorphic site trends in Phase 1. These trends are described in more detail in the following sections.

- Similar to 2015 and 2016, channel stability was meeting performance targets.
- During high out of bank flows in 2017 (approximately 350 cfs above the design Qbf or 2-year flow), high water marks indicated up to a foot of overbank flow depth in near-channel floodplain environments. Wood was mobilized and microtopography continued to be reworked. The high flows did not result in any floodplain destabilization or avulsion.
- Similar to 2016, the 2017 QRA did not identify the need for any additional or supplemental data collection to verify site trends prior to the scheduled Year 5 effectiveness monitoring cycle.
- The QRA should be repeated in 2018 if flows exceed bankfull or a significant ice event occurs. If neither occur, the assessment should be limited to visiting the

streambanks where issues were identified in 2016 to ensure no maintenance actions are needed.

Table 7. Phase 1 2017 QRA geomorphology results and trends.

Metric	2017 QRA Results		Performance Trend
	Category	Results	
Channel Stability	Category 1 (Likely degrading) Category 2 (Largely stable with potential aggradational/ degradational trend) Category 3 (Likely aggrading)	Category 2: Largely Stable (avg score 3.6).	Some field indication of sediment aggradation relative to 2015.
Floodplain and Secondary Channel Stability	Category 1 (Low risk/consequence of avulsion) Category 2 (Moderate risk/consequence of avulsion) Category 3 (High risk/consequence of avulsion) Category 4 (Avulsion has occurred)	No floodplain channels creating elevated avulsion risk beyond Category 1.	Following repairs of fall 2014, no floodplain channels are present that pose a high avulsion risk.
Floodplain Connectivity	None	Clear evidence of floodplain inundation with high water marks, wood mobilization and fine sediment deposition.	Floodplain activation occurred as expected for spring 2017 flows and is supporting establishment of woody riparian vegetation in the floodplain.
Streambank	None	Twenty-three streambank treatments were noted for continued observation regarding fabric condition, toe stability, and/or poor willow growth.	Continued QRA monitoring is recommended for two specific streambanks. No management actions are recommended at this time.

Channel Stability

Channel stability trends identified by the QRA team in 2017 indicated that the channel was trending towards meeting project goals and objectives and performance target values. The QRA channel stability form indicated an overall rating of 3.6, which is within the Largely Stable category. A few indicators suggested some aggradation was occurring in the reach with continued deposition on point bars, mid-channel bars, and near-channel floodplain areas. Deposition on point bars ranged from fines up to approximately 32 mm gravel. The observed depositional trends were as expected and supporting willow, cottonwood and herbaceous wetland vegetation establishment on point bars. Indicators of bar morphology, streambank failure mechanisms, bar development, erosion extent, width to depth ratio, channel pattern, and sediment storage all indicated a stable condition.

Floodplain and Secondary Channel Stability

Floodplain stability trends identified by the QRA team in 2017 indicated that the channel was trending towards meeting project goals and objectives and performance target values. Although overbank flows occurred in 2017, there was no evidence of rill formation or increase in near-term avulsion risk. Areas previously identified as posing increased avulsion risk in 2014 (Figure 3) showed no evidence of rill reformation or reactivation. There was also no evidence of streambank failure at overflow return points. The 2017 QRA results showed that floodplain resilience had increased substantially since 2014.

Floodplain Connectivity

Floodplain stability trends identified by the QRA team in 2017 indicated that the channel is hydrologically connected to its floodplain. The 2017 high flow event overtopped streambanks as evidenced by silt lines on wildlife exclusion fences up to one foot above the floodplain surface, mobilization of wood on the floodplain surface, and sediment deposition on the tops of streambanks and the adjacent floodplain. QRA results showed that the remediation design had achieved floodplain connectivity with two events exceeding bankfull since construction completion in 2013.

Streambanks

In 2017, all streambanks were observed and the streambanks specifically noted in 2016 where conditions had changed since construction were re-evaluated for overall condition. The streambanks described as slumping in 2016 were still slumping in 2017, and four streambank treatments described as slumping in previous years had since lost additional coir logs (LB-S-10, LB-N-7, RB-N-23 and LB-N-40). Of the four streambanks specifically identified in 2016 as potential maintenance concerns (RB-N-5, LB-N-7A, RB-N-14 and RB-N-47), all but one (RB-N-47) had increased growth of willows and no additional signs of instability in 2017. RB-N-47 is a DVSL treatment that lost portions of both lifts during high flows in 2014 due to toe scour. This streambank continued to show signs of active erosion and had poor woody vegetation cover in 2017. This streambank should continue to be monitored. A photo of RB-N-47 is provided in Attachment B (*Phase 1 Geomorphology QRA Photographs* 2017, Photo 13). If woody vegetation planted behind this streambank continues to grow it will provide some resistance to continued bank erosion at this site. Detailed maintenance inventory forms were not completed for any banks.

Phase 1 2017 Geomorphology Management Actions

No geomorphology management actions were recommended based on the results of the Phase 1 2017 QRA.

Vegetation

Year 2015

This section describes the results of the vegetation QRA completed at the Phase 1 Project Site in 2015. The 2015 vegetation QRA field team included Amy Sacry (Geum), Tom Parker (Geum), Marisa Sowles (Geum), Mark Traxler (RESPEC), and Brian Bartkowiak (DEQ). The QRA took place on July 8, 2015. Since Phase 1 had been monitored for vegetation in the summer of 2014, the 2015 QRA assessment focused on testing and evaluating QRA procedures. In addition, the QRA process was used to further evaluate trends since 2014, determine if additional monitoring was necessary, and identify any new management actions. The QRA included walking the entire length of the channel in Phase 1 to record woody vegetation cover at each streambank on the *Streambank Canopy Cover* form included as part of the QRA protocols. As the team moved through the Phase 1 Project Site they also visited pre-determined woody vegetation survival monitoring plots. At each monitoring plot survival was recorded using the *Survival* form and woody vegetation cover was recorded using t *Floodplain Woody Vegetation* form. In addition, all but one of the floodplain transects established for monitoring herbaceous vegetation cover and composition in the floodplain were walked and herbaceous vegetation was estimated for distinct sections of each transect using the *Floodplain Herbaceous Vegetation* form. Visual observations, photographs, and potential management actions were also recorded. An overall rating was assigned to each vegetation metric using the collected data.

Table 8 provides an overall summary of the results of the Phase 1 2015 vegetation QRA. Detailed results of the assessment are provided in Attachment E. Example photos are provided in the following text and additional supporting photos taken during the 2015 vegetation QRA are provided in Attachment D.

In 2015, the QRA team identified the following vegetation site trends in Phase 1. These trends are described in more detail in the following sections:

- Observations throughout Phase 1 regarding streambank woody cover, planted woody vegetation survival, floodplain woody cover and floodplain herbaceous cover indicated a positive trend toward meeting project goals and objectives and in some areas, performance targets were already being met.
- In general, observations from informal walk-throughs in 2014 compared to observations made during the 2015 QRA indicated that the floodplain and streambanks were transforming rapidly. Rapid transformation was expected to continue during early stages of floodplain and streambank development. It may be useful for future vegetation assessments to develop a form that specifically documents locations of natural recruitment of woody vegetation.
- Observations of salt precipitation on the soil surface and the presence of exotic species made during informal walk-throughs were less frequent in 2015.

- Overall survival of planted woody vegetation was 85.5% as documented by 2014 and 2015 effectiveness monitoring (RESPEC, 2016a,b). However, many surviving plants showed signs of stress and limited growth and results of the 2015 QRA indicated that survival had decreased (only 56% of plots had greater than 80% survival).
- High seasonal water table elevations in wetlands and swales remained a potential cause of low woody vegetation survival in some planting units. The bottom of several swale features were supporting cattail colonization.
- Survival of willow cuttings installed in streambanks was variable, although there was a general positive trend for woody streambank cover. Twenty six percent of streambanks were meeting the year five performance target for woody vegetation cover.
- The 10 cubic inch plants and naturally recruited young willows and cottonwoods colonizing the bare alluvium behind streambank treatments appeared to have high survival but limited growth and were vulnerable to browse and trampling.
- Herbaceous cover was meeting the Year 1 target of 20% or greater in most of the Project Site. In some areas, the dense cover of herbaceous seeded species may limit expansion of woody vegetation from planting units but no action was recommended.
- Beaver browse was observed, primarily on the left bank. Cottonwoods were browsed the heaviest and less browse observed on sandbar willow compared with other shrubs (i.e. planting unit OM04). Beavers were easily able to access plants through the browse protectors and chicken wire used for protection. For future phases, additional browse protection methods should be considered. Implementation of these methods could be prioritized in areas where beaver activity is observed to reduce costs.
- Overall, the vegetation field forms worked well. The QRA team found it useful to assign a (+) to a rating when the location was at the higher end of the range and a (-) to a rating when the location was at the lower end of the range.

Table 8. Phase 1 2015 Vegetation QRA results and trends.

Metric	2015 QRA Results		Performance Trend
	Category	Percent of Plots/Transects in Category	
Canopy cover woody vegetation on streambanks	Category 1 (> 40%) Category 2 (10 to 40%) Category 3 (<10%)	26% 59% 13%	Meeting or trending toward meeting short term target of 40%.
Canopy cover woody vegetation on floodplain	Category 1 (> 30%) Category 2 (10 to 30%) Category 3 (<10%)	13% 13% 74%	Low woody vegetation cover in the floodplain is expected in Year 1 and should increase significantly over the next several years.
Canopy cover herbaceous vegetation on floodplain[2]	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (20 to 50%) Category 4 (<20%)	35% 34% 12% 18%	Only 18% of the area not meeting the Year 1 target of 20% cover. Most of the species composition was native.
Woody vegetation survival	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (<50%)	56% 40% 4%	Monitoring results indicate Year 1 survival of 85.5%[1]. QRA results indicate that overall survival may have declined between 2014 and 2015 with only 56% of observed plots having greater than 80% survival.

[1]RESPEC, 2016 a, b

[2] For purposes of the QRA, total canopy cover of herbaceous species is evaluated not just cover of native herbaceous species.

Streambank Woody Vegetation Cover

The 2015 QRA showed that 87% of banks have greater than 10% woody vegetation cover (sum of Category 1 and Category 2). This indicates that streambanks were either meeting or trending toward meeting the five year performance target. Thirteen percent of banks had less than 10% cover and may not meet the performance target of 40% cover by year five. Monitoring in 2014 showed average cover of 15.2% for all plots monitored (RESPEC, 2016a). Therefore, QRA results suggest that cover was increasing in the second growing season.

In 2015, double vegetated soil lift (DVSL) streambank treatments were mostly in Category 2 (10-40% cover) (35 of 47 banks). Some treatments installed at the later end of the season (June and July) showed die back after the first year as observed in informal walk-throughs. However, after a second growing season, willows in these banks were re-sprouting at the base and exhibiting similar numbers of surviving willows as streambanks installed earlier in the season, though growth was not as tall (Figure 20). There was no observable difference in survival of willows placed between the two lifts compared with those placed above the top lift. Significant natural recruitment was observed in the bare alluvium behind the streambank treatments (Figure 22). Natural

recruitment was primarily willows, but also included black cottonwood and one quaking aspen. This recruitment likely occurred after 2014 out of bank flows.

Overall, DVSL structures appeared stable in 2015. Similar to the geomorphology observations, there were several locations identified where localized coir log loss, toe loss, and undercutting was observed but the vegetation team determined these changes did not affect overall structure integrity or function. Vegetation team notes regarding DVSL structure conditions included: decomposition of soil lift fabric on the lower lift of RB-N-19; low cover of willows on RB-N-7; and loss of the lower lift coir logs at RB-N-14 DVSL and RB-N-46 DVSL.

The majority of preserve vegetation (PV) streambanks fell within Category 1 (>40% cover) (17 of 28 banks) (Figure 21). Three herbaceous banks were recorded as N/A to avoid artificially lowering woody vegetation cover because the potential for these banks may not be woody vegetation. Herbaceous PV banks supported a mix of sedges, rushes and reed canarygrass.

Brush trench (BT) structures mostly fell within Category 2 (10-40% cover) (18 of 27) and 6 banks were recorded as Category 1 (Figure 21). Brush trenches along the back edge of PV streambanks were often dominated by herbaceous vegetation and had less woody vegetation cover compared with other brush trench structures. Brush trenches placed behind DVSL structures and along the top edge of point bars had the highest cover of woody vegetation.

While not part of the QRA assessment, conditions on point bars were noted during the 2015 QRA. As of July 2015, almost all point bars had natural recruitment of woody species such as willow and black cottonwood. Survival and expansion of herbaceous wetland species on point bars was also observed and all had evidence of recent inundation such as fine sediment and woody debris accumulation (Figure 22).

Figure 20. Re-growth of willows in 2015 that appeared to have died back in earlier observations.

Figure 21. Top left photo of streambank treatment LB-N-7 (DVSL) Category 3 (<10%). Top right photo of streambank treatment RB-N-22 (PV) Category 2 (10 to 40%). Bottom left photo of streambank treatment LB-N-8 (PV) Category 1 (>40%). Bottom right photo of streambank RB-N-49 (BT) Category 2 (10 to 40%).

Figure 22. Natural recruitment of herbaceous wetland vegetation on constructed point bar (left photo) and willows on placed alluvium behind a streambank structure (right photo).

Floodplain Woody Vegetation Cover

Woody vegetation cover was recorded in survival plots established for effectiveness monitoring throughout the Project Site (Attachment A, *Map 2* and RESPEC, 2016 a, b). In 2015, 13% of plots (Category 1) had met the 5 year woody canopy cover performance target of 30%. Another 13% were trending toward meeting the 5 year woody canopy cover performance target (Category 2) (Figure 24). For the remaining 74% of plots, it was too early to detect a trend. Woody vegetation cover can be slow to increase and is greatly affected by natural recruitment and expansion of surviving woody vegetation. Although the woody vegetation cover was low in many of the observed plots, planted woody vegetation survival numbers (below) suggested that woody vegetation will continue to expand in the floodplain over time. RESPEC (2016 a, b) recorded woody plant cover in Phase 1 in late summer 2015. They monitored twelve plots, 6 were planted in 2013 and 6 were planted in 2014. For all plots, mean woody plant cover was 14.8% (25.1% for units planted in 2013 and 4.5% for plots with plants installed in 2014). This is consistent with observations made during the 2015 QRA and also indicates how drastic the increase and cover can be between the first and second year of growth.

Some planting units in their second growing season had woody cover meeting performance targets for year five (greater than 30% cover). Units with high woody cover included SW04 (constructed island on right bank); and wetlands at the north end of the project (SCS04, SW10, SW11 and SW09). Some outer meander planting units also had high cover (Figure 24). In these areas, woody cover may have actually been higher because browse protectors were preventing full expression of shrubs in some areas. In areas without browse protectors or within the 4 foot wire fences, cover was reduced due to browse. Some browse was observed within the 8 foot net exclosures fences, but at lower levels than outside the fences.

Planted Woody Vegetation Survival

Survival data collected during the 2015 QRA showed that 56% of plots have met the survival performance target of 80% (Category 1). 2014 monitoring completed by RESPEC documented overall survival of 85.5% (RESPEC, 2016a). Therefore, 2015 QRA results may have indicated a slight declining trend in survival compared with monitoring that occurred in the first growing season (for plants installed prior to fall 2014). Survival for plants installed in fall 2014 were not monitored by RESPEC until August, 2015. Survival plots however were established prior to the QRA to allow evaluation of these areas during the QRA. The final effectiveness monitoring report became available after the first version of this QRA document was completed and the results have been inserted here. In 2015, RESEPC monitored 53 floodplain plots for woody plant survival within the floodplain planting units (9.4% of total plants were monitored). Among all the containerized plants sampled, survival was at least 85.5%. This represents year 1 survival for 2013 plants and year 1 survival for 2014 plants. Survival was lowest in upland areas and highest in outer bank areas.

Plots that did not meet the survival performance metric in 2015 based on QRA results were mostly located in swales where prolonged inundation occurred, drowning plants (Figure 23). Surface water in wetlands and swales was much lower during the 2015 QRA compared with observations made in informal walk-throughs in summer 2014. This lower surface water may allow additional woody vegetation to establish in these areas. To reduce the risk of too much water in swales, swale criteria should be modified in future designs to be shallower or criteria should be based on groundwater data. In general, swale design should be modified to be approximately 0.5 to 1 feet above expected perennial groundwater instead of intercepting perennial groundwater. Survival of sandbar willows planted in meander core planting units was also poor in 2015 (i.e. plot MC02). This may be due to drier conditions because of meander cores higher position on the floodplain or it may be due to disease observed in 8 gallon container plants planted in that area. Sandbar willows were planted in these areas because they made up a large percentage of the species mix available for Phase 1. In future phases, sandbar willow planting should be limited in meander cores. Further, 8 gallon container plants should only be selected if delays result in the need to pot up nursery plants into larger sizes (as was the case in Phase 1).

Browse by deer, rabbits, and beaver was observed throughout planting units at the Phase 1 Project Site. Individual browse protectors were effective at preventing deer browse to the height of the protector but not effective at protecting against rabbit and beaver browse. The 4 foot wire fences were effective at preventing beaver browse along the streambanks but were not effective at preventing deer and rabbit browse. Plants within the 4 foot wire fences had significant amounts of deer browse with some having almost complete defoliation. 2014 effectiveness monitoring completed by RESPEC documented mild deer browse in 11% of streambank survival plots and 70% of floodplain survival plots; and beaver activity in 18% of streambank survival plots and 3% of floodplain survival plots. The 2015 QRA results may indicate a higher level of browse is now occurring along streambanks. While effective browse protection adds incremental cost to the revegetation effort, it is necessary to protect the State's investment in plant growing and installation. Most short- and mid-term risks to the project (bank erosion, floodplain avulsion) can be addressed by successfully establishing woody vegetation during the first five years after construction. Few river and floodplain projects in western Montana have achieved this without addressing wildlife browse in a meaningful and effective way early on. The design team will continue to work towards developing effective, cost effective methods for protecting plants from browse during the establishment period. Subsequent phases have used sturdier browse protectors and complete wildlife exclusions that will be evaluated for effectiveness.

Figure 23. Survival monitoring plot SO81 (left photo) assigned to woody vegetation cover Category 3 (<10%) and survival Category 2 (50 to 80%). Swale S056 (right photo) with low survival and herbaceous cover.

Figure 24. Survival plot OM16 (left photo) assigned to woody vegetation cover Category 2 (10 to 30% cover) and survival Category 1 (>80%). Survival plot SCS04A (right photo) assigned to woody vegetation cover Category 1 (>30% cover) and survival Category 1 (>80%).

Floodplain Herbaceous Vegetation Cover

Observations of herbaceous cover along floodplain transects in July 2015 showed that 35% of transects were already meeting the year five performance target of 80% cover in year one (Category 1) and 82% of transects were meeting the herbaceous cover performance target for year one of 20% cover (sum of Category 1, Category 2, and Category 3). The transect segments not meeting the year 1 criteria included areas where sparse vegetation would be expected the first year, including unvegetated bottoms of swales and wetlands, bare alluvium behind streambanks, exposed and colonizing depositional areas on point bars, and construction access routes. A few areas of the floodplain also had sparse herbaceous cover (Figure 26). Prior to the 2015 QRA, precipitation of salts on the soil surface was observed on the west side/left bank of the floodplain near Warm Springs Pond (near Transects 4 and 5) and on the east side/right bank of the floodplain near the east ends of Transects 7 and 8. In 2015, salt

precipitation had greatly decreased and was only seen in a few localized areas. Although overall vegetation cover appeared lower in areas with observed salt precipitation it was not preventing grass colonization. RESPEC (2016 a, b) monitored herbaceous cover in 76 plots along floodplain transects in 2015. They reported that mean total percent cover of all herbaceous plants was 51% and mean cover of native herbaceous plants was 31%.

In July 2015, the dominant herbaceous species across the floodplain included slender wheatgrass (*Elymus trachycaulus*), yarrow (*Achillea millefolium*) and alfalfa (*Medicago* spp) in some areas. Additional observed species included greasewood (*Sarcobatus vermiculatus*), big bluegrass (*Poa secunda*), witchgrass (*Panicum capillare*), blanketflower (*Gaillardia aristata*), blue flax (*Linum lewisii*), and sage species (*Artemesia* spp). Common yarrow (*Achillea millefolium*) had high cover in some areas, particularly upstream of the bridge (Figure 25). Seeded annuals prevalent in 2014 such as sunflower (*Eriophyllum* spp) and Rocky Mountain bee plant (*Cleome serrulata*) were no longer prevalent in 2015. Noxious weeds were observed in only a few locations and in low densities. Noxious weed species included Canada thistle (*Cirsium arvense*), perennial pepperweed (*Lepidium latifolium*), leafy spurge (*Euphorbia esula*), and common toadflax (*Linaria vulgaris*). Other exotic species such as mustard species (*Brassicacea* spp), and kochia (*Bassia scoparia*) were widespread in 2015.

Herbaceous cover of wetland species, including sedges and rushes, was high in a concentrated area around the perimeter of the most wetlands (Figure 27). This concentrated development of zones is common in wetlands and relates to the hydrologic preference of wetland species. Natural colonization of cattails (*Typha latifolia*), bulrush (*Schoenoplectus* spp) and sedges (*Carex* spp) was also observed. Sedges were the primary herbaceous cover, but cover of mannagrass (*Glyceria* spp) (a native, seeded species) was also high in some wetlands. Redtop (*Agrostis gigantea*) was also a common, and sometimes dominant, species in wet areas.

Figure 25. Top left photo is of floodplain transect 8 showing dominance by yarrow and assigned to Category 2 (50-80%). Top right photo is of floodplain transect 2 showing yarrow, alfalfa, and slender wheatgrass assigned to Category 1 (>80%). Bottom left photo is of floodplain transect 3 showing dominance by slender wheatgrass.

Figure 26. Floodplain areas with lower herbaceous cover along Transect 3 (photo left) and Transect 4 (photo right).

Figure 27. Herbaceous cover of planted sedges in constructed wetland SW01 (top left photo); dense cover of sedges and bulrushes from pre-vegetated coir mats placed along constructed wetland SW05 (top right photo); expanding cover of pre-vegetated coir mats and planted herbaceous wetland plants along side channel SCS03 (bottom left photo); and good survival of herbaceous wetland plants planted on a constructed point bar (bottom right photo).

Phase 1 2015 Vegetation Management Actions

The overall positive trend seen in Phase 1 in July 2015 led to minimal recommended management actions; however, a few actions were recommended following the 2015 QRA to ensure the project area remains on a trajectory to meet project goals and objectives. For vegetation, the following maintenance needs were identified and status of completion for Phase 1 in 2015:

- Repairs to individual browse protectors and fences. Repairs were completed in August, 2015.
- Browse protection for plantings outside of fenced areas or areas where individual protectors were installed. No additional browse protection was installed. The need for additional browse control should be re-evaluated in 2016.
- Supplemental irrigation of fall 2014 plantings may be needed depending on weather conditions. This was determined to not be necessary and was not completed as a maintenance action in 2015.
- Selective weed control in planting units. The capacity of some browse protectors has been filled with exotics such as mustard species. In some locations this is likely out competing the surviving shrub or tree. Browse protectors in these areas should be removed, exotics should be hand pulled, and browse protectors should be reinstalled in the following planting units: TS07, OM18, OM21, OM22, OM24. This was determined to not be necessary and was not completed as a maintenance action in 2015. The need for selective weed control should be re-evaluated in 2016.

Vegetation management actions were completed through a Tier II solicitation that was awarded to Watershed Consulting, Inc. Quantities and a map showing the locations of maintenance actions were provided in the previous version of this report.

Year 2016

This section describes the results of the vegetation QRA completed at the Phase 1 Project Site in 2016. The 2016 vegetation QRA field team included Amy Sacry (Geum), Karissa Ramstead (Geum), Marisa Sowles (Geum), Mark Traxler (RESPEC), and Brian Bartkowiak (DEQ). The QRA took place on July 11, 2016. Since Phase 1 monitoring completed in 2014 and 2015 indicated that either early performance targets had been met or were trending towards being met, the 2016 QRA was done at a reduced level compared to 2015. The 2016 QRA focused on determining if vegetation trends in Phase 1 were changing, if additional monitoring was necessary, or if any management actions were needed. The QRA included walking the entire length of the channel in Phase 1 to record woody vegetation cover at each streambank on the *Streambank Canopy Cover* form included as part of the QRA protocols. As the team moved through the Phase 1 Project Site they also visited all woody vegetation survival monitoring plots. At each monitoring plot survival was recorded using the *Survival* form and woody vegetation cover was recorded using the *Floodplain Woody Vegetation* form. In 2016, only half of the floodplain transects established for monitoring herbaceous vegetation cover and composition in the floodplain were observed. For each transect, herbaceous vegetation was estimated for distinct sections of each transect using the *Floodplain Herbaceous Vegetation* form. Visual observations, photographs, and potential management actions were also recorded during the assessment. An overall rating was assigned to each vegetation metric using the collected data. Table 9 provides an overall summary of the results of the Phase 1 2015 vegetation QRA. Detailed results of the assessment are provided in Attachment E. Example photos are provided in the following text and additional supporting photos taken during the 2015 vegetation QRA are provided in Attachment D.

In 2016, the QRA team identified the following vegetation site trends in Phase 1. These trends are described in more detail in the following sections:

- Overall woody vegetation cover on streambanks was increasing.
- Browse continued to be an issue in all areas where woody vegetation was planted or installed in streambank treatments. Browse pressure was particularly high within the 4-ft wire fences installed along streambank planting units.
- Overall survival of planted shrubs and trees had decreased, but overall cover of woody vegetation had increased.
- Floodplain herbaceous vegetation continued to expand, but dominant species had shifted in many areas.
- 2016 QRA results indicated that additional vegetation monitoring and data collection was not necessary until the scheduled Year 5.
- The vegetation QRA team reiterated the importance of the annual QRA in all phases because a dramatic change can occur early during establishment of seeded and planted species and this is the period when maintenance actions would most likely be required and effective. If after the third year of QRA,

vegetation establishment seems adequate, the QRA for vegetation could subsequently become less frequent to allow vegetation time to establish. However, similar to geomorphology, a QRA should occur after any significant high flow or severe drought occurs.

- The QRA team discussed the need for Year 5 effectiveness monitoring to begin looking at how resilient/resistant plants are to browse and consider removal of browse protection. Site resilience would be based on total cover, and structural and species diversity.

Table 9. Phase 1 2016 Vegetation QRA results and trends.

Metric	2016 QRA Results		Performance Trend
	Category	Percent of plots/transects in Category[1]	
Canopy cover woody vegetation on streambanks	Category 1 (> 40%) Category 2 (10 to 40%) Category 3 (<10%)	33% (26%) 50% (59%) 17% (13%)	Slight shift between Category 1 and 2 but overall trending toward 40% canopy cover to meet 5 year short term target.
Canopy cover of woody vegetation on floodplain	Category 1 (> 30%) Category 2 (10 to 30%) Category 3 (<10%)	24% (13%) 26% (13%) 50% (74%)	Despite lower survival, woody cover is increasing and trending toward 30% canopy cover to meet 5 year short term target.
Canopy cover of herbaceous vegetation on floodplain[2]	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (20 to 50%) Category 4 (<20%)	36% (35%) 30% (34%) 31% (12%) 3% (18%)	Increasing in areas where it was very low in Year 1 and trending toward 80% cover to meet 5 year short term goal. Most of the species composition is native.
Woody vegetation survival	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (<50%)	47% (56%) 45% (40%) 8% (4%)	Survival has decreased and majority of plots do not meet the year 1 80% survival performance target – as long as overall woody cover is increasing this should not be considered a negative trend.

[1] The value provided in () is the 2015 value included for comparison.
[2] For purposes of the QRA, total canopy cover of herbaceous species is evaluated not just cover of native herbaceous species.

Streambank Woody Vegetation Cover

Overall woody vegetation cover on streambanks increased between July 2015 and July 2016 (Table 9). The cover of willows on individual streambanks was still highly variable in 2016, but overall cover increased compared to 2015 (Figure 28). Deer browse of willows was observed on all streambanks, with less browse observed on sandbar willow compared to other willow species. Beaver browse was observed on some

streambanks. Although beaver cutting reduced the height of willows, it did not appear to be affecting survival of willow cuttings and may increase willow growth and density over time as cutting stimulates root production and development of lateral branches. Several DVSL streambank treatments had gaps with low woody vegetation cover (LB-S-12, LB-N-31, LB-N-50, LB-N-51, RB-N-7, RB-N-5, RB-N-37 and RB-N-47). The QRA team discussed a rule of thumb for density of surviving willows (regardless of growth) that may indicate a trend toward acceptable long term woody vegetation cover and stability. Based on past experience, having at least one living willow within a 5-foot span of streambank typically indicates that long-term woody vegetation cover will be adequate. If willows are less dense than this, it may indicate that woody vegetation cover will not be sufficient within the 5-7 year expected life of the fabric and coir logs to provide long-term bank stability.

Fabric degradation was observed on most DVSL structures and was greatest in bottom lifts where there was prolonged inundation during high flows in 2014. Several rips/tears were observed and a few banks have lost a few coir logs in either the bottom or top lifts. The potential risk of this degradation was evaluated in terms of woody cover in the bank and the potential for woody vegetation cover to expand in the next 2 to 3 years and the rule of thumb mentioned above was applied to determine if a possible management action should be done. There were few if no instances where gaps greater than 5 feet were present between growing willows.

Survival of 10 cubic inch woody plants installed behind DVSL streambank treatments remained high, although most were being browsed and plants have not grown substantially since planting. The willows and cottonwoods that naturally recruited on the alluvium placed behind streambanks after 2014 high flows also appeared to have good survival but overall growth of these seedlings was also low (Figure 29). Willow cuttings are beginning to sucker into the 10 feet of alluvium placed behind constructed banks.

Fine sediment deposition was observed on the toe of several DVSL structures and on top of the lower lift in DVSL structures. This fine sediment has been colonized by annuals such as spikerush (*Eleocharis palustris*) and mosses primarily, but also by willows and cottonwoods in some areas. Point bars also had fine sediment deposition resulting in extensive colonization by wetland herbaceous vegetation as well as willow seedlings (Figure 30).

In 2016, preserve vegetation (PV) banks throughout Phase 1 had robust vegetation that is starting to expand out towards the floodplain (Figure 30). Little to no erosion or slumping of these banks was observed. One bank, LB-N-14-16 had localized erosion where willow cover was low (Figure 30).

Figure 28. Typical increase in woody vegetation cover on DVSL structures between 2015 and 2016 (photo is of LB-S-07). Cover went from a Category 2- in 2015 to a Category 2 in 2016.

Figure 29. Left photo of streambank treatment LB-N-27/28 (DVSL) showing colonization of woody vegetation in alluvium placed in streambank. Right photo is of a constructed point bar with willow cover increasing in brush trench (LB-N-1) and herbaceous and woody vegetation colonization on fine sediments deposited on the point bar.

Figure 30. Top photos are of preserve vegetation (PV) streambanks showing expansion of preserved willows into the floodplain (left photo is LB-N-3; right photo is RB-N-48). Right photo is of one of the few preserve banks where erosion had occurred (LB-N-14-16).

Floodplain Woody Vegetation Cover

Woody vegetation cover was recorded for survival plots established for effectiveness monitoring throughout the Project Site (Attachment A, *Map 2* and RESPEC, 2016 a, b). In 2016, 24% of plots had met the 5 year target of 30% cover, up from only 13% of plots in 2016. The number of plots in Category 2 (10 to 30%) increased from 13% in 2015 to 26% in 2016. Fifty percent of plots were still in Category 3 (<10% cover). Similar to 2015, it was still too early to detect a trend for plots with low woody cover. Woody vegetation cover can be slow to increase and is greatly affected by natural recruitment and survival. In 2016 there was a decrease in planted woody vegetation survival (Table 9). For plots with low survival, it is unlikely they will meet the Year 5 30% woody vegetation cover target. However, because woody cover is increasing in most plots, this will not likely affect total woody cover for the Project Site as a whole. Streambanks where both woody vegetation survival had decreased and woody vegetation cover was low should be considered for management actions. For example, unit OM01 was Category 3 (<10% cover) for woody cover in 2015 and 2016 but went from a survival category 1 (>80%) to a survival category of 3 (<50%) in 2016. This may be an area

where streambank woody cover will not meet performance targets; however, streambank woody vegetation cover at this location increased slightly between 2015 and 2016 and it is possible this woody vegetation will expand out into the area with low woody cover over time. Areas like this should continue to be monitored for the need for potential management actions.

Planted areas and other areas that were inundated during the 2014 high flows had significant expansion of plantings and natural recruitment of new willows and cottonwoods. In 2016, the survival and growth of willows continued to expand in these areas (Figure 31). This may contribute to the increase in woody cover at the Project Site. The secondary channel constructed at the downstream end of the project (north end, west side of river) had the highest overall survival and willow cover. Beaver swam under the fence in 2014 and cut down almost all of the willows at the lower end of the side channel which resulted in significant re-growth and expansion of woody vegetation cover in this area (Figure 33). Constructed wetlands in this area also had high woody vegetation cover (Figure 33).

Planted Woody Vegetation Survival

Overall, survival of planted woody species decreased in Phase 1 in 2016 (Table 9). In 2016, survival upstream of the bridge had noticeably decreased. Units upstream of the bridge had a maximum of 5% woody cover (Figure 32). No individual browse protectors were installed upstream of the bridge. The only protection for bank plantings was 4-foot wire fence intended for protection against beaver. Browse was heavy for all plantings outside of 8-foot net exclosures. Herbaceous vegetation is dense upstream of the bridge with a distinct transition from native grasses and yarrow to a predominance of alfalfa occurring between 2015 and 2016. The abundance of alfalfa was likely encouraging excessive use of the area by deer and other ungulates. It is likely that dense herbaceous cover was also directly competing with planted trees and shrubs, a factor that can be exacerbated when plants are already stressed from browse or dry conditions. There were also several indicators that the area upstream of the bridge was becoming drier, particularly on the east side of the river. This may be due to the high constructed floodplain elevations and a lower water table in this area. In general, the floodplain on the west side of the river appears to have a higher water table compared to the east side of the river and this may be affecting overall survival of planted woody vegetation on higher surfaces.

Downstream of the bridge, planted woody vegetation survival was much higher compared to upstream, and plants were healthy and thriving despite dense and widespread alfalfa in some areas, particularly inside of individual browse protectors. One possibility is that in areas where soil moisture is not a limiting factor, the dense alfalfa inside the protectors may actually be protecting the plant from browse, beaver cutting, and providing additional shade and moisture for the establishing shrub or tree. Overall survival downstream of the bridge had also decreased, but not to the extent it had upstream of the bridge. Deer browse was also severe downstream of the bridge in

areas with no plant protection or only 4-ft wire fences which has likely contributed to a decline in survival. No beaver cutting was observed within the 4-ft fences, but several shrubs and trees with individual protectors have been cut by beaver. Some of these were re-sprouting from the base, but most were not.

Survival of plants in the bottom of swale features continued to be poor due to prolonged standing water (Figure 33). The design criteria for these features continue to be adjusted to limit depth and duration of standing water. Survival in outer meander bank planting units was variable but high overall. Although survival increased slightly in the one meander core survival plot, overall survival appeared to have decreased in the meander core planting unit, with an increase in dead sandbar willows observed in 2016, likely due to a lower water table in these areas. Survival was highest in side channel planting units and shrub wetland planting units. Significant growth and expansion of willows has occurred in both of these areas and shrub wetland units (Figure 31). The two upland units, TS02 and TS07, have very poor survival.

Figure 31. Planted swale showing significant natural expansion of willows after inundation in 2014 high flows (photo top left is S063, photo top right is S088, photo bottom left is S092 and photo bottom right is SW11).

Figure 32. Planting units upstream of the bridge with decreased survival in 2016. Planting unit OM01 shown on the left with decreased survival due to droughty conditions, browse and competition with alfalfa. Planting unit TW02 shown on the right with poor survival due to droughty conditions.

Figure 33. Planting Unit SO48 (swale) (top left photo) showing standing water late in the growing season. Planting unit OM13 (outer meander) (top right photo) showing high survival, but suppressed growth from browse protectors and alfalfa competition. Planting unit SCS04A (side channel) (bottom left photo) showing extensive cover of planted willows in the secondary channel wetland after browse by beaver. Planting unit SW09 (shrub wetland) (bottom right photo), located on the west side river at the downstream end of Phase 1 where woody cover is extensive.

Floodplain Herbaceous Vegetation Cover

Herbaceous cover in the floodplain remained high in 2016 (34% of floodplain transect sections in the Category 1 >80% cover). Only 3% of the floodplain transect sections were in Category 4 (<20% cover). The high herbaceous cover is good for short-term floodplain stability, but it can increase competition and reduce the potential for woody vegetation to expand across the floodplain. Due to the high herbaceous cover, a larger flood disturbance is likely needed to open up new habitats for woody vegetation to expand into. This process occurred in areas activated by 2014 high flows which now support dense cover of willow seedlings. In absence of a flood disturbance, future management efforts could include actions that mimic a disturbance to expand woody vegetation.

As described above, upstream of the bridge the dominant seeded species shifted from slender wheatgrass and yarrow to alfalfa (Figure 34). This transition was not occurring downstream of the bridge yet, although alfalfa cover was increasing in some outer meander planting units. Alfalfa cover was so high upstream of the bridge that it is attracting ungulates and concentrating their use in the constructed floodplain area. The negative effects of this can be observed in planting areas outside of areas protected by 8 foot net exclosure fences. The dense alfalfa was also increasing competition upstream of the bridge and reducing the potential for natural expansion of woody vegetation. Because alfalfa can persist for 6 years or more this will likely become a management issues at some point. Alfalfa is no longer included in seed mixes. Downstream of the bridge wheatgrasses were still dominant (Figure 34). Yarrow cover had decreased compared to 2015 and other seeded forbs were beginning to increase. Some areas had increasing densities of young alfalfa that should be watched to make sure they don't increase dramatically as they have upstream of bridge. Rocky Mountain bee plant, which was dominant in Year 1 was no longer present, confirming its value as an initial nurse crop species.

Noxious weed cover remained low in Phase 1 (weed control occurred in 2014 and 2015 prior to the QRA). Some reed canarygrass was growing along banks but overall cover was low. Herbicide applicators were attempting to control the reed canarygrass along the banks (Figure 35). Reed canarygrass was not observed in constructed wetlands, but these areas should continue to be observed closely so early colonization can be detected and eradicated. Reed canarygrass can take over wetlands within just a few years. Other exotic species such as mustard were observed but are not a major concern and appear to have decreased in cover between 2015 and 2016.

Wetland vegetation in constructed wetlands expanded further in 2016. The concentrated species zones that started to develop in 2015 further developed in all constructed wetlands in 2016 (open water, bulrush dominated, sedge dominated, rush dominated). The dominant species were planted in these areas. In most zones, cover is near 100% (Figure 36). The width of these vegetation zones in general was narrow and maximizing the zone where desired vegetation is establishing should be integrated

into future designs. This can be done by increasing the length of side slopes. Several species of waterfowl, migratory birds, and amphibians were observed in constructed wetlands.

Figure 34. Top photos showing areas along floodplain transect #5 showing good yarrow and slender wheatgrass cover. Bottom photo showing dense cover of alfalfa upstream of the bridge.

Figure 35. Reed canarygrass on preserved vegetated bar in Phase 1.

Wetland hydrology continued to vary greatly in Phase 1. There appeared to be a significant influence on wetland vegetation establishment due to hydraulic conductivity differences between the east and west side floodplain areas. The east side in general was much drier than the west side of the river in Phase 1. The west floodplain is influenced by coarse grained, permeable glacial outwash from the Flint Creek Range, and old Warm Springs Creek alluvium. The glacial outwash is likely interbedded with finer grained clay horizons that can perch water relatively high in the alluvial profile. There also appeared to be greater recharge volumes from the west, due to natural inputs off of the Flint Creek Range as well as up-gradient flood irrigation. The Warm Springs treatment ponds and Warm Springs Creek also may contribute groundwater on the west side of the river. In contrast, the east floodplain is influenced by fairly fine grained and less permeable sands derived from Elk Horn volcanic rocks, and less natural recharge from the low hills on the east side of the Deer Lodge Valley. These conditions tend to support a higher water table west of the channel, which is noticeable in wetland areas. The wetland constructed on the west side of the river downstream of the bridge had more open water compared with other constructed wetlands. The constructed wetland upstream of the bridge on the east side of the river dries out annually, as does the wetland east and downstream of the bridge, and furthest from the channel. This wetland furthest from the channel had the driest conditions at the time of the QRA and lacks distinct wetland vegetation zones, but still had high emergent and woody vegetation cover.

The QRA team discussed the need to understand groundwater elevations and flow paths and how floodplain re-construction influences them in order to better design highly functioning wetland features and improve revegetation success. For Phase 1, the simplest approach would be to measure surface water elevations in constructed wetlands and swales and compare them with water elevation/flow data for the main channel to see how these features relate. Installing a staff gage at every phase could help with these correlations. Additionally, pre-project existing vegetation communities may provide some insight into where we are seeing wetland hydrology differ. Correlating existing variations in vegetation cover, survival, and wetland hydrology to pre-existing vegetation conditions may help floodplain and wetland grading plan development for future project phases. As of this report update these analyses had not been completed.

In addition to constructed wetlands, several swales are transitioning to emergent wetland or open water in the bottoms. These areas were not planted or seeded with emergent wetland species, but are being naturally colonized by cattail, sedges and wet grasses. Foxtail barley, a native perennial bunchgrass, (*Hordeum jubatum*) is also increasing in several wetlands and swales (Figure 36).

Figure 36. Top left photo of wetland on east side of river upstream of bridge. Top right photo of wetland on west side of river near Warm Springs water treatment ponds. Bottom left photo showing dense bulrush cover but also increased cover of meadow foxtail. Bottom right photo showing a swale with open water, cattails, redtop, and meadow foxtail.

Phase 1 2016 Vegetation Management Actions

Due to extensive deer browse and reduced survival of planted woody vegetation upstream of the bridge, management actions to protect the surviving bank plantings were recommended after the QRA assessment. For vegetation, the following management actions were identified for Phase 1 in 2016. The list indicates whether the needs were addressed.

- For outer bank planting units on the east side of the river upstream of the bridge: install weed mats around select surviving willows to suppress alfalfa and potential competition issues (exacerbated by droughty conditions and intense browse), install individual browse protectors and water plants in outer bank planting units to try to keep remaining plants alive. These maintenance actions were completed in August 2016.
- Repair exclusion fences and individual browse protectors. This maintenance task was completed in November 2016.

- Continued noxious weed control, monitoring of reed canarygrass presence in wetlands, and selective targeting of reed canarygrass along the channel should continue. Weed control was completed in summer 2016.
- The river and floodplain were scheduled to be open to the public again in August 2016 and signs should be installed that discourage impacting vegetation. Signs were installed in November 2016.

Vegetation management actions were completed in August 2016 (Native Yards through a sub-contract with Geum Environmental Consulting) and in November 2016 (through a Tier II solicitation awarded to Watershed Consulting, Inc.)

Year 2017

This section describes the results of the vegetation QRA completed at the Phase 1 Project Site on September 11, 2017. The 2017 vegetation QRA field team included Amy Sacry (Geum) and Marisa Sowles (Geum). Other participants included Jeffrey Johnson (National Park Service, Grant Kohrs Ranch) and Ben Quiñones (DEQ). Streambank woody vegetation cover was recorded by the 2017 geomorphology QRA field team. Similar to 2016, the 2017 QRA was also completed at a reduced level compared to 2015. The 2017 QRA focused on determining if vegetation trends in Phase 1 had changed, if additional monitoring was necessary, or if any management actions were needed. The 2017 QRA included walking the entire length of the channel in Phase 1 to record woody vegetation cover at each streambank on the *Streambank Canopy Cover* form. All survival monitoring plots were observed and survival was recorded using the *Survival* form and woody vegetation cover was recorded using the *Floodplain Woody Vegetation* form. In 2017, floodplain cover was recorded by delineating areas with similar herbaceous vegetation cover on aerial photos while in the field. For each area, the average cover of herbaceous vegetation and dominant species were recorded. No *Floodplain Herbaceous Vegetation* forms were completed in 2017. Visual observations, photographs, and potential management actions were also recorded during the assessment. An overall rating was assigned to each vegetation metric using the collected data. Table 10 provides an overall summary of the results of the Phase 1 2017 vegetation QRA. Detailed results of the assessment are provided in Attachment E. Supporting photos taken during the 2017 vegetation QRA are provided in Attachment D.

In 2017, the QRA team identified the following vegetation trends in Phase 1. These trends are described in more detail in the following sections:

- Woody vegetation cover on streambanks continues to increase and willows are expanding towards the floodplain. This trend is particularly noticeable in areas where out of bank flows occurred in 2017 or in previous years.
- Survival of planted shrubs and trees has decreased in several planting units, particularly swale units and units planted in 2014. The decrease in survival is

due to dry conditions and browse. Browse pressure is particularly high within the 4-ft beaver protection fences which are doing little to prevent deer browse.

- Cover of woody vegetation is increasing in most planting units. The rate at which cover is increasing appears to be influenced by: year of planting, type of browse protection installed, and flood disturbance, with areas inundated by high flows showing more growth and higher cover.
- Floodplain herbaceous vegetation continues to increase and be dominated by seeded species; however, an increase in exotic species was observed in 2017. Alfalfa cover did not appear to increase in 2017 compared to 2016.
- Reed canarygrass was observed on more streambanks and point bars compared to 2016.
- The drop in woody vegetation survival along the left streambank could result in not achieving floodplain woody vegetation performance targets long-term. For this reason, the QRA should be repeated in Phase 1 in 2018 and management actions should be considered. No additional data collection is needed to document this trend.

Table 10. Phase 1 2017 Vegetation QRA results and trends.

Metric	2017 QRA Results		Performance Trend
	Category	Percent of plots/transects in Category[1]	
Canopy cover woody vegetation on streambanks	Category 1 (> 40%) Category 2 (10 to 40%) Category 3 (<10%)	61% (33%, 27%) 37% (50%, 61%) 2% (15%, 12%)	Willows in streambanks continue to increase in cover and expand towards the floodplain.
Canopy cover of woody vegetation on floodplain	Category 1 (> 30%) Category 2 (10 to 30%) Category 3 (<10%)	33% (24%, 13%) 36% (26%, 13%) 31% (50%, 74%)	Canopy cover of woody vegetation continues to increase as surviving plants grow and expand; units with very low survival continue to have low woody vegetation cover.
Canopy cover of herbaceous vegetation on floodplain[2]	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (20 to 50%) Category 4 (<20%)	12% (36%, 35%) 80% (30%, 34%) 7% (31%, 12%) 1% (3%, 18%)	Herbaceous cover continues to increase in the floodplain; the shift in cover categories is likely due to use of a different methodology for estimating cover in 2017. Species composition remains primarily native.
Woody vegetation survival	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (<50%)	27% (47%, 56%) 52% (45%, 40%) 21% (8%, 4%)	Overall decrease in survival, particularly in left bank planting units where dry conditions and heavy browse were factors.

[1] The values provided in () are the 2016, 2015 values included for comparison.

[2] For purposes of the QRA, total canopy cover of herbaceous species is evaluated not just cover of native herbaceous species.

Streambank Woody Vegetation Cover

Woody vegetation cover was recorded for all streambanks in Phase 1. In 2017, 61% of streambanks had achieved the Year 5 performance target of greater than 40% cover of woody vegetation. A total of 37% of streambanks had cover between 10% and 40% and 2% had less than 10% woody vegetation cover. In 2016, 13% of streambanks had less than 10% woody vegetation cover indicating an overall increase in woody vegetation cover on streambanks between July 2016 and September 2017 (Table 10). The cover of willows on individual streambanks continued to vary in 2017 but a general trend of increasing cover was observed. Streambanks documented in 2016 as having gaps with low woody vegetation cover still have gaps in woody vegetation cover but all showed an increase in cover between 2016 and 2017. Increased woody vegetation cover is primarily from growth of dormant willow cuttings used in streambank treatments, but also from natural recruitment of cottonwoods and willows during spring out of bank flows, and 10 cubic inch woody plants installed behind DVSL streambank treatments.

Cover remains highest on brush trench (BT) streambank treatments. Preserve vegetation (PV) banks continue to support robust herbaceous and woody vegetation with woody vegetation cover also increasing on these banks. Less beaver and deer browse was observed on streambank woody vegetation compared to 2015 and 2016.

Both herbaceous and woody vegetation continues to increase on constructed point bar features in Phase 1. Reed canarygrass was observed on more point bars in 2017 compared with previous years. Photos 1-4 in Attachment D (*Phase 1 2017 Miscellaneous Vegetation Photographs*) show typical conditions of point bars in Phase 1 in 2017.

Floodplain Woody Vegetation Cover

Woody vegetation cover was recorded for survival plots established for effectiveness monitoring throughout Phase 1 (Attachment A, *Map 2*). In 2017, 33% of plots had met the 5 year target of 30% cover, up from 24% of plots in 2016. The number of plots in Category 2 (10 to 30% cover) increased from 26% in 2016 to 36% in 2017. Thirty-one percent of plots were still in Category 3 (<10% cover) but overall floodplain woody vegetation is increasing in Phase 1. Woody vegetation had expanded significantly in areas inundated during high flows including streambanks and connected floodplain features (the backwater area on the left bank upstream of bridge; the discontinuous secondary channel on the left bank; and the continuous secondary channel on the left bank at the downstream end of the project). Photos 5-8 in Attachment D show areas where floodplain woody vegetation has expanded as a result of inundation by high flows.

In areas where survival of planted trees and shrubs was low or had decreased, floodplain woody vegetation cover was low and it is unlikely these areas will meet the 30% cover target by Year 5. These areas occur primarily on the west side of the

floodplain in areas planted in fall 2014 and include swales and streambank planting units where no deer browse protection was installed. Photos 6-7 in Attachment D (*Phase 1 2017 Vegetation Miscellaneous Photographs*) provide a useful comparison of the effect browse is having on planted woody vegetation in Phase 1. Photos 9-10 in Attachment D (*Phase 1 2017 Vegetation Miscellaneous Photographs*) are of planting units OM19 (2013) and OM19 (2014), which are immediately adjacent to each other on an outside meander bend. Unit OM19 was planted in fall 2013 and plants were protected with individual plant protectors. Survival was Category 1 (>80%) and woody vegetation cover was Category 1 (>30%). Unit OM19 (2014) was planted in fall 2014 and plants were protected with a 48-inch wire fence, which does not exclude deer. Survival was Category 3 (<50%) and woody vegetation cover was Category 3 (<10% cover). Photos 12-14 in Attachment D (*Phase 1 2017 Vegetation Miscellaneous Photographs*) provide additional photos documenting this trend planting units on the west side of the river near the center of the Phase 1 project reach.

Streambanks and floodplains where both woody vegetation survival and cover were low should be considered for management actions. Table 11 provides a list of areas where supplemental revegetation actions were identified as a high priority during the QRA. Some planted areas may have low survival and cover within the planted area itself, but either woody seedlings had recruited naturally and will like expand, or high cover of woody vegetation was present in adjacent streambanks. These areas are a lower priority for supplemental vegetation and are not included in Table 11.

Planted Woody Vegetation Survival

Woody vegetation survival was recorded for survival plots established for effectiveness monitoring throughout Phase 1 (Attachment A, *Map 2*). Survival of planted woody species continued to decrease in Phase 1 in 2017 (Table 10). Survival was lowest in planting units upstream of the bridge (right and left banks) and on the left bank in units planted in 2014 downstream of the bridge. There were two main reasons for low survival of planted woody vegetation in these areas – drought conditions and heavy browse by ungulates, primarily whitetail deer. Survival was also very low in the two upland planting units (TS02 and TS07) due to dry conditions and compacted soils.

Conditions during the first growing season varied between planting units planted in fall 2013, which have higher overall survival, and planting units planted in fall 2014. Spring 2014 flows exceeded the design Q2 bank elevation and inundated a large area of floodplain (Figure 4). Many of the fall 2013 streambank planting units, side channel planting units and several swales were inundated by surface flows in spring 2014. This surface inundation created ideal conditions for woody vegetation to grow and expand. Streamflow remained elevated late into the spring in 2014 resulting in a higher groundwater table than normal. This also contributed to higher initial survival, although in some swale features the high groundwater resulted in decreased survival for some shrubs. High groundwater was also a reason for poor survival along the western edge of the floodplain near Warm Springs Ponds. Spring run-off flows in 2015 did not rise

above the top of banks and were only high for a short period of time. Therefore, planting units planted in fall 2014 were not subject to surface inundation or high spring moisture.

The most notable difference between areas of high survival and low survival; however, was the type of browse protection installed. Planting units planted in fall 2013 all received individual protectors (streambanks) or were enclosed by 8-ft net fences (wetlands and swales). Due to the high cost of browse protection, project managers decided not to use individual protectors for fall 2014 plantings. Instead, streambank plantings were protected with 48-inch wire fences. These fences protect the plants from beaver but not deer or rodents. The 8-ft net exclosure fences have varied in effectiveness. Deer are moving along utility corridors in Phase 1, likely because these areas were cleared of vegetation in the past and allowed easy movement through the site and deer are accustomed to using these corridors. Where 8-ft net exclosures cross a utility path, the fence was torn. Despite maintenance in 2016, several tears and downed sections of fence were observed again in 2017, particularly in the large exclosures. For this reason, it may not be effective to continue to repair the larger net exclosures and alternate protection should be considered in areas where there is low woody vegetation survival and cover.

The trend in decreased survival due to browse was observed in 2016, most notably upstream of the bridge. In response to this, individual browse protectors were installed on plants in units OM05 and OM03 on the right bank upstream of the bridge in fall 2016. The protected plants had up to 3 feet of new growth on them in 2017 confirming that managing browse has a significant positive effect on woody plant growth and cover.

Survival of woody plants planted in swale features is highly variable throughout Phase 1. As mentioned above, many plants were lost in these locations due to prolonged elevated groundwater in 2013. The bottom of many swales now supports cattails or other herbaceous wetland vegetation. In areas where swales were inundated by surface flows during high flows in 2014 and 2017, woody vegetation cover is high despite initial survival being high or low. In areas not activated by surface flows, but with adequate plant protection, cover is not as high but surviving plants are growing and expanding. In areas without adequate plant protection, survival and cover are low.

In some areas, particularly wetland areas connected to the main river channel such as SCS03 and SCS04, willows have become dominant and other planted species are rare. This is likely due to the ability of willows to sucker and expand rapidly in response to flooding.

Beaver browse was observed on streambank willow cuttings during construction and in 2014 and 2015. Beaver browse on planted trees and shrubs was observed on a small percentage of plants in 2015 and 2016. Few signs of beaver activity were observed in 2017. It is unclear why beaver activity decreased in 2017, but activity will likely increase

over the next several years as willow cover continues to increase in the floodplain and along the streambanks.

Floodplain Herbaceous Vegetation Cover

Herbaceous cover Phase 1 remained high in 2017. To reduce the level of effort for the QRA, herbaceous cover in the floodplain was recorded by delineating areas of similar cover on aerial photographs of the site during the on the ground assessment instead of recording cover by distance on established transects. This resulted in most of the floodplain (80% of the total area) being mapped as cover Category 2 (50-80%). Twelve percent of the area was mapped as having greater than 80% cover (Category 1), 7% of the area had 20-50 % cover (Category 3), and 1% of the area was mapped as Category 4 (<20% cover). In 2016, 36% of the transect lengths were recorded as Category 1 so the 2017 results appear to show a decrease in cover. Herbaceous cover has not decreased in 2017 and this apparent decrease in cover is more likely the result of mapping the entire project area rather than discrete transect locations. The 2017 data indicates that herbaceous cover has either met or will meet the Year 5 performance target of 80% cover in 80% of the area by year 5.

Herbaceous vegetation conditions in 2017 had not changed significantly since observations made in 2016. Areas that were seeded in fall 2012/Spring 2013 and subject to high spring moisture in Spring 2013 continued to have the highest cover and seeded species diversity. Alfalfa cover may be slightly lower compared to 2016 upstream of the bridge but was still the dominant species and was increasing in other areas (Attachment D, *Floodplain Herbaceous Vegetation Cover Category Photos*). Alfalfa was still a contributing factor in heavy deer use of the area. High herbaceous cover continued to be a concern for limiting expansion of woody vegetation into the floodplain, but was not as significant an issue as heavy browse and drought conditions on woody vegetation expansion. There was still low herbaceous vegetation cover in some areas, primarily areas used as haul roads or access routes, the avulsion repair area on the floodplain between RB-N-30 and RB-N-42, and the large area of floodplain on the west side near Warm Springs Ponds that remains saturated late into the growing season.

Cover of seeded shrubs was high in some areas, including the access road on the east side of the project upstream of the bridge and the west floodplain area at the downstream end of the Phase 1 site. This latter area also had high diversity of seeded forb species. Photos 26-28 in Attachment D (*Phase 1 2017 Vegetation Miscellaneous Photographs*) show areas with high seeded shrub and forb cover.

Wetlands continued to support high cover and diversity of wetland vegetation. Most wetland features had herbaceous cover greater than 80% (Category 1). Expansion of wetland vegetation was not as pronounced in 2017 compared with previous years, likely due to drought conditions. Water levels in wetlands in 2017 were lower than observed between 2014 and 2016. Several species of waterfowl, migratory birds and amphibians were observed using constructed wetlands in 2017. Photos 15-21 in Attachment D

(*Phase 1 2017 Vegetation Miscellaneous Photographs*) document wetland conditions in wetlands in 2017.

Noxious weed cover remained low in Phase 1. Reed canarygrass was increasing on point bar features and some streambanks and selective treatment of small patches should be considered for future weed management activities. Reed canarygrass was not observed in wetlands, but these areas should continue to be closely evaluated for the presence of reed canarygrass as they are highly susceptible to invasion. An aster species had high cover in several areas of the floodplain (Photo 30, Attachment D – *Phase 1 2017 Vegetation Miscellaneous Photographs*). Prairie aster (*Symphyotrichum falcatum*), was included in seed mixes and this may be the species observed to have high cover in 2017. Redtop (*Agrostis gigantea*) cover was also increasing along the west edge of the floodplain where it has high cover in the adjacent, existing willow stands.

Phase 1 2017 Vegetation Management Actions

The primary Phase 1 vegetation trend of concern observed in 2017 was the low woody vegetation survival and cover in fall 2014 planting units. The combination of droughty conditions in 2016 and 2017 and heavy browse pressure had decreased survival and woody vegetation cover in these units. These plants were more susceptible to these factors compared to fall 2013 plants which benefited from the high spring moisture in 2014 that allowed the fall 2013 plants to become well established initially. Management actions that increase woody vegetation cover in these areas, particularly along streambanks are recommended.

For vegetation, the following management actions were identified for Phase 1 in 2017.

- Remove individual browse protectors where plants have out-grown them and re-use on surviving plants in fall 2014 streambank planting units. Most of the planting units on the right bank planted in Fall 2013 have outgrown the individual browse protectors and are now large enough to be resistant to on-going browse. Protectors should be removed from these units and placed on surviving shrubs and trees in fall 2014 streambank planting units.
    - Specifically, units where individual protectors should be removed include: OM06, OM10, OM13, OM16, OM18, OM21, OM22, OM19 (2013), OM20, and OM23.
    - Individual protectors on plants in OM-19 2013 should be removed and placed on the surviving plants in OM-19 2014.
- Remove 8-ft net exclosure fencing where it is no longer needed or not functioning (i.e. can't be effectively maintained), including:
    - Island/planting unit SW04 (no longer needed).
    - Large exclosure on east side towards the downstream end of Phase 1 (no longer needed and difficult to maintain due to size).
    - Large exclosure on the west side at the downstream end of Phase 1 (no longer needed and difficult to maintain due to size).

    - Large exclosure on west side in the middle of Phase 1. Browse protection is still needed in this area but the exclosure is too large to effectively maintain. The fence blocks the utility corridor so deer push through it. Smaller fences or individual protectors should be installed in areas with surviving woody vegetation in this area.
- Maintain 8-ft net exclosure where it is still needed or where exclosures are small enough that maintenance is effective, including:
    - Exclosures upstream of bridge. A gap was left along the utility corridor in this area that is allowing deer to move through without damaging netting.
    - Exclosure east of river immediately downstream of bridge.
- Inter-plant select streambank and swale planting units with 10 cubic inch shrubs (high frequency). See Table 11 below.
- Continue selective control of noxious weeds and selectively treat reed canarygrass on point bars during annual weed control.

Table 11. Planting units in Phase 1 with low woody vegetation survival and cover where supplemental planting should be considered.

Planting Unit	Streambank	Comment
OM01	Right	Low survival and cover of woody vegetation
OM04	Left	Low survival and cover of woody vegetation
OM07	Left	Low survival and cover of woody vegetation
OM08	Left	Low survival and cover of woody vegetation
OM09	Left	Low survival and cover of woody vegetation
SCE01	Left	Low survival and cover of woody vegetation
Swales between OM08 and SCS03 (approximately 30)	Left	All swales in this area have poor survival and cover due to heavy browse

No vegetation management actions were completed in 2017.

Phase 2

This section describes the results of QRAs completed at the Phase 2 Project Site. One QRA was completed in late summer 2017 (Year 1). This section provides a summary of observations made for geomorphology and vegetation in Year 1, and recommended management actions resulting from the QRA. Streambank construction was completed in Phase 2 in spring 2016. Floodplain construction was completed in summer 2016. Revegetation activities were completed in fall 2015, spring 2016 and fall 2016. Map 1 in Attachment F provides an overview of streambank treatments constructed in Phase 2. Map 2 in Attachment F shows the locations of planted areas. According to the QRA methods in the Monitoring Plan, the QRA is to be conducted using the effectiveness monitoring layout as a guide. No effectiveness monitoring has been completed in Phase 2 therefore there was no effectiveness monitoring spatial data collection lay-out available to guide the QRA process. The 2017 QRA team evaluated all streambanks and floodplain areas within the Project Site and pre-selected several planting units representing a wide range of conditions to document woody vegetation survival and cover.

Geomorphology

Year 2017

This section describes the results of the geomorphology QRA completed at the Phase 2 Project Site in 2017. The 2017 geomorphic QRA field team included Karin Boyd (Applied Geomorphology) and Karin Mainzhausen (CDM Smith). Ben Quiñones (Montana DEQ) also participated. The QRA took place on September 11, 2017. The 2017 QRA assessment focused on evaluating any changes in streambank or channel condition since the completion of construction and after spring 2017 out of bank flow and identifying any new management actions. The QRA included walking the entire length of channel in Phase 2. Visual observations and photographs were recorded during the assessment and information was recorded on the *Channel Stability* form and *Streambank Condition* form included as part of QRA protocols (Geum and AGI 2017). At the end of the assessment, the QRA teamed assigned a score to each of the characteristics on the *Channel Stability* form and recorded an overall stability score to the Phase 2 Project Site. All streambanks with observable altered conditions since construction were noted. For streambanks with considerable altered conditions, the more detailed *Streambank Condition* form was used. Flows exceeded design bankfull in 2017 also completed the *Floodplain Connectivity* or *Secondary Channel and Floodplain Stability* forms in 2017.

Table 12 provides an overall summary of the results of the 2017 Phase 2 geomorphic QRA. Detailed results of the assessment are provided in Attachment H. For 2017, supporting photographs are included in Attachment G.

In 2017, the QRA assessment team identified the following geomorphic site trends in Phase 2. These trends are described in more detail in the following sections.

- Channel stability was meeting performance targets.
- During high out of bank flows in 2017 (approximately 300 cfs above the design Qbf or 2-year flow), high water marks indicated up to 0.5 feet of overbank flow depth in near-channel floodplain environments. Wood was mobilized and microtopography continued to be reworked. The high flows did not result in any floodplain destabilization or avulsion. Several meander cores identified as at high risk of avulsion showed no evidence of having overtopped during spring high water.
- The 2017 QRA results indicated that no additional monitoring and data collection is necessary until the scheduled Year 5 monitoring cycle unless flows exceed bankfull or a significant ice event occurs.

Table 12. Phase 2 2017 QRA geomorphology results and trends.

Metric	2017 QRA Results		Performance Trend
	Category	Results	
Channel Stability	Category 1 (Likely degrading) Category 2 (Largely stable with potential aggradational/ degradational trend) Category 3 (Likely aggrading)	Category 2: Largely Stable (avg score 3.2).	Positive: smooth transitions on point bars, single thread, some indication of sediment aggradation.
Floodplain and Secondary Channel Stability	Category 1 (Low risk/consequence of avulsion) Category 2 (Moderate risk/consequence of avulsion) Category 3 (High risk/consequence of avulsion) Category 4 (Avulsion has occurred)	No floodplain channels creating elevated avulsion risk beyond Category 1.	No floodplain channels are present that pose a high avulsion risk.
Floodplain Connectivity	None	Clear evidence of floodplain inundation with high water marks, wood mobilization and fine sediment deposition.	Positive—results provided to design engineers.
Streambank	None	One streambank treatment was noted for continued observation regarding toe stability.	Uncertain – continued monitoring is recommended for one specific bank. No management actions are recommended at this time.

Channel Stability

Channel stability trends identified by the QRA team in 2017 indicated that the channel was trending towards meeting project goals and objectives and performance target values. The QRA channel stability form indicated an overall rating of 3.2, which is within the 'Largely Stable' category. A few indicators suggested some aggradation in the

reach with some bar development, isolated areas of non-planform related bank erosion, high width to depth ratios, and active deposition on point bars. In general, however, the observed depositional trends were as expected and support willow and cottonwood recruitment on point bars. The combined indicators indicate a stable/mildly aggradational condition.

Floodplain and Secondary Channel Stability

Floodplain stability trends identified by the QRA team in 2017 indicated that the channel is trending towards meeting project goals and objectives and performance target values. Although overbank flows occurred in 2017, there was no evidence of rill formation or increase in near-term avulsion risk.

Floodplain Connectivity

Floodplain connectivity trends identified by the QRA team in 2017 indicated that the channel is hydrologically connected to its floodplain. The 2017 high flow event overtopped banks in Phase 2, as evidenced by wood trapping on brush trenches, and high water marks on the floodplain that were 0.5 feet above the floodplain surface.

Streambanks

This was the first QRA evaluation of Phase 2 streambanks. Several streambanks had some toe slumping; however, willow growth in the bank treatments appeared more robust than what was observed in the Year 1 QRA for other project phases. Most of the streambanks represented early growth of willow cuttings, but some bank treatments had up to 5 feet of willow growth.

Phase 2 2017 Geomorphology Management Actions

No management actions were recommended in the Phase 2 2017 QRA other than localized streambank monitoring.

Vegetation

Year 2017

This section describes the results of the vegetation QRA completed at the Phase 2 Project Site in 2017. The 2017 vegetation QRA field team included Amy Sacry (Geum) and Marisa Sowles (Geum). Other participants included Ben Quiñones (DEQ). The QRA took place on September 11 and 12, 2017. This was the first year a QRA was completed for Phase 2. Construction activities were completed in summer 2016 and revegetation activities, including planting, seeding and fencing were completed in fall 2016. The 2017 QRA focused on documenting Year 1 vegetation trends in Phase 2, determining if additional monitoring was necessary, or if any management actions were needed. The 2017 QRA included walking the entire length of the channel in Phase 2 to record woody vegetation cover at each streambank on the *Streambank Canopy Cover* form. Streambank woody vegetation cover was recorded by the 2017 geomorphology QRA field team. Effectiveness monitoring was completed for Phase 2 in 2017, but the

spatial lay-out was not available prior to conducting the QRA so several planting units were pre-selected to collect woody vegetation survival and woody vegetation cover data. Survival was recorded using the *Survival* form and woody vegetation cover was recorded using the *Floodplain Woody Vegetation* form. Herbaceous floodplain cover was recorded by delineating areas with similar herbaceous vegetation cover on aerial photos while in the field. For each area, the average cover of herbaceous vegetation and dominant species were recorded. No *Floodplain Herbaceous Vegetation* forms were completed in 2017. Visual observations, photographs and potential management actions were also recorded during the assessment. An overall rating was assigned to each vegetation metric using the collected data. Table 13 provides an overall summary of the results of the Phase 2 2017 vegetation QRA. Detailed results of the assessment are provided in Attachment J. Supporting photos taken during the 2017 vegetation QRA are provided in Attachment I.

In 2017, the QRA team identified the following vegetation trends in Phase 2. These trends are described in more detail in the following sections:

- Woody vegetation cover on streambanks was high for Year 1 and is expected to continue to increase over time.
- Survival of planted shrubs and trees was high. Survival was noticeably low on the west side of the floodplain between planting unit wl01 and sb01 and is attributed to dry conditions in this area. Woody vegetation cover and survival seemed to generally increase in a downstream direction.
- Browse protection measures installed in Phase 2 were functioning. The smaller 8-ft net exclosures had few maintenance issues and are effectively preventing browse. The larger 8-ft net exclosures had several downed sections that should be repaired. Plants inside the 4-ft wire fences showed more sign of deer browse compared with the 8-ft net exclosures, but browse levels were moderate to low overall. Individual protectors (both net and wire) were only installed on select species in streambank planting units to protect susceptible species (cottonwood, aspen and willow) from beaver. Few signs of beaver were observed but individual protectors were protecting plants from deer browse.
- Floodplain herbaceous vegetation cover was high overall but species composition varied greatly. In some areas, cover was predominantly seeded grasses. In other areas, cover was almost entirely annual/biennial exotic species. The main factors influencing species composition appeared to be soil source (on site or imported) and soil moisture. Exotic cover was very high in areas where on site soil was used and conditions were dry. Exotic cover was much lower in areas where imported soil was used and soil moisture was higher. Soil moisture generally related to surface elevation and even with as little as 0.5 feet of elevation change there was a noticeable transition from a predominance of exotic species to a predominance of seeded grasses.

- There was less evidence of out of bank flows observed in Phase 2 compared to Phase 1. This resulted in minimal expansion of woody vegetation installed in streambank treatments and streambank planting units. Woody vegetation expansion was only observed in areas connected to the main channel such as the oxbow wetland, secondary channel, and backwater area into the discontinuous wetland (planting unit sw07).
- Floodplain features designed to maximize floodplain connectivity functioned well. Both the constructed oxbow wetland and secondary channel were active during high flows in 2017. The diverse range of features at varying elevations constructed in the oxbow wetland allowed for rapid colonization and expansion of wetland herbaceous and woody riparian vegetation to occur. Flows entering the secondary channel resulted in mobilization and deposition of woody debris which increased aquatic habitat diversity and is providing microsites for woody and herbaceous wetland vegetation to establish. The large wetland area constructed on the secondary channel has high cover of willow seedlings and wetland plugs planted in this area have high survival and cover is increasing.
- Vegetative cover in irrigated hayfields was high. There was some evidence of slope erosion from irrigation which resulted in fine sediment deposition in the floodplain near planting unit om02b and om26 (Photo 4, *Attachment I, Phase 2 2017 Vegetation Miscellaneous Photographs*).

Table 13. Phase 1 2017 Vegetation QRA results and trends.

Metric	2017 QRA Results		Performance Trend
	Category	Percent of plots/transects in Category1	
Canopy cover woody vegetation on streambanks	Category 1 (> 40%) Category 2 (10 to 40%) Category 3 (<10%)	52% 38% 10%	Willow cover on streambanks is trending towards achieving the short-term performance target of 40% cover by Year 5. Over half of the constructed streambanks have already met the target.
Canopy cover of woody vegetation on floodplain	Category 1 (> 30%) Category 2 (10 to 30%) Category 3 (<10%)	7% 59% 34%	Low woody vegetation cover in the floodplain is expected in Year 1 and should increase significantly over the next several years.
Canopy cover of herbaceous vegetation on floodplain[1]	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (20 to 50%) Category 4 (<20%)	22% 35% 37% 7%	Only 7% of the area is not meeting the Year 1 target of 20% cover; however, high cover is attributed to exotic species in several areas on the west side of the floodplain. Species composition is a mix of native and exotic species.
Woody vegetation survival	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (<50%)	73% 23% 4%	Despite some areas with low survival, overall survival is high and meeting short-term performance targets.

[1]For purposes of the QRA, total canopy cover of herbaceous species is evaluated not just cover of native herbaceous species.

Streambank Woody Vegetation Cover

Woody vegetation cover was recorded for all streambanks in Phase 2. In 2017, 52% of streambanks had achieved the Year 5 performance target of greater than 40% cover of woody vegetation. A total of 38% of streambanks had cover between 10% and 40% and less than 10% had cover less than 10% woody vegetation cover. This is a positive trend for Year 1. There was less evidence of out of bank flow during high spring flows in 2017 in Phase 2 compared to Phase 1. Little expansion of streambank willows or natural recruitment of willows or cottonwoods was observed on streambanks. Ten cubic inch woody plants installed along streambanks had high survival although many were browsed.

Woody vegetation cover is highest on the following streambank treatments: preserve vegetation (PV), brush trench (BT), brush trenches associated with preserve vegetation (PV/BT), and brush trenches associated with point bars (PB/BT) and lateral bar (LB/BT). Woody cover was also high on double vegetated soil lift (DVSL) streambank treatments (average woody cover category score of 1.5, n=38). Woody vegetation cover was

lowest on Gap and Habitat streambank treatments. One wood matrix treatment was installed in Phase 2 where the constructed streambank transitions into an existing steep terrace. This streambank treatment (LOGANS MATRIX) also had very low woody vegetation cover likely due to the high elevation of the bank. Brush matrix (BM) streambank treatments had the most variable woody vegetation cover. The brush trenches installed with this treatment generally had high cover but re-sprouting of willows used in the brush matrix varied and influenced the overall cover category. Woody vegetation in streambanks was heavily browsed by deer in some areas but overall browse was moderate. Little beaver activity was observed in 2017. Beaver activity will likely increase over the next several years as willow cover continues to increase in the floodplain and along the streambanks. Photos in Attachment I (*Phase 2 2017 Streambank Woody Vegetation Cover Categories*) show examples of woody vegetation cover on streambanks.

Woody and herbaceous vegetation were colonizing constructed point bar surfaces. Some point bars, such as LB-07, LB-27, and LB-35 had high cover of willow seedlings that established from seed deposited during the recession of high spring flows in 2017. The point bar at bank treatment LB-35 had several cottonwood seedlings. Fine sediment deposition was observed on most point bars. Herbaceous vegetation cover was generally low on point bars but several species were observed including field mint, reed canarygrass and *Rumex* spp. Photos 1-3 in Attachment I (*Phase 2 2017 Vegetation Miscellaneous Photographs*) show typical conditions of point bars in Phase 2 in 2017.

Floodplain Woody Vegetation Cover

Woody vegetation cover was recorded for several planting units throughout Phase 2. In 2017, 7% of planting units met the 5 year target of 30% cover. Fifty nine percent of planting units were in Category 2 (10 to 30%) and 34% were in Category 3 (<10%). Low cover was expected in the first growing season after planting, especially in the absence of high flows inundating the floodplain. In areas where surface inundation did occur, woody vegetation cover was higher. These areas included: the oxbow wetland, the outlet of the disconnected wetland feature (planting unit sw07), the wetland along the secondary channel, and the confluence of the secondary channel with the main river channel (planting unit om30). Photos in Attachment I (*Phase 2 2017 Floodplain Woody Vegetation Cover Categories*) show examples of woody vegetation cover categories.

Planted Woody Vegetation Survival

Woody vegetation survival was recorded for several planting units throughout Phase 2. In 2017, 73% of planting units met the performance target of greater than 80% survival. Twenty three percent were in Category 2 (50 to 80%) and 4% were in Category 3 (<50%). In general, streambank planting units had high survival. Survival and woody vegetation cover generally increased in a downstream direction. Planted tree and shrub survival was lowest in planting units located furthest from the channel or in other dry areas.

Survival was noticeably low on the west side of the floodplain between planting unit wl01 and sb01. The only two units with <50% survival (Category 3) were recorded in this area. The wildlife planting unit (wl01), which had only dry sub-shrubs planted in it, and shrub wetland planting units (sw04 and sw05), had moderate survival. All swale features in this area had low survival and many had no living shrubs or trees. Low survival in this area can be attributed to the high elevation of the surface (leaving plants far from groundwater) and sandy well-drained soils. Further, with the exception of one large rain event in mid-June, moisture during the 2017 growing season was very low. This area has high cover of exotic species and given the low moisture and nutrient poor soils, it is possible competition with exotic species also contributed to low survival of planted shrubs and trees in this area.

Survival was highest in planting units inside the 8-ft wire fence (average survival category score 1.2, n=25) and protected by 48-inch wire fences (average survival category score 1.0, n=2). For planting units with both 8-ft wire fence and individual protectors the average survival category was 1.0 (n=8). The average survival category score for plants within the 8-ft net exclosure was 1.5 (n=13). Survival was lowest in units where no browse protection measures were installed (average survival category 2.0, n=3).

Survival of planted trees and shrubs was higher in swales in Year 1 in Phase 2 compared to Year 1 in Phase 1. After observing the high groundwater table (open water) and resulting poor survival of woody species planted in the bottom of several swales in Phase 1, swales were subsequently designed to be shallower in Phase 2 and Phases 5 and 6. In Phase 2, survival of plants installed in swales was higher and fewer swale bottoms were converting to cattails compared to Phase 1. Several swales had standing water during planting in fall 2016; therefore, only the side slopes were planted. Only a few of these swales had standing water in the bottom at the time the QRA. Further, several swales had a ring of dense willow seedlings near the bottom. The presence of willow seedlings was common in swales closer to the river channel. Photos 15-19 in Attachment I (*Phase 2 2017 Vegetation Miscellaneous Photographs*) show the condition of swales in Phase 2 in 2017.

The secondary channel island had high survival of woody vegetation. Planting unit om30, located at the downstream confluence of the secondary channel and the main river channel, was one of the few floodplain surfaces inundated by surface flows during high spring flows in Phase 2 in 2017. This resulted in significant natural expansion of woody vegetation planted in this area. This area had the highest woody vegetation cover observed at the Phase 2 site in 2017.

Windbreak planting units also had high survival. These units were designed to be shallower than swale features and support dense cover of trees and shrubs to provide a future windbreak and shade for livestock using this area in the future. All windbreak planting units had high survival, although plants appeared healthier in units on the west side of the river. Both wb03 and wb04 had ideal hydrology for shrub and tree growth

and the design dimensions of these features should be repeated in future designs. Unit wb01 receives irrigation return from the hayfield to the east of the railroad grade. This unit had slightly lower survival of planted woody vegetation compared to other windbreak units and it may be from prolonged inundation from irrigation return. The bottom of wb01 was planted with wetland herbaceous plugs in anticipation of the supplemented hydrology and these plants have high survival and growth. Photos 28-29 in Attachment I (*Phase 2 2017 Vegetation Miscellaneous Photographs*) show the condition of windbreak planting units in Phase 2 in 2017.

Meander core planting units in Phase 2 had variable survival. In general, these areas are high surfaces and the depth to ground water is likely greater than the rooting zone depth of the newly planted trees and shrubs. However, even if survival is low overall, surviving shrubs will expand rapidly in these areas if high flows inundate the surface and given their proximity to the channel it is likely this will occur in the relative near future.

Floodplain Herbaceous Vegetation Cover

Herbaceous cover was high in Phase 2 in 2017. To reduce the level of effort for the QRA, herbaceous cover in the floodplain was recorded by delineating areas of similar cover on aerial photographs of the site instead of recording cover by distance on established transects as described in the QRA protocols. This resulted in 21% of the floodplain mapped as Category 1 (>80% cover); 34% mapped as Category 2 (50-80%); 39% mapped as Category 3 (20-50%) and 4% percent mapped as Category 4 (<20% cover). The Year 1 performance target is for 20% cover over 80% of the floodplain area and nearly all of the floodplain has met this target. Photos in Attachment I (*Phase 2 2017 Floodplain Herbaceous Vegetation Cover Categories*) and photos 5-8 in Attachment I (*Phase 2 2017 Vegetation Miscellaneous Photographs*) show the various types of herbaceous vegetation cover in Phase 2 in 2017.

Although herbaceous cover was high overall, species composition varied greatly across the site. Many areas were dominated by seeded species. Some areas had high cover of seeded grasses, particularly slender wheatgrass, and low cover of forbs, both seeded and exotic (i.e. west floodplain from the upstream end of the project down to the start of planting unit om03 and east floodplain from om02c downstream to om08). Seeded forb cover also varied greatly, but in some areas seeded forbs, such as yarrow, dominated the cover (i.e. west floodplain from om03 downstream through om05 and the secondary channel island). The downstream end of the west floodplain (om15 to the downstream end of the Phase 2 site) had low total cover but species composition was mostly seeded grasses and forbs with low cover of exotic forb species. The same aster species observed in Phase 1 also had high cover in this portion of Phase 2. The east floodplain from om17 downstream to the end of the project site was similar, with low overall cover and a mix of seeded grasses, seeded forbs and exotic forb species. In general, herbaceous cover was lower in areas where microtopography and hand broadcast seeding were completed compared to areas where drill seeding was done. This same

trend was observed in Year 1 in Phase 1 but in 2017 there was no difference between areas seeded by hand compared to those seeded by drill. All hayfields within construction limits were irrigated in 2017 and had high cover of seeded species.

A few areas of the floodplain were dominated by exotic forb species such as sweet clover (*Melilotus officinalis*), tumble mustard (*Sisymbrium altissimum*), curly dock (*Rumex crispus*) and kochia (*Bassia scoparia*). Kochia cover was also high along the access road constructed along the downstream west edge of the site. The one seeded species consistently present in areas with high exotic forb cover was Rocky Mountain bee plant (*Cleome serrulata*). In areas where exotic forb species dominate, seeded grasses, such as slender wheatgrass and western wheatgrass, are present but plants were small and hard to see under the high cover of exotics. By far, the area with the highest cover of exotic species was the west floodplain starting near planting unit om07 and extending downstream to planting unit om11. The two main factors that appear to have contributed to dominance by exotic species over seeded species in these areas were: 1) source of vegetative backfill, and 2) moisture. Areas where clean soil adjacent to the project site was used had much higher exotic cover compared with areas where imported sub soil from Beck Borrow was used. Beck borrow soil is taken from the B and C horizons where few seeds are present. The on-site soil was taken from below the top 12 inches in areas that were frequently cultivated for hay production so the likelihood of a disturbance related seed bank was more likely. The on-site soil also has high sand content, which when used in higher elevation areas can create extremely dry conditions that favor exotic forbs over perennial grasses. The west floodplain area dominated by exotic species is higher in elevation than the rest of the constructed floodplain. This area was constructed at a higher elevation to accommodate the adjacent land owners request to re-build their property to the 10-year water surface return flow elevation. Similar to Phase 1, where imported sub-soil from Beck Borrow was used, salt precipitation on the surface was observed, particularly in areas that were saturated earlier in the year. Based on observations made in Phase 1 and other floodplain revegetation projects, if seeded species are present, even with low cover, and the surface is low enough to have high moisture for at least the first part of the growing season, cover of seeded species will increase in over time and become the dominant vegetation. In dry areas, that may not occur. Photos 11-14 in Attachment I (*Phase 2 2017 Vegetation Miscellaneous Photographs*) show the condition of west floodplain between planting unit om07 and om11 in Phase 2 in 2017.

Wetland conditions varied throughout the Phase 2 Project Site. In most wetland features, planted wetland vegetation had rapidly expanded or wetland vegetation had naturally established and most wetlands had herbaceous cover greater than 80% (Category 1). In some wetlands, such as the oxbow wetland and sw04, planted herbaceous wetland species were dominant. In other wetlands, such as sw02/ew01, wetland plants have developed a distinct zone of concentration near the bottom of the wetland but the bottom was dominated by naturally colonized cattails. Concentrated zonation of wetland species will continue to develop based on site hydrology in these

constructed wetlands over the next few years. Which species increase in cover and how far their zone expands will depend on site hydrology in the coming years. The oxbow wetland supported highly diverse conditions including emergent vegetation, shrub vegetation, open water, and gravels and cobbles where willows were naturally colonizing. The secondary channel wetland had high survival of herbaceous wetland plants and small woody plants, along with naturally recruited willows. Vegetation in this wetland is expected to expand rapidly and create diverse aquatic habitat for the Clark Fork River. Photos 20-27 in Attachment I (*Phase 2 2017 Vegetation Miscellaneous Photographs*) document wetland conditions in wetlands in 2017.

Although annual and biennial exotic species cover was very high in some areas of the Phase 2 site, noxious weed cover was low. Noxious weed species observed during the 2017 QRA included Canada thistle and perennial pepperweed. Only a few occurrences of each species were observed and cover was low. Reed canarygrass was not observed in any of the constructed wetland features, but was present on depositional features preserved along the channel (i.e. LB-35A).

Phase 1 2017 Vegetation Management Actions

The primary Phase 2 vegetation trend of concern was the poor survival and high cover of exotics in the west floodplain between wl01 and sb01. The combination of well-drained soils, high distance to groundwater, dry conditions in 2017 and possibly competition from exotic species had led to very low survival in this area. Management actions that increase woody vegetation cover in this area should be considered.

For vegetation, the following management actions were identified for Phase 2 in 2017.

- Repair 8-ft net exclosure fences.
- Continue selective control of noxious weeds and isolated patches of reed canarygrass.
- Implement adaptive management for the west floodplain problem area. This area should be observed earlier in the growing season (July) in 2018 to determine if the conditions observed during the QRA are still present. If conditions are the same, aggressive management actions such as discing or plowing and re-seeding the area may need to be considered. The sandy soils and high elevation of this area will make it difficult for woody vegetation to establish or for high flows to inundate and allow natural revegetation processes to occur.

No vegetation management actions were completed in 2017.

Phases 5 and 6

This section describes the results of the QRAs completed at the Phases 5 and 6 Project Site. QRA's were completed in Phases 5 and 6 in summer 2016 (Year 1), and late summer 2017 (Year 1 and 2). This section provides a summary of observations made for geomorphology and vegetation, recommended management actions resulting from each QRA, and management actions completed. Streambank construction was

completed in Phases 5 and 6 in winter 2015. Floodplain construction was completed in Phase 5 in winter 2015. Floodplain construction and all remaining construction activities were completed in Phase 6 in July, 2016. Revegetation activities were completed for most of Phase 5 in spring, 2016. Revegetation activities were completed for remaining areas of Phase 5 and all of Phase 6 in October, 2016. Attachment K provides the locations of streambank and revegetation treatments constructed in Phases 5 and 6. According to the QRA methods in the Monitoring Plan, the QRA is to be conducted using the effectiveness s monitoring layout as a guide. No effectiveness monitoring has been completed in Phases 5 and 6 therefore there was no effectiveness monitoring spatial data collection lay-out available to guide the QRA process. The QRA team evaluated all streambanks and floodplain areas within the Project Site and pre-selected several planting units representing a wide range of conditions to document woody vegetation survival and cover.

Geomorphology

Year 2016

This section describes the results of the geomorphology QRA completed at the Phases 5 and 6 Project Site in 2016. The 2016 geomorphic QRA field team included Karin Boyd (Applied Geomorphology), Joe Naughton (RESPEC), Karin Mainzhausen (CDM Smith), Larry Cawlfield (Tetra Tech), Jeff Dunn (RESPEC), Tom Mostad (NRDP) and Josh Robino (DEQ). The QRA took place on July 12, 2016. The 2016 QRA assessment focused on evaluating any changes in streambank or channel condition since the completion of construction, determining if additional geomorphic monitoring was necessary, and identifying any new management actions. The QRA included walking the entire length of channel in Phases 5 and 6. Visual observations and photographs were recorded during the site review and information was recorded on the *Channel Stability* form included as part of the QRA protocols and *Streambank Condition* form. At the end of the review, the QRA team assigned a score to each of the characteristics on the *Channel Stability* form and recorded an overall stability score to the Phases 5 and 6 Project Site. All streambanks with observable altered conditions since construction were noted. For streambanks with considerable altered conditions, the more detailed *Streambank Condition* form was used. No flows exceeded design bankfull in 2016 so the team concentrated on channel conditions, including channel stability and streambanks; therefore, no *Floodplain Connectivity* or *Secondary Channel and Floodplain Stability* forms were completed in 2016.

Table 14 provides an overall summary of the results of the 2016 Phases 5 and 6 geomorphic QRA. Detailed results of the assessment are provided in Attachment M. For 2016, supporting photographs were integrated into the following observation summary.

In 2016, the QRA assessment team identified the following geomorphic site trends in Phases 5 and 6. These trends are described in greater detail in the following sections:

- Floodplain stability and floodplain connectivity were not evaluated because no high flows had occurred prior to the QRA assessment.
- The channel stability assessment indicated a mildly aggradational trend.
- Toe scour on DVSL streambanks was observed in several locations and ice build-up was identified as one of the primary causes. No management actions were recommended but some future design considerations include: 1) integrating roughness into constructed streambank toes; 2) field verifying areas of local high shear stress; 3) identifying criteria that lead to ice build-up and integrating toe roughness and gradual toe slopes in these areas;
- Phases 5 and 6 is the first phase where brush matrix (BM) treatments were used extensively. Installation quality was highly variable and some of the main issues identified included: 1) lack of brush cover on the bank face; 2) poor viability of willows used as brush; and 3) uniform orientation of brush in the bank face. Future design considerations for brush matrix banks include: 1) increasing cover of brush; 2) considering ways to phase clearing and grubbing activities to increase viability of willows used in bank construction; 3) integrating live, dormant willow cuttings into the brush (rather than in a trench behind the brush); and 4) alternating the direction of placed brush to increase roughness.
- Results indicated that a QRA evaluation in 2017 will be important to evaluate streambank development and floodplain conditions in the event that overbank flows or ice events occur.
- Year-1 geomorphology and vegetation effectiveness monitoring were scheduled for 2017 in Phases 5 and 6 (the growing season following completion of all project work). QRA results indicated that additional monitoring and data collection beyond the planned scope of the Year 1 monitoring was not required. Effectiveness monitoring had not yet been completed in Phases 5 and 6 at the time of this report update.
- The QRA team reiterated that Year 1 QRA monitoring should take place in all phases regardless of flows to evaluate streambanks and channel stability. If flows have not exceeded bankfull or no significant ice event occurred since the last QRA, the annual QRA assessment could potentially be performed by boat or limited to spot observations.

Table 14. Phases 5 and 6 2016 QRA geomorphology results and trends.

Metric	2016 QRA Results		Performance Trend
	Category	Results	
Channel Stability	Category 1 (Likely degrading) Category 2 (Largely stable with potential aggradational/ degradational trend) Category 3 (Likely aggrading)	Category 2 – Largely Stable, with some indicators of fine sediment deposition in slackwater areas.	Geomorphically stable, with some localized deposition.
Floodplain and Secondary Channel Stability	Category 1 (Low risk/consequence of avulsion) Category 2 (Moderate risk/consequence of avulsion) Category 3 (High risk/consequence of avulsion) Category 4 (Avulsion has occurred)	No out of bank flows in spring 2016 so not assessed	No out of bank flows in spring 2016 so not assessed
Floodplain Connectivity	None	No out of bank flows in spring 2016 so not assessed	No out of bank flows in spring 2016 so not assessed
Streambank	None	Thirty nine streambank treatments were noted for continued observation regarding fabric condition, toe stability, and/or poor willow growth.	Uncertain – continued monitoring is recommended. No management actions are recommended at this time.

Channel Stability

The QRA stability rating reflected mildly aggradational conditions in Phases 5 and 6 based on fine sediment deposition within the channel. Fine deposition consisted of discrete fine grained bar deposits in slack water areas that are up to several inches thick (Figure 37). Additional fine grained deposition was also observed on point bars and within brush matrix bank treatments. These deposits were providing conditions that support colonization by both woody and non-woody vegetation.

There was no evidence of systemic coarse grained aggradation, and riffles show good mobility and general gradation variability. There was also no evidence of systemic degradation. Point bar morphologies show smooth transitions to the channel. Bank erosion tends to be concentrated on cut banks or high shear stress areas.


Figure 37. Left photo shows fine grained deposition in a slack water area along the channel and on a constructed point bar in right photo. Right photo also shows colonization of willows and herbaceous wetland vegetation.

Floodplain and Secondary Channel Stability

Floodplain stability was not evaluated due to a lack of overbank flows since construction.

Floodplain Connectivity

Floodplain connectivity was not evaluated due to a lack of overbank flows since construction. High water marks could be seen on point bars which supported the design criteria of minimal floodplain inundation under recent flow conditions. High water marks were indicated by fine sediment deposition and debris lines low on point bars (Figure 38).

Figure 38. Sediment deposition on point bar indicating high water line.

Streambank Condition

Phases 5 and 6 has numerous DVSL treatments that are hundreds of feet long. The QRA team discussed the risk of having such long continuous structures such as the potential for increased shear stress on the face of the bank. In a few banks, brush

matrix/gap treatments were used to create roughness and break up the continuous, smooth surface of these treatments. The team noted that it appeared that these intermittent brush matrix treatments were effectively breaking up the treatment by adding roughness and local habitat elements. Further discussions and evaluations after higher flows are needed to determine if this is a desired component to integrate into future designs.

There are several DVSL banks where more of the toe could be seen at low flows (between baseflow and bottom lift) compared to others (Figure 39). The general consensus by the QRA team was that although these banks appeared to be too high in elevation, this was just a result of more variability in lift heights in Phases 5 and 6 compared to Phase 1. Coir logs used to construct DVSL structures in Phases 5 and 6 were 9 to 13 inches in diameter whereas coir logs used in Phase 1 DVSL structures were closer to the specified 12 inch diameter. Follow up discussions with the full QRA team brought up the topic that at some point further downstream in Reach A it is likely that the height between base flow and design Q2 will exceed 2 feet (the height of 2, 12-inch coir logs). Amy Sacry with Geum indicated that at the Milltown Dam restoration site that was the case and the bottom lift was constructed using a 16-inch soil lift to increase the bank height and eliminate the need for a third lift.

Localized scour of both constructed and native toe material was observed on several DVSL structures. Ice scour appeared to be a significant factor contributing to toe scour in Phases 5 and 6. In general, if a bank was constructed at a pool with an overhang or ledge with a steep drop off, the overhang scoured and the soil lifts slumped. This happened in areas of both native and imported toe and the angle of the toe seemed to be one of the main contributing factors. If the toe was at a steep angle then the ice froze to it and was able to pull the material away during melt/water level changes. It appeared that reaches with a flatter/lower gradient and north facing banks were at a higher risk for ice scour of toe material. In Phases 5 and 6 ice build-up started with cold temperatures at the Whalen ditch diversion where it backed the water up and allowed the water to freeze. The ice formation was then followed by a change in flow elevation which caused the fabric in the DVSL lifts to rip or the lifts to slide or slump off the toe. In Phase 1, the toe scour mechanism did not appear to be ice. Ice build up may be less common in Phase 1 due to the influence of Warm Springs Ponds on winter water temperatures. The influence of ice on constructed banks is likely to increase in a downstream direction.

The QRA team agreed that roughness in the toe could likely prevent many of the toe scour issues caused by ice build-up and discussed factors that would determine where incorporating toe roughness might be appropriate (or necessary). The general consensus was that integrating toe roughness should be decided based on field and local hydraulic conditions. Similar to Phase 1, toe erosion issues seem to be in localized, high energy areas that the HEC RAS model doesn't always identify, such as:

eddies, high angle intersections; split flow areas; and east/west meanders that increase the amount of north facing bank.

The QRA team noted that a winter streambank walk could help identify these ice risk areas and that it may be worth doing a sensitivity analysis to see how that toe bench affects channel flow.

The QRA team observed some issues at specific streambank treatment locations. A log was kept of all banks that appeared to have changed since construction, which included fabric tears, slumping DVSLs, and little evidence of active growth in brush matrix banks. A detailed bank condition form was filled out at one bank where conditions were significantly different and provided some insight for future design (LB-46).

Streambank LB-46-DVSL (DVSL): This structure was constructed on the downstream end of a long meander bend. The treatment showed substantial localized toe loss, particularly where the structure was built on an existing clay shelf along a deep hole (Figure 39). The toe material and soil lifts froze and due to the weight of the ice both the toe material and lifts cantilevered into the channel. The coir fabric was still in good condition. Willow survival and growth was moderate (the bank appeared to have been constructed with short, small willow cuttings due to their small dimeter and little projection beyond the bank and no sign of browse). Because only a short section of streambank was affected and willows were surviving and expected to grow, no management action was recommended. Important considerations for future designs based on observations of this streambank include: 1) if there is a deep pool where a clay layer/shelf is present, a brush matrix should be built instead of soil lifts to create roughness and prevent ice build-up on the bank (toe scour from ice was not observed at any of the brush matrix treatment sites); and 2) make sure willow cuttings are in good condition and of specified length, particularly in areas where high shear stresses are anticipated.

Figure 39. Phases 5 and 6 LB-46-DVSL toe loss and structure slumping (left photo) and streambank that appeared to be installed higher than Q2 (right photo).

Brush matrix treatments (referred to as Gap treatments in Phases 5 and 6) were installed for the first time in Phases 5 and 6. The installation of these treatments varied greatly. The brush material for these treatments came from vegetation cleared from the floodplain prior to sediment removal. This material was primarily birch and willows. Cleared woody vegetation sat in stockpiles near work zones for several months prior to use in streambanks. In some areas, the willows used as brush had remained viable and was observed to be actively growing. In most brush matrix banks, however, the brush material was no longer viable and no living material was left. The density of brush also varied greatly between treated banks. Some banks had almost complete coverage of woody material while others had only 50% coverage (Figure 40). This appeared to be a result of the type of material available for use at each site (i.e. if whole shrubs were available v. individual branches). In some areas sloughing and scour of bank material (alluvium) was observed, particularly where woody material coverage was lower. All brush matrix treatments were constructed on native toe material due to the passive locations selected for their use and little scour of toe material was observed. Some scour was observed at the upstream end of these structures where they transitioned to another type of treatment, typically a DVSL structure. No evidence of ice build-up or scour was observed on these structures. Jeremy Mickey with Princeton Planning and Project Management, the primary floodplain oversight contractor, noted that these structures seemed to prevent the build-up of ice and that similar locations on the river where other structures types were installed had issues with ice build up when these structures did not.

Fine sediment deposition within the placed brush was a common observation and in some areas this sediment was being colonized by herbaceous and woody vegetation. Red sands were observed in some areas and there appeared to be some association between the presence of red staining of the sand and poorer willow survival. Test pit data indicates high non-ferrous metals (COCs) in these areas.

All brush matrix/gap treatments had a brush trench installed at the back edge where living, dormant willow cuttings were installed. Overall, survival and growth of willows installed in these trenches was high. Where willow cutting trenches were close to the bank, the likelihood of woody vegetation colonization in the bank and brush is likely to occur faster.

Based on these observations, future design considerations for brush matrix structures included:

- Prioritize cleared and grubbed material to be used in these banks (i.e. ensure that these structures get entire shrubs whenever possible).
- If possible wait to do clearing and grubbing closer to sediment removal and bank construction in a particular area. This would increase the potential for the availability of viable material for use in bank treatments.
- Integrate living material into the brush. This can be done by placing the dormant willow cuttings in the brush rather than in a trench set behind the brush.

- Although no toe erosion was observed on these structures, consider installing a cobble toe in areas where shear stresses may be high or where this treatment transitions to another type of treatment such as a DVSL.
- Consider back-filling the structure with Type A material (alluvium mixed with vegetative backfill) to increase the potential for vegetative cover behind the brush.
- Ensure that brush is oriented in several directions (compared to all being oriented upstream or downstream) to maximize roughness and increase wood coverage of the bank.
- Consider a pilot treatment to improve construction techniques that will increase woody material density, vary brush orientation and incorporate, more living material in face, etc.

Figure 40. Left photo of brush matrix (gap) treatment with some viable brush material and right photo showing a brush matrix treatment with no viable brush material.

Phases 5 and 6 2016 Geomorphology Management Actions

No management actions were identified in Phases 5 and 6 in July 2016. The QRA team decided that the DVSL structures with toe erosion were only occurring locally and low risk to overall stability. These treatments should continue to be observed.

Year 2017

This section describes the results of the geomorphology QRA completed at the Phases 5 and 6 Project Site in 2017. The 2017 geomorphic QRA field team included Karin Boyd (Applied Geomorphology), and Karin Mainzhausen (CDM Smith). Ben Quiñones (Montana DEQ) also participated. The QRA took place on September 12, 2017. The 2017 QRA assessment focused on evaluating any changes in streambank or channel condition since the completion of construction and after spring 2017 out of bank flow and identifying any new management actions. The QRA included walking the entire length of channel in Phases 5 and 6. Visual observations and photographs were recorded during the site review and information was recorded on the *Channel Stability*

form and *Streambank Condition* form included as part of QRA protocols. At the end of the review, the QRA teamed assigned a score to each of the characteristics on the *Channel Stability* form and recorded an overall stability score to the Phases 5 and 6 Project Site. All streambanks with observable altered conditions since construction were noted. For streambanks with considerable altered conditions, the more detailed *Streambank Condition* form was used. Flows exceeded design bankfull in 2017 also completed the *Floodplain Connectivity* or *Secondary Channel and Floodplain Stability* forms in 2017.

Table 15 provides an overall summary of the results of the 2017 Phases 5 and 6 geomorphic QRA. Detailed results of the assessment are provided in Attachment M. Supporting photographs are compiled in Attachment L.

In 2017, the QRA assessment team identified the following geomorphic site trends in Phases 5 and 6. These trends are described in greater detail in the following sections:

- The channel stability assessment indicated a geomorphically stable condition trend.
- Floodplain inundation indicators were notably rare in Phases 5 and 6 considering the magnitude of 2017 spring flows. This should be of considered in relation to both bankfull design hydrologic calculations as well as bank construction techniques that may inadvertently expand the channel cross section during implementation.
- Numerous brush matrix banks that had been previously identified as having no to poor willow sprouting now show substantial or even robust expansion of willows.

Table 15. Phases 5 and 6 2016 QRA geomorphology results and trends.

Metric	2016 QRA Results		Performance Trend
	Category	Results	
Channel Stability	Category 1 (Likely degrading) Category 2 (Largely stable with potential aggradational/ degradational trend) Category 3 (Likely aggrading)	Category 2: Largely Stable (avg score 3.2).	Geomorphically stable, with some localized deposition.
Floodplain and Secondary Channel Stability	Category 1 (Low risk/consequence of avulsion) Category 2 (Moderate risk/consequence of avulsion) Category 3 (High risk/consequence of avulsion) Category 4 (Avulsion has occurred)	No floodplain channels creating elevated avulsion risk beyond Category 1.	No floodplain channels are present that pose a high avulsion risk.
Floodplain Connectivity	None	Variable evidence of floodplain inundation with high water marks, wood mobilization and fine sediment deposition.	Floodplain inundation indicators were less robust than expected—results provided to design engineers.
Streambank	None	Notably increased growth in brush matrix treatments.	Uncertain – continued monitoring is recommended for three specific banks. No management actions are recommended at this time.

Channel Stability

Channel stability trends identified in 2017 indicated no evidence of systemic instability through either aggradation or degradation. Performance targets were being met.

Floodplain and Secondary Channel Stability

Floodplain stability trends identified by the QRA team in 2017 indicated that the channel is trending towards meeting project goals and objectives and performance target values. Although overbank flows occurred in 2017, there was no evidence of rill formation or increase in near-term avulsion risk.

Floodplain Connectivity

Floodplain stability trends identified by the QRA team in 2017 indicated that floodplain connectivity was less than that anticipated. Although there was evidence of some floodplain overflow through wood reworking, and there were locally high water marks on the floodplain surface that reached 1.4 feet in depth, these indicators were concentrated in the upstream portion of Phases 5 and 6, and they were much more localized than in other phases. Discussions regarding these observations included the following:

- The potential for overly conservative design bankfull (2-year) calculations due to the non-synchronous nature of CFR flows and Lost Creek/Modesty Creek tributary inflows. Field observations indicate that Lost Creek and Modesty Creek flows typically do not contribute substantially to CFR flows during spring runoff, hence their inputs may be overestimated.
- The potential for overly conservative design bankfull (2-year) calculations due to irrigation withdrawals.
- The potential that construction of a toe for streambank treatments is increasing channel cross sectional area and resulting in less out of bank flows. In some cases, DVSLs were set back on the toe to create a bench at the bank toe that was up to several feet wide. These in-field cross section modifications were not necessarily incorporated into the hydraulic model which may result in an oversized cross section.

Streambank Condition

Three DVSL streambank treatments in Phases 5 and 6 were identified as having slumping. These included RB-14, RB-17 and LB-46E. These streambanks should continue to be monitored. No streambanks were recorded for detailed structural issues.

The 2016 QRA in Phases 5 and 6 included the identification of 28 brush matrix treatments that had little to no living material (i.e. growth of willows placed in the matrix). The 2017 QRA showed that 12 of the banks identified in 2016 now have willow growth and sometimes vigorous sprouting of willows in the cores of the treatments. The remaining treatments were tagged for continued monitoring.

Phases 5 and 6 2017 Geomorphology Management Actions

No geomorphology management actions were recommended for the Phases 5 and 6 Project Site in 2017 other than continued monitoring of select streambank treatments.

Vegetation

Year 2016

This section describes the results of the vegetation QRA completed at the Phases 5 and 6 Project Site in 2016. The 2016 vegetation QRA field team included Amy Sacry (Geum), Karissa Ramstead (Geum), Marisa Sowles (Geum), Mark Traxler (RESPEC), and Brian Bartkowiak (DEQ). The QRA took place on July 12, 2016. At the time of the 2016 QRA, floodplain revegetation activities had only been completed in Phase 5 and one work zone in Phase 6. Seeding had been completed in some additional Phase 6 work zones at the time of the QRA. Revegetation was not completed until the last week of August, 2016 for wetland planting and October, 2016 for woody shrub and tree planting in Phase 6. Therefore, the vegetation QRA focused on streambanks in both Phases 5 and 6 and planting areas and floodplains in Phase 5. Woody streambank cover was recorded for all treated streambanks. Several planting units were pre-

selected to collect woody vegetation survival and woody vegetation cover data. No herbaceous floodplain cover data was collected in 2016. Table 16 provides an overall summary of the results of the 2016 Phases 5 and 6 vegetation QRA. The 2016 QRA assessment focused on testing and evaluating QRA procedures to determine if additional monitoring was necessary, and identify any new management actions. Detailed results of the assessment are provided in Attachment O. Supporting photos taken during the 2016 vegetation QRA are provided in Attachment N.

In 2016, the QRA assessment team identified the following vegetation site trends in Phases 5 and 6. These trends are described in greater detail in following sections:

- Deer browse was much lower in Phases 5 and 6 compared to Phase 1 which may be a result of on-going construction activities, less cover available within and adjacent to the new floodplain, and not using alfalfa in the seed mixes.
- Annual exotic species cover was much higher in Phases 5 and 6 compared to Phase 1. This is likely a result of using on-site vegetative backfill sources compared to all sub-soil from the Beck borrow source.
- Woody vegetation survival was high overall with dry conditions and beaver predation being one of the main factors affecting survival.
- Wetlands were developing as expected but waterfowl predation on planted herbaceous wetland plants was high in borrow ponds with a large amount of open water.
- The QRA team reiterated that for vegetation, Year 1 and Year 2 QRA monitoring should always take place in all phases because a dramatic change can occur early during establishment of seeded and planted species, and this is the period when maintenance actions would most likely be required and effective. If at Year 3 vegetation establishment seems adequate, the QRA for vegetation could become less frequent to allow vegetation time to establish. Similar to geomorphology, QRA should occur after any significant high flow or severe drought occurs.

Table 16. Phases 5 and 6 2016 Vegetation QRA results and trends.

Metric	2016 QRA Results		Performance Trend
	Category	Percent of Plots/Transects in Category	
Canopy cover woody vegetation on streambanks	Category 1 (> 40%) Category 2 (10 to 40%) Category 3 (<10%)	42% 48% 10%	Many banks already meet the Year 5 short term performance target of 40% cover and only 10% were at risk of not meeting the target.
Canopy cover of woody vegetation on floodplain	Category 1 (> 30%) Category 2 (10 to 30%) Category 3 (<10%)	0% 11% 89%	Most plants were installed in fall 2015/Spring 2016 and are in the first growing season so low cover is expected.
Canopy cover of herbaceous vegetation[1]	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (20-50%) Category 4 (<20%)	No data collected	Herbaceous vegetation cover varies throughout the floodplain but most areas meet the >20% cover target for year 1 – exotic species cover is high in some areas. Based on visual observations most areas are likely in Category 2 and 3, few areas are Category 1.
Woody vegetation survival	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (<50%)	71% 25% 4%	Most of the observed planting units meet the 80% survival performance target for year 1.

[1] For purposes of the QRA, total canopy cover of herbaceous species is evaluated not just cover of native herbaceous species.

Streambank Woody Vegetation Cover

Willow cover in Phases 5 and 6 was much higher compared with streambanks in Phase 1 (Figure 42) and 42% of streambanks had already met the 5 year woody vegetation cover target of 40% (Category 1). Another 48% of streambanks were in Category 2 (10% to 40%) and are trending towards meeting the 5 year target. Only 10% of treated streambanks had less than 10% woody vegetation cover. Several of the Category 3 streambanks are gap treatments or brush trenches installed in short sections of preserve vegetation (PV) banks (Figure 41). There was no other obvious difference in cover between streambank treatment types.

Some of the DVSL structures that were installed late in 2015 (June-July) had low willow cover in summer 2015. For this reason, supplemental brush trenches were installed behind the lifts in the fall of 2015 to increase willow cover. Willow survival and growth in these supplemental trenches was good in 2016 based on observations made during the QRA. Further, observations made during the 2016 QRA showed that the growth of

willow cuttings installed in the DVSL structure itself had also increased between 2015 and 2016. To evaluate whether the low initial cover was a result of the timing of installation, the streambank woody cover data collected in 2016 was compared to installation data and mean temperature at time of installation. There was no strong trend observed with this analysis, but there was some indication that both installation date and temperature at time of installation may affect year 1 willow growth. Most of the streambanks in the lowest cover class (Category 3, <10%) during the 2016 QRA were constructed in June or later. Although some of the streambanks constructed in July did have cover high enough to be in Category 1 (>40%) or 2 (10-40%). The lowest cover occurred on DVSL structures that were installed when the maximum daily temperature was greater than 75° F and there was a mean maximum daily temperature for the week of installation greater than 60° F.

Species composition of willows in streambanks was a mix of Booth's willow (*Salix boothii*) and sandbar willow (*Salix exigua*) compared with primarily sandbar willow in Phase 1. Although a mix of species is preferred, deer browse was higher on streambanks in Phases 5 and 6 and browse was higher on Booth's willow compared to sandbar willow.

The small (10 cubic inch) woody plants installed in streambanks had high overall survival and better growth compared to Phase 1. This may be a result of spring vs. fall installation for these plants. Because of the low cost of 10 cubic inch plants and easy installation, supplemental planting behind streambanks with low survival of dormant willow cuttings may be a good option.

Survival of dormant willow cuttings installed in trenches at the back edge of brush matrix/gap treatments was high (Figure 42). Further, some of the brush used in the brush treatment had sprouted and grew, although this was only observed in a few locations. Much of the brush material used to build these banks sat on site for several months prior to use so it was not surprising that overall viability was low. Some localized scour/erosion of the alluvium placed in these banks was observed, particularly where woody brush cover is low. Fine sediment deposition was common at the toe of the brush matrix/gap treatments and both woody and herbaceous vegetation was observed growing in the deposited sediment (Figure 42).

Similar to the geomorphology QRA team, the vegetation team observed localized toe erosion in several locations and concluded it was primarily from ice scour in areas of high shear stress. Although there was localized slumping of DVSL structures in these areas, survival of willow cuttings was high and cover is increasing. The team concluded the slumping was a short-term risk unless a very high flow event occurs during the vegetation establishment period (5 years).

Figure 41. Streambank treatment with low woody vegetation cover (Category 3). Photo is of preserve vegetation treatment LB-34A which has high cover of herbaceous vegetation but low cover of woody vegetation in the short sections of this bank where gap treatments were installed.

Figure 42. Left photo is of brush matrix/gap treatment RB-6B showing recruitment of herbaceous wetland vegetation in fine sediment deposited within the placed brush. Right photo is of RB-35-DVSL with good growth of dormant willow cuttings.

Floodplain Woody Vegetation Cover

None of the planting units had met the 5 year performance target of 30% woody vegetation cover in 2016. Most of the plants were in their first growing seasons so low overall cover was not a concern. Most observed planting units (89%) were in the lowest woody vegetation cover category (Category 3, <10%) (Figure 43). Survival of woody plants however was lower than expected which may affect meeting the five year performance target.

Woody Containerized Planting Survival

Most (71%) of the observed planting units were in Category 1 (>80%) for survival of planted trees and shrubs. Beaver browse, dry conditions, and perennial standing water in swales were the main factors contributing to lower survival in some areas. Dry conditions and beaver browse appeared to be the two most significant factors. Beaver

activity was sporadic and concentrated in a few areas. In these areas, beaver browse occurred within 15 feet of channel. Some plants had been completely up-rooted indicating browse occurred immediately after installation (Figure 44). Areas of high beaver activity were noted on QRA maps. In future phases, pre-construction beaver activity should be evaluated to identify where post-planting issues with beaver may arise. Deer browse was minimal in Phases 5 and 6 despite the wildlife exclusion not being complete at the time of the QRA. This may have been due to the on-going construction in this phase. Swales generally had low survival in the bottom due to the presence of standing water. In future phases, swale design criteria should be revised to reduce the potential for prolonged standing water (see criteria described for Phase 1).

Some work zones were much drier than others. In two work zones in particular, RWZ6E and RWZ4E, the water surface elevation was lower than the toe of the DVSL structures compared to upstream and downstream areas. This may be the result of a gradient shift or groundwater changes, but it may reflect a lower groundwater table through these areas. In these work zones, survival of shrubs planted in swales was high but survival of shrubs and trees planted in outer bank planting areas and 10T Floodplain 'X' planting areas was lower. The opposite was true in other work zones where swales were too wet and survival in streambank planting units was higher. Further, in RWZ4W, to minimize the risk of avulsion, the meander core was elevated and cobble was incorporated into the soil placed on the surface. This planting unit had the lowest survival observed in Phases 5 and 6 in 2016. Drier areas were noted on forms and maps during the QRA. In general the 10 cubic inch floodplain planting areas (Floodplain 'X' plots) had good survival on wetter inside meander bends and poor survival on drier inside meander bends. This should be taken into consideration in future planting efforts.



Figure 43. Top left photo shows planting unit OM15 in RWZ4W where survival appeared to be the lowest and beaver activity was high. Top right photo shows planting unit OM43 where survival was high. Bottom photo shows higher cover in drill seeded (left side of photo) compared to hand broadcast seeded (right side of photo).


Figure 44. Left photo of plant pulled out of the ground by beaver shortly after installation. Right photo of soil settling exposing roots and leading to desiccation of shrub stem.

Floodplain Herbaceous Vegetation Cover

In Phase 5, cover of seeded herbaceous species was high. Cover varied between work zones with some areas having higher cover of annual exotic species and others having higher cover of seeded species (Figure 45). This appeared to be related to the use of on-site vegetative borrow in some work zones that likely had a greater content of exotic species seed compared with the imported Beck Borrow sub soil which has little residual seedbank. The main exotic species observed during the 2016 QRA included: *Rumex* spp, kochia, pennycress (*Thlaspi arvense*), mustard (*Sisymbrium* sp.), thistle (*Cirsium* sp.), redtop (*Agrostis gigantea*) and alfalfa (*Medicago sativa*) (not included in the seed mix for Phases 5 and 6). Herbaceous floodplain cover was dominated by annuals, primarily Rocky Mountain bee plant (*Cleome serrulata*) (Figure 45). However, numerous grasses were establishing under the bee plant, which functions as a nurse crop to limit noxious weed and exotic species invasion and provide conditions for perennial grasses to establish. Several concerns were raised about the dominance of Rocky Mountain bee plant in the floodplain because it is poor forage for cattle. Outreach was done to inform landowners that the purpose of the species is as a nurse crop to help establish grasses and that it would not persist beyond the first year (Phase 1 also had dense cover in year 1 and it is no longer present there). Other seeded species observed growing in the Phase 6 floodplain included: yarrow, blue flax, triticale (sterile wheatgrass), and several wheatgrasses that were too small to identify.

In Phase 6, cover of seeded species was lower. Most of the work zones in Phase 6 were drill seeded in late June 2016. These areas were seeded prior to implementing floodplain roughness and woody debris. In many areas, seed had already germinated by the time floodplain roughness was completed so young seedlings were uprooted. This led to low cover and the need to re-seed all of these areas in fall 2016. Some natural recruitment of desirable forb species that were not seeded, such as paintbrush (*Castilleja occidentalis*) and fireweed (*Chamaenerion angustifolium*), was observed in 2016.

Wetlands in Phase 5 were developing as expected. All wetlands had perennial standing water in some portion of the wetland that maintained shallow depths late in the growing season (Figure 46). Some areas were being colonized naturally by cattails. Survival of planted wetland herbaceous plants was high. Wetland herbaceous plants had not expanded much since planting, but they typically expand rapidly during the second growing season after planting if hydrology is appropriate. In most Phase 5 wetlands, the emergent zone appears to be much smaller compared to Phase 1 wetlands. This may be due to the fact that wetlands are generally further from the channel and there are no major groundwater sources like Warm Springs Creek and Warm Springs Ponds like there is in Phase 1. Criteria used to design wetlands in future phases should continue to focus on maximizing the emergent wetland zone. Similar to swales, woody shrubs planted at a lower elevation in wetland features had lower survival.

Figure 45. Photos of Rocky Mountain bee plant dominating seeded floodplain areas in Phase 5.

The Phase 5 borrow ponds were much deeper than other wetlands at the site with a large area of open water in each pond. The pond fringes were planted with wetland herbaceous plants and containerized shrubs and trees. Because of the large amount of open water, the ponds attract migratory waterfowl, particularly Canada geese, which resulted in substantial browse on planted herbaceous wetland vegetation. Attempts were made to reduce predation by installing wooden stakes and stringing coir twine between the stakes. Most of the coir twine fell down within a few weeks of installation and only provided moderate protection. This technique can be effective if installed correctly. For future phases, planting around large open water features should be minimized unless effective measures to prevent goose and duck predation can be implemented. In Phase 1, woody debris appeared to have prevented goose and duck use of constructed wetlands, but the wetlands and open water portion of the wetlands was much smaller compared to the Phases 5 and 6 borrow ponds. Woody debris was placed around the Phase 6 borrow ponds but predation on wetland plants was still high.

In Phases 5 and 6 several areas along the channel were preserved because they had diverse, native wetland vegetation. These areas were left in place to provide habitat and seed sources for colonization of constructed point bars. All of these preserved features continued to support diverse wetland vegetation in 2016 (Figure 47).

Phase 5 and 6 2016 Vegetation Management Actions

Although several vegetation related issues were identified in Phases 5 and 6, overall the floodplain seeding and planting was establishing as expected for the first year post construction. Only a small number of browse protectors were installed and the few that required repair were fixed during the QRA site visit.

Figure 46. Left photo of wetland SW01 on east side of channel and right photo of wetland planting unit SW04B, which is part of the Phase 5 borrow pond on the west side of the channel.

Figure 47. Preserved wetland vegetation along the channel in Phases 5 and 6 is expanding and colonizing constructed point bars downstream.

Year 2017

This section describes the results of the vegetation QRA completed at the Phases 5 and 6 Project Site in 2017. The 2017 vegetation QRA field team included Amy Sacry (Geum) and Marisa Sowles (Geum). Other participants included Ben Quiñones (DEQ). The QRA took place on September 12, 2017. Revegetation was completed in August, 2016 for wetland planting and October, 2016 for woody shrub and tree planting in Phase 6. Phase 5 revegetation was completed in fall 2015 and spring 2016. A QRA was completed in Phases 5 and 6 in 2016 that assessed areas complete at the time. The 2017 QRA focused on documenting vegetation trends in Phases 5 and 6, determining if additional monitoring was necessary, or if any management actions were needed. Effectiveness monitoring was completed in Phases 5 and 6 in 2017 but the spatial layout was not available prior to conducting the QRA so several planting units were pre-selected in 2016 and additional units added in 2017 to collect woody

vegetation survival and woody vegetation cover data. The 2017 vegetation QRA re-evaluated planting units assessed in 2016, added new units for Phase 6, mapped vegetative cover and dominant species occurring in the floodplain, and recorded woody cover on streambanks in both Phases 5 and 6. The 2017 QRA included walking the entire length of the channel in Phase 2 to record woody vegetation cover at each streambank on the *Streambank Canopy Cover* form. Streambank woody vegetation cover was recorded by the 2017 geomorphology QRA field team. Survival was recorded using the *Survival* form and woody vegetation cover was recorded using the *Floodplain Woody Vegetation* form. Herbaceous floodplain cover was recorded by delineating areas with similar herbaceous vegetation cover on aerial photos while in the field. For each area, the average cover of herbaceous vegetation and dominant species were recorded. No *Floodplain Herbaceous Vegetation* forms were completed in 2017. Visual observations, photographs and potential management actions were also recorded during the assessment. An overall rating was assigned to each vegetation metric using the collected data. Table 17 provides an overall summary of the results of the 2017 Phases 5 and 6 vegetation QRA. Detailed results of the assessment are provided in Attachment O. Supporting photos taken during the 2017 vegetation QRA are provided in Attachment N.

In 2017, the QRA assessment team identified the following vegetation site trends in Phases 5 and 6. These trends are described in greater detail in following sections:

- Woody vegetation cover on streambanks continued to increase.
- Plants installed in 2016 met the Year 1 survival performance target of greater than 80% survival. However, survival for plants installed in 2015 had decreased since 2016. Survival was lowest in planting units at high elevations relative to the river channel, including meander core and terrace planting units. The 2017 drought conditions combined with the high elevation of some planting units resulted in little groundwater contact with plants and a decrease in survival.
- Despite a decrease in survival, woody vegetation cover overall was increasing in most planting units as surviving shrubs and trees continued to grow and expand. Natural expansion of planted willows was much lower in Phases 5 and 6 compared to Phase 1 due to the lack of high flows inundating floodplain surfaces.
- Herbaceous cover increased; however, many areas had high cover of exotic species. High elevation areas where conditions were driest had the highest cover of exotic species. Lower elevation floodplain surfaces with higher moisture had the highest cover of seeded species.
- There are several locations where deer can enter the 8-ft wire fence. The number of deer entering the fenced area were not high enough to affect establishing woody vegetation, but deer were having problems leaving the fenced area once they entered it.

Table 17. Phases 5 and 6 2017 Vegetation QRA results and trends.

Metric	2017 QRA Results		Performance Trend
	Category	Percent of Plots/Transects in Category[1]	
Canopy cover woody vegetation on streambanks	Category 1 (> 40%) Category 2 (10 to 40%) Category 3 (<10%)	75% (42%) 23% (48%) 2% (10%)	Willows in streambanks continue to increase in cover.
Canopy cover of woody vegetation on floodplain	Category 1 (> 30%) Category 2 (10 to 30%) Category 3 (<10%)	2% (0%) 49% (11%) 49% (89%)	Canopy cover of woody vegetation continues to increase as surviving plants grow and expand; units with very low survival continue to have low woody vegetation cover.
Canopy cover of herbaceous vegetation[2, 4]	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (20-50%) Category 4 (<20%)	17% 60% 23% 1%	Herbaceous cover is high, however exotic species cover is also high in some areas.
Woody vegetation survival	Category 1 (> 80%) Category 2 (50 to 80%) Category 3 (<50%)	74%[3], 57% (71%) 10%[3], 22% (25%) 16%[3], 21% (4%)	Overall decrease in survival, particularly in higher elevation planting units where dry conditions were a factor.

[1] The value provided in () is the 2016 value included for comparison.
[2] No data collected in 2016.
[3] The first number reports survival of planting units planted in 2016 (Year 1 for those units). The second number is for all planting units evaluated, including those planted in 2015 (Year 2) and 2016.
[4] For purposes of the QRA, total canopy cover of herbaceous species is evaluated not just cover of native herbaceous species.

Streambank Woody Vegetation Cover

Woody vegetation cover was recorded for all streambanks in Phases 5 and 6. In 2017, 75% of streambanks had achieved the Year 5 performance target of greater than 40% cover of woody vegetation. A total of 23% of streambanks had cover between 10% and 40% and less than 2% had less than 10% woody vegetation cover. Only two streambanks were recorded as Category 3 (<10% cover): LB-46E-DVSL on the left bank and RB-13B-GAP on the right bank. This indicates an increase in woody vegetation cover in streambanks from 2016 and a positive trend in streambank woody vegetation cover. Woody vegetation cover is expected to increase greatly over the next

few years. There was less evidence of out of bank flow in 2017 in Phases 5 and 6 compared to Phase 1 and Phase 2. Little expansion of streambank willows was observed. Some natural recruitment of willows and cottonwoods was observed on streambanks. More willow seedlings were present on streambanks at the upstream end of the site compared with the downstream end of the site. The ten cubic inch woody plants planted along streambanks continued to have high survival although plants are still small despite little sign that they were being browsed.

Woody vegetation cover was highest on preserve vegetation (PS) streambanks, including PS banks with brush trenches (PS/BT) (average woody cover category score of 1.0, n=78). Woody vegetation cover was also high on brush trench (BT) and gap with brush trench (GAP/BT treatments, referred to as Brush Matrix, BM, in Phase 2) streambank treatments. Brush trenches had an average woody cover category score of 1.07 (n=34). GAP/BT treatments had an average woody cover category score of 1.1 (n=30). Woody cover was also high on double vegetated soil lift (DVSL) streambank treatments (average woody cover category score of 1.35, n=52). Woody vegetation cover was lowest on Gap treatments (average woody cover category score of 1.7, n=27). Very few signs of beaver activity were observed in 2017 despite numerous signs during construction and in 2016. It is uncertain why beaver activity was less in 2017, but beaver activity will likely increase over the next several years as willow cover continues to increase in the floodplain and along the streambanks. The GAP/BT streambanks continued to collect fine sediment along the toe of the treatment. The sediment was being colonized by sedges, mint and sometimes willows. Sprouting of willows used in the GAP/BT treatments varied greatly and remained low overall, although more willow sprouting was observed in 2017 compared to 2016. Redtop was also observed colonizing several streambanks that are close to areas of existing vegetation. Photos in Attachment N (*Phases 5 and 6 2017 Streambank Woody Vegetation Cover Categories*) show examples of woody vegetation cover on streambanks.

Point bars continued to recruit sediment and vegetation in 2017. Cover of willow seedlings appeared to have increased in 2017. It is unclear if these seedlings were recruited in 2016 or 2017 but both years had flows that covered point bar surfaces timed closely with the seed release window. Clear zonation of willow colonization was observed in several areas and was located approximately 1 foot below the brush trench marking bankfull (Q2, 2-year flow). The lower gradient, larger point bars seemed to have more woody vegetation recruitment. Herbaceous vegetation is also increasing on point bars, dominated by common spikerush (*Eleocharis palustris*).

Several areas of existing vegetation were preserved on point bars and inside meanders in Phases 5 and 6. This vegetation remains robust and was contributing seed to adjacent point bars and low floodplain surfaces. Preservation of existing low elevation surfaces along the channel should be continued in future design phases. In areas

where backwater features were constructed or re-built a lot of fine sediment deposition and colonization by wetland vegetation was occurring.

Photos 1-5 in Attachment N (*Phases 5 and 6 2017 Streambank Woody Vegetation Cover Categories*) show typical conditions of point bars and depositional features in Phases 5 and 6 in 2017.

Floodplain Woody Vegetation Cover

Woody vegetation cover was recorded for several planting units throughout Phases 5 and 6 and included a mix of planting units planted in 2015 and 2016. In 2017, 2% of planting units met the 5 year target of 30% cover. Forty nine percent of planting units were in Category 2 (10 to 30%) and 49% were in Category 3 (<10%). This represents an increase in woody vegetation cover from 2016. Planting units installed in 2016 were expected to have low cover which is common for year 1 plantings. The increase in cover was from growth of surviving plants installed in 2015.

Very little expansion of woody vegetation was observed in Phases 5 and 6 in 2017. A few streambanks had evidence of inundation from high flows and an increase in woody vegetation cover was recorded in these locations, but there was no specific trend of rapid expansion of woody vegetation where high flows accessed the floodplain such as what occurred in Phase 1 after 2014 high flows. Some swales located close to the active channel had significant expansion of planted willows and these areas likely did get inundated by high flows in either 2016 or 2017. For swales further from the channel, less willow expansion was observed and there is little potential for willows to expand beyond swale boundaries in these areas in the absence of flood disturbance.

Attachment N (*Phases 5 and 6 2017 Floodplain Woody Vegetation Cover Categories*) shows woody vegetation cover in the Phases 5 and 6 floodplain in 2017.

Woody Containerized Planting Survival

A total of 116 planting units were observed during the 2017 QRA. Fifty seven percent of the planting units were in Category 1 (>80% survival). Twenty two percent had 50 to 80% survival and 21T had less than 50% survival. Most (74%) of the observed planting units that were planted in 2016 (representing Year 1) were in Category 1 (>80% survival) indicating that the main decline in survival occurred in planting units planted in 2015. This is similar to the trend observed in Phase 1 where survival declined in year 2. Dry conditions were the main cause of decreased survival in Phases 5 and 6 in 2017 and the work zones identified in 2016 for Phase 5 continue to be areas of concern. Phase 6 had even more dry areas, particularly on meander tabs on the west side of the floodplain. Survival was generally low in dry areas outside of swales or away from the streambank. Beaver browse resulted in loss of some plants in 2016 but little sign of beaver was observed in 2017. Deer browse was minimal in Phases 5 and 6 despite many signs of deer being inside the fence. Several low spots were observed where deer can move under the fence, including the Galen ditch crossing. Deer can also access the site through the river crossings at the upstream and downstream ends of the

site, although only a few tracks were observed in these areas. The fence river crossings were functioning well in terms of conveying water and debris.

Hydrology of swale features continued to vary greatly with some swales dry or moist on the bottom and others having standing water. Many swales were dry at the time of planting in the fall but had prolonged groundwater in the spring resulting in loss of plants installed at the bottom of the swale. Plants installed on swale slopes generally had higher survival. Swales with prolonged spring inundation typically have cattails establishing in the bottom. This trend is not consistent within Phases 5 and 6 and varied throughout the site and between years.

FPX units (areas of the floodplain where 10 cubic inch woody plants were planted at tight spacing) had poor survival overall. In units, such as FPX-2, where soil moistures was high, plants are easily identified and have grown between one and two feet. In drier areas (FPX-5, FPX-6, FBX-7, FPX-3) the dry conditions have led to high cover of exotic species and poor survival of small woody plants. In low elevation areas where moisture is high, this treatment remains an effective and inexpensive method to increase woody vegetation cover in the floodplain and should be repeated in the future phases or used to inter-plant areas with poor survival.

Overall, survival of plants in upland or terrace planting units decreased between 2016 and 2017. Survival and cover of silver buffaloberry at trans01 however was very high indicating this is good species to use in dry planting areas in future phases.

Photos in Attachment N (*Phases 5 and 6 2017 Woody Vegetation Survival Categories*) show conditions of woody vegetation survival in planting units observed in the Phases 5 and 6 floodplain in 2017.

Floodplain Herbaceous Vegetation Cover

In Phase 5, cover of seeded herbaceous species remained high but total cover and species composition continued to vary. Cover of seeded species was lower in Phase 6 compared to Phase 5 and cover of exotic species cover was higher. Exotic species cover increases greatly in Phase 6 and in areas with lower soil moisture. The most common exotic species observed included: kochia, tumble mustard, sweet clover, witchgrass (*Panicum capillare*), curly top knotweed (*Polygonum lapathifolium)* and *Rumex* spp. There was also high cover of the aster species observed in Phase 1 and Phase 2 observed at the Phases 5 and 6 site in 2017. Much of Phase 6 was seeded in fall 2016 and 2017 represents the first growing season for seeded species. The drought conditions in 2017, combined with high elevation floodplain areas, has likely contributed to low overall cover of seeded species and high cover of exotic species in Phase 6. There is a large infestation of kochia in a drill seeded area on the west side of the floodplain at the downstream end of the site along the access road.

Species composition appeared to be highly dependent on soil moisture. On both sides of the river, areas that were closer to the river channel and lower in elevation had higher cover of seeded species. On the west side of the river, the driest areas included

planting unit mc02, planting unit mc03, and the last four meander bends/inside meander tabs at the downstream end of the project. On the east side of the river, the driest areas included the meander bend where planting units om25 and om24 are located and the last three full meander bends/inside meander tabs at the downstream end of the project.
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In general seeded species cover still remained higher in areas where seed was applied by drill rather than broadcast. The areas with the highest exotic species cover all had floodplain microtopography and were broadcast seeded, although when soil moisture was in these areas seeded species cover increased. This trend was very noticeable in areas where the floodplain was drill seeded but planted swales in the area were not. Exotic species cover, particularly sweet clover and tumble mustard, was high in the swales but not in the adjacent floodplain. These annual exotic species are generally shallow rooted and not likely to provide much competition for establishing shrubs and trees. The high cover and large size of both the clover and mustard may actually be creating favorable conditions for shrubs in the swale features by increasing shade and moisture.

RWZ4W (mc02 planting unit) continued to stand out as being too dry to support woody riparian vegetation. Nearly all planted shrubs and trees in this unit are dead and herbaceous cover is consists of almost entirely exotic species, many of which are over 8 feet tall (sweet clover and mustard). The conditions created by installing additional measures to reduce avulsion risk, including elevating the meander core and mixing alluvium to the surface of the floodplain, have resulted in an area that cannot support woody riparian vegetation. Due to the higher elevation of the area there is also less of a chance that the area will be inundated during high spring flows. Areas closer to the channel in this work zone, where the surface is lower and moisture increases, the cover of seeded grass species and survival of woody vegetation planted in swales increases.

Attachment N (*Phases 5 and 6 2017 Floodplain Herbaceous Vegetation Cover Categories* and Photos 19-26, 27-33 *Phases 5 and 6 2017 Vegetation Miscellaneous Photographs*) show conditions of herbaceous vegetation cover observed in the Phases 5 and 6 floodplain in 2017.

Vegetation in the Phase 5 borrow ponds continued to expand and had created a dense band of wetland vegetation around the first two ponds (closest to the road). The third pond (furthest from road) had a much smaller emergent zone and lower wetland vegetation cover overall. This was likely due to higher initial predation by waterfowl in this area and more variable hydrology compared to the other ponds. Shrubs planted around the pond perimeters and between ponds had high survival and were starting to expand, particularly in the planted areas between ponds. The ponds were being used by several water fowl species. The high level of predation by waterfowl on herbaceous wetland plugs did not appear to have limited cover of wetland vegetation except for the east side of the third pond and in a few other small areas. Vegetation cover was much lower in the Phase 6 borrow ponds. This area was planted in August 2016 and October

2016 so vegetation was just starting to establish in 2017. Many of the planted shrubs showed signs of stress, but wetland herbaceous vegetation was present despite high initial predation. The brush trenches installed between the Phase 6 borrow ponds had high willow survival, especially the downstream most structure (BT-10A and BT-10B).

Wetland vegetation cover was increasing in other constructed wetlands at the Phases 5 and 6 site (sw01, sw02, sw03, sw05, sw06) and zonation of species was starting to occur. Cattails had colonized the bottom of most wetlands with zones of planted sedges and rushes occurring in approximately 1-foot increments above the cattail zone. Foxtail barley (*Hordeum jubatum*) had colonized most wetlands, but neither reed canarygrass or Garrison's creeping foxtail were observed. Woody vegetation was also expanding in most of the wetlands. The abandoned oxbow wetland (sw08) was activated during high flows resulting in an increase of woody vegetation cover where surfaces were inundated. Several birds were observed using this wetland.

There are several beaver dams in Galen Creek at the road crossing location where a culvert was installed. There is a beaver deceiver structure on the culvert inlet but three dams were observed in 2017 that span the Galen Creek channel downstream of the culvert. At the road crossing over Galen ditch, beaver have plugged the culvert and water is ponded above the culvert and flowing over the access road. At both of these locations, beaver dams have spread flows across a wide area of floodplain and the flows return to the Clark Fork River over constructed streambanks.

Photos 6-10 in Attachment N (*Phases 5 and 6 2017 Vegetation Miscellaneous Photographs*) show wetland development in Phases 5 and 6 in 2017. Photos 11-14 and Photos 15-18 in Attachment N (*Phases 5 and 6 2017 Vegetation Miscellaneous Photographs*) show wetland development in Phases 5 and 6 in 2017.

Modesty Creek and Dry Cottonwood Creek

A new Modesty Creek channel was constructed as part of restoration work. The lower portion of the channel flows through the Phase 6 site. The lower channel was revegetated using soil lifts, transplanted wetland sod and containerized woody shrubs and trees. Survival of both 10 cubic inch and larger plants was high in planted areas. Wetland sod mats are healthy but still have a high percentage of pasture grass composition. The hydrology is appropriate to support wetland vegetation and the species composition is expected to change over time. Some algae growth was observed on gravel and cobbles in the streambed. Survival of willow cuttings in streambank treatments varies, with some cuttings being lost to prolonged inundation. There are surviving willows along the length of the stream and cover will increase over time. Seeded grasses and forbs are also coming in well in this area. There are some bare spots, near the transitions between broadcast seeding (microtopography) and drill seeding and in areas where the drill seeder couldn't access.

The confluence of Dry Cottonwood Creek was reclaimed after removal of the east haul road. Slopes were roughened and woody debris was buried into and scattered on

sloping surfaces. Woody plants were installed on the slopes and willows were salvaged from a nearby irrigation canal and transplanted along the channel. Containerized plants are small but have high survival and appear healthy. Willow transplants have high survival and are growing. Some exotic species are present, including tumble mustard and kochia.

Attachment N (*Phases 5 and 6 2017 Vegetation Miscellaneous Photographs*) shows Modesty Creek (Photos 36-39) and Dry Cottonwood Creek (Photos 40-41) conditions observed in 2017.

Phase 5 and 6 2017 Vegetation Management Actions

The dry condition of the floodplain in several areas is the main vegetation management concern in Phases 5 and 6. The combination of well-drained soils, high distance to groundwater, dry conditions in 2017 and possibly competition from exotic species had led to very low survival in this area. Management actions that increase woody vegetation cover in this area should be considered.

For vegetation, the following management actions were identified for Phases 5 and 6 in 2017.

- Continue selective control of noxious weeds and include selective treatment of reed canarygrass along the channel.
- Consider installing deer jump-outs so deer inside the fence can exit.
- Continue to allow beaver activity in Galen Creek to occur as it is increasing the water table in the floodplain in these areas.
- Implement adaptive management for the dry floodplain areas. Options for increasing floodplain connectivity should be explored, including lowering floodplain surfaces and construction of additional floodplain features including side channels and wetlands. Even 0.5 feet in elevation rise in the floodplain is showing reduced water table connectivity resulting in loss of planted trees and shrubs and high cover of exotic species.

No vegetation management actions were completed in 2017.

References

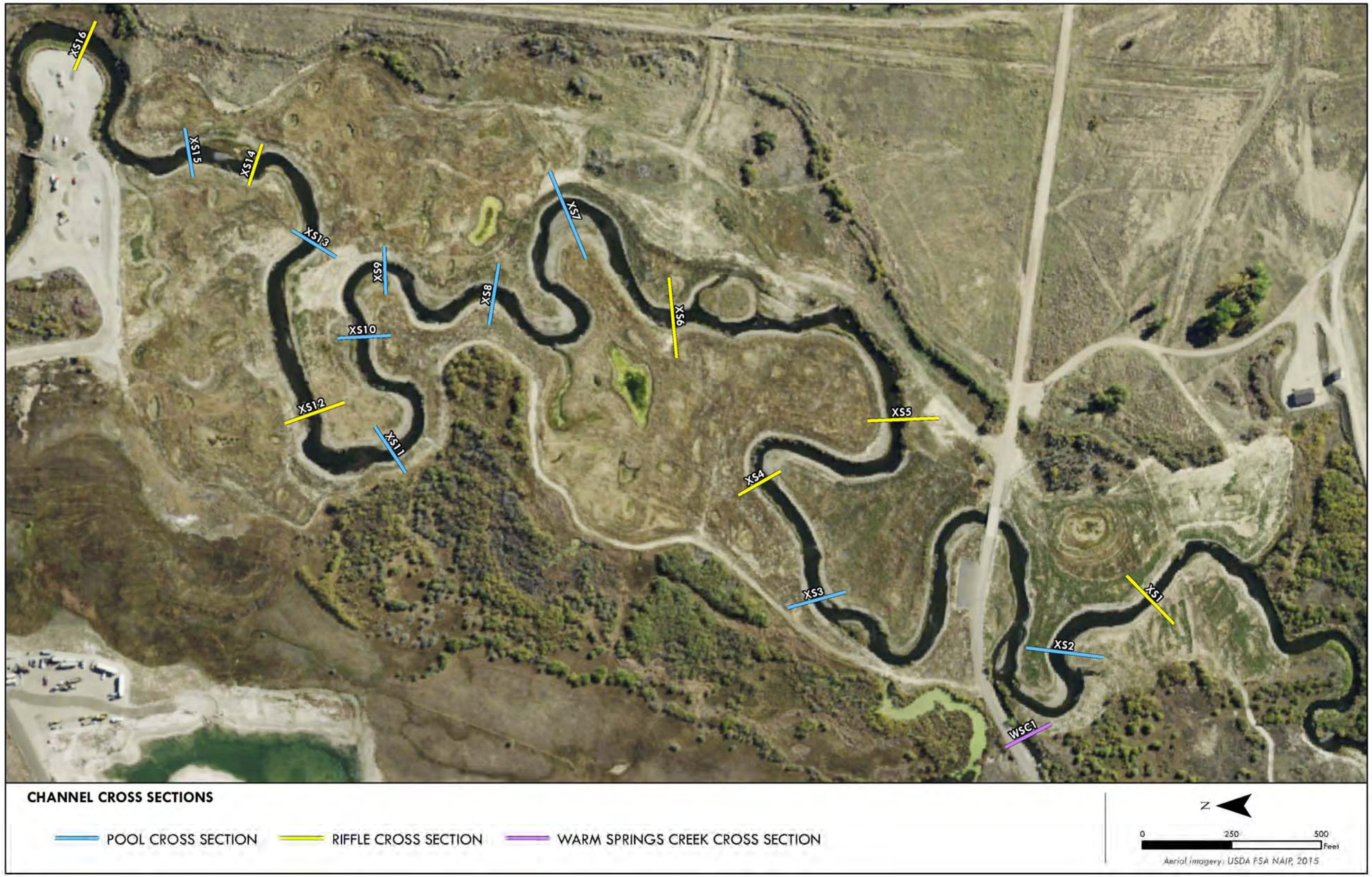
Geum and AGI. 2015. Clark Fork River Operable Unit, Reach A, Geomorphology and Vegetation Monitoring Plan. Report prepared for Montana Department of Environmental Quality, Helena, Montana, December, 2015.

Geum and AGI. 2017. Qualitative Rapid Assessment 2015-2016 Status Report, Milltown Reservoir/Clark Fork River NPG Site Clark Fork River Operable Unit, Reach A, Phase 1 and Phases 5 and 6. Report prepare for Montana Department of Environmental Quality, April, 2017.

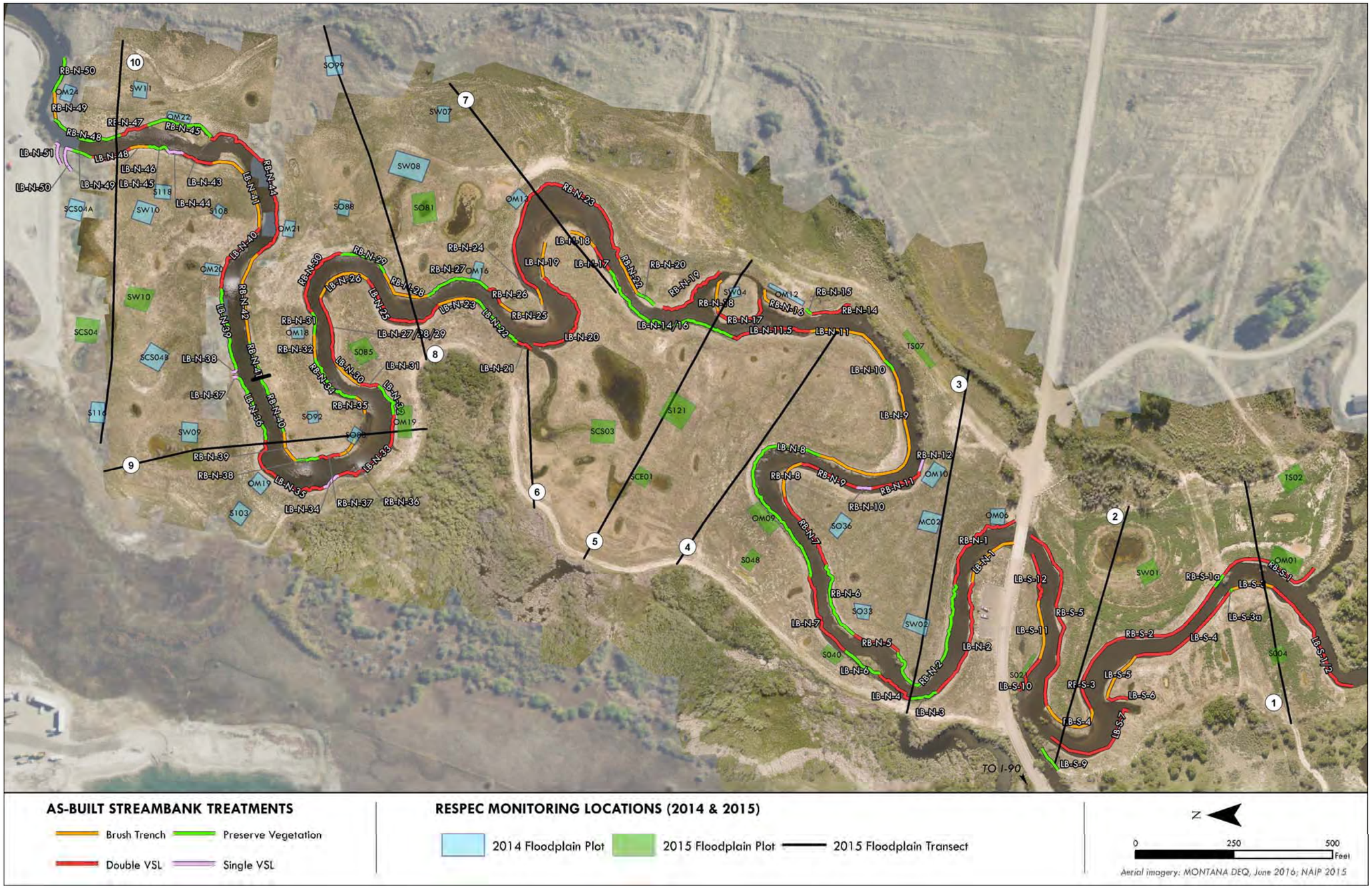
RESPEC, 2016a. Clark Fork River Operable Unit, Reach A, Phase 1 2014 Vegetation and Geomorphology Monitoring Report. Report prepared for Montana Department of Environmental Quality, Helena, Montana.

RESPEC, 2016b. Clark Fork River Operable Unit, Reach A, Phase 1 2015 Vegetation and Geomorphology Monitoring Report. Report prepared for Montana Department of Environmental Quality, Helena, Montana.

Attachment A – Phase 1 Streambank Treatment and Monitoring Locations



Map 1. Location of Phase 1 geomorphology channel cross sections.



Map 2. Phase 1 streambank treatments, vegetation monitoring plots, and floodplain transects.

Attachment B – Phase 1 Geomorphology QRA Photographs

2015






Photos 1-5. Overbank flows in May of 2014 showing overflow channel formation.

Photo 6. View downstream of bank and floodplain repairs at overflow site.

Photo 7. Point bar deposition and vegetation recruitment following 2014 high flows.

Photo 8. Point bar expansion following 2014 high flows.

Photo 9. Large wood mobilization and concentration by 2014 high flows.

Photo 10. Torn fabric on slumping DVSL, Phase 1.

2017






Photos 2-6. Indicators of June 2017 overbank flows.






Photos 7-12. Examples of vegetation establishment on point bars, 2017.

Photo 13. View downstream of streambank treatment DVSL RB-N-47 identified for continued monitoring.

Photo 14. Example of continued fabric decay coupled with vegetative expansion.

Photo 15. Willow expansion into alluvium placed behind streambank treatment.

Photo 16. Woody vegetation expansion in streambank and on floodplain.

Attachment C -- Phase 1 Geomorphology QRA Results

Channel Stability

Category	Score
Category 1: Likely Degrading	1
Category 2: Largely Stable/Trending	2 to 4
Category 3: Likely Aggrading	5

Year	2015	2016	2017
Location	Phase 1	Phase 1	Phase 1
Parameter	Score	Score	Score
Riffle Substrate Consolidation	4	4	4
Point Bar Morphology	3	3	4
Bank Failure Mechanism	3	3	3
Bar Development	3	4	4
Bank Erosion Extent	3	3	4
Width:Depth Ratio	3	4	4
Channel Pattern	3	3	3
Constructed Bank Toe Height	4	4	3
Sediment Source or Sink	3	4	3
Field Stability Rating	3.2	3.6	3.6
Over all Category	**Category 2: Largely Stable/Trending**	**Category 2: Largely Stable/Trending**	**Category 2: Largely Stable/Trending**
Notes		**2016 some field indication of sediment aggradation relative to 2015**	**Light aggradation is still indicated; continued vertical accretion on point bars evident.**

Floodplain Connectivity

Year[1]	Station	Observation
2015	48+00	Floodplain wood mobilization
2015	65+00	Overbank sediment deposition
2015	66+50	Overbank sediment deposition
2015	70+50	Overbank sediment deposition
2015	82+00	Overbank sediment deposition
2015	85+50	Floodplain wood mobilization
2015	87+00	Overbank sediment deposition
2015	92+50	Floodplain wood mobilization
2015	95+00	Floodplain wood mobilization
2015	96+00	Overbank sediment deposition
2015	97+50	Overbank sediment deposition
2015	98+00	Floodplain wood mobilization
2015	99+00	Overbank sediment deposition
2015	99+50	Floodplain wood mobilization

[1] Floodplain connectivity was evaluated in 2014 following out of bank flows (RESPEC, 2016). During the 2015 QRA, numerous areas were identified as having been inundated by overbank flows (in 2014) and this table reflects those observations.

Year[1]	Station	Observation
2017	44+50	Floodplain wood mobilization
2017	46+00	Floodplain wood mobilization
2017	48+00	High water mark left bank 0.8 ft
2017	51+00	Floodplain wood mobilization
2017	60+00	High water mark right bank 0.8 ft
2017	61+00	Floodplain wood mobilization
2017	56+00	Floodplain wood mobilization
2017	58+00	Overbank sediment deposition
2017	60+00	High water mark right bank 0.8 ft
2017	67+00	Floodplain wood mobilization
2017	68+00	High water mark left bank 0.8 ft
2017	74+00	Floodplain wood mobilization
2017	87+00	Floodplain wood mobilization
2017	90+11	Floodplain wood mobilization
2017	65+00	High water mark left bank 1.2 ft

[1] Floodplain connectivity was evaluated in 2017 because flows exceeded bankfull design flows of 522cfs. The highest recorded flow in 2017 at the USGS 12323800 Galen Station was 878cfs on June 14, 2017.

Streambank Condition

Year[1]	Streambank Treatment ID[2]	Issue	Recommended Management Action
2016	LB-S-4 DVSL	Minor slumping or may have been constructed low by design	None
2016	RB-S-5 DVSL	Minor settling of constructed toe/DVSL slumping	None
2016	LB-S-10 DVSL	Slumping of lifts	None
2016	RB-N-1 DVSL	Top lift coir log exposed; ice damage?	None
2016	LB-N-2 DVSL	Gap in lower bank where fabric rolls meet	None
2016	RB-N-5 DVSL	Bottom lift coir log missing and top coir log slumping	Streambank evaluation form completed – monitor or possible gap treatment
2016	LB-N-7 DVSL	Gap between bottom coir log of DVSL (likely a joint)	None
2016	LB-N-7A DVSL	13.5 feet of streambank within LB-N-7 DVSL bank only treated with alluvium	Detailed form completed – monitor/possible gap treatment
2016	RB-N-7 DVSL	Slumping lower lift due to high shear on toe	Monitor - possible willow planting behind
2016	RB-N-9 DVSL	Top lift ice damage to fabric in DVSL	None
2016	RB-N-14 DVSL	Both coir logs in lifts gone due to high shear stress on bank - approx. 70 feet missing	Detailed form completed - monitor
2016	LB-N-14-16 PV	PV is undercut; large gaps between willows, some erosion behind preserved vegetation	None
2016	RB-N-17 DVSL	Fabric torn in both lifts	None
2016	RB-N-19 DVSL	Fabric missing; ice damage/missing bottom log	None
2016	RB-N-23 DVSL	Toe missing; lifts slumping over clay toe; outer fabric ice damage, some lower logs missing	None
2016	RB-N-29 PV	Some vegetation missing/fallen in	Monitor
2016	RB-N-30 DVSL	Some fabric torn/abraded	Monitor
2016	LB-N-33 DVSL	Lower log missing - small slump in bank approx.1 coir log length	None
2016	LB-N-40 DVSL	Intersection between PV and DVSL	None
2016	LB-N-43 DVSL	Some undercutting/slight settlement	Monitor
2016	RB-N-44 DVSL	Lifts may have slumped in- some low spots	Monitor
2016	RB-N-47 DVSL	Extensive loss of Top and lower logs; undercutting; high shear with ice	Detailed form completed - Monitor
2016	LB-N-Pilot SVSL	Slumping SVSL in Pilot Test 1	None

[1]Streambank condition was not recorded in 2015.

[2]All locations where streambank treatment condition had changed since construction were recorded. Additional details were recorded for streambanks that shows substantial change (see 2016 streambank evaluation form below).

Year	Streambank Treatment ID[1]	Issue	Recommended Management Action
2017	RB-S-1 DVSL	Torn fabric/variable vegetation density	None
2017	LB-S-1 DVSL	Deteriorating fabric	None
2017	LB-S-4 DVSL		None
2017	RB-S-3 DVSL	Some slumping; fabric tears show no instability	None
2017	RB-S-5 DVSL	Top willows show strong growth	None
2017	LB-S-8 DVSL	No willows in between logs	None
2017	LB-S-10 DVSL	Continued slumping; part of one log missing	None
2017	RB-N-1 DVSL		None
2017	LB-N-2 DVSL	Active undercutting	None
2017	RB-N-5 DVSL	Healing; deep pool with willows	None
2017	LB-N-7 DVSL	Some log loss	None
2017	LB-N-7A DVSL	No apparent change	None
2017	RB-N-7 DVSL	Still slumping, sparse vegetation but no indication of failure	None
2017	RB-N-9 DVSL	Fines at toe with rush growth	None
2017	RB-N-14 DVSL	Failed lifts but structure largely intact; very dense brush trench behind	None
2017	LB-N-14-N-16 PV		None
2017	RB-N-17 DVSL	Slumped lifts but strong willow growth	None
2017	RB-N-19 DVSL	Willow recovery locally dense	None
2017	RB-N-23 DVSL	Long DVSL on native fine grained toe, some lower lift peeling out	None
2017	RB-N-29 PV	High angle of attack; performing well	None
2017	RB-N-30 DVSL	Good willow growth on repaired Top lift	None
2017	LB-N-33 DVSL		None
2017	LB-N-35_DVSL	Some log damage	None
2017	RB-N-37 DVSL	Bare spots look like fishing access trails to adjacent riffle crossing	None
2017	LB-N-40 DVSL	Some logs missing; veg ok; large willows	None
2017	LB-N-43 DVSL		None
2017	RB-N-44 DVSL	Spotty willow growth	None
2017	RB-N-47 DVSL	Poor condition-- lost lifts, poor vegetative recovery	Monitor
2017	LB-N-Pilot SVSL		None

[1]All locations where streambank treatment condition had changed since construction were recorded. There were no banks recorded for detailed issues in 2017.

Phase 1 2016 Streambank Evaluation Form and Streambanks with Potential Risk Documented Using QRA Streambank Form				
Streambank	**RB-N-5**	**RB-N-7A**	**RB-N-14**	**RB-N-47**
Year	2016	2016	2016	2016
As-Built Treatment	DVSL	None (alluvium only)	DVSL	DVSL
Channel Feature	Outer Meander	Outer Meander	Outer Meander	Outer Meander/high angle thalweg
Nature of Bank Change	Toe loss, slumping, cantilever failure	No treatment was installed along approx. 13.5 feet of bank causing flanking risk	Both Top and lower coir logs missing, top fabric is all that remains	Loss of lifts; torn fabric; undercutting
Toe Material Size	Approx. 2"	Approx. 2"	Not recorded	Not recorded
Toe Constructed	Yes	Unknown	Unknown	Yes on downstream end
Undercutting (ft)	Approx. 1.5 ft	Minor	Not recorded	Approx. 1 ft
Fabric Condition	Variable; locally intact and locally gone	N/A	Torn; lower coir log is still in place on upstream end	Torn; top lift is gone and about 15 feet of lower lift coir log is missing
Vegetation Condition	No support from woody vegetation	Small willows providing limited support	No support from woody vegetation	Poor; minimal woody vegetation survival
Potential Cause of Change	Shear stress on outside bend	Outer bank erosion	Loss of toe material due to high local shear stress	High shear stress caused by high angle thalweg impingement; failures is in eddy upstream at and upstream of thalweg angle of attack
Risk Associated with Change	Minimal	Risk of flanking the head of a long DVSL just downstream	None	Minimal
Possible Management Actions	No; slumped coir logs have formed bench that is trapping fines	Consider wood/gap treatment	None	None
Access	N/A	OK	Would damage vegetation	Poor
Implications for Future Design	Pay attention to quantity/quality of toe material; add sacrificial toe where localized high shear stress	Unsure as original treatment is unknown (likely untreated)	Consider local hydraulics in with respect to quantity and quality of toe material	Adjust bank treatments to accommodate local hydraulics; consider in both design and during construction
Action Recommended	No	Maybe - woody brush matrix/gap treatment	No	No

Attachment D – Phase 1 Vegetation QRA Photographs

Phase 1 2015 Streambank Woody Vegetation Cover Categories

Top left: Category 1 (>40%) (RBN-2); Top right: Category 2 (10 to 40%) (RBN-22); Bottom center: Category 3 (<10%) (RBN-5).

Phase 1 2015 Floodplain Woody Vegetation Cover Categories

Top left: Category 1 (>30%) (SW11); Top right: Category 2 (10 to 30%) (OM16); Bottom center: Category 3 (<10%) (SW08).

Phase 1 2015 Floodplain Herbaceous Vegetation Cover Categories

Top left: Category 1 (>80%) (Transect 7, wetland herbaceous); Top right: Category 2 (50-80%) (Transect 8, yarrow); Lower Left: Category 3 (20-50%) (Transect 3, staging area and haul road); Lower right: Category 4 (<20%) (Transect 5, behind bank).

Phase 1 2015 Woody Vegetation Survival Categories

Top left: Category 1 (>80%) (OM12); Top right: Category 2 (50 to 80%) (SO81); Bottom center: Category 3 (<50%) (SW07).

Phase 1 2016 Streambank Woody Vegetation Cover Categories

Top left: Category 1 (>40%) (RB-S-2); Top right: Category 2 (10 to 40%) (RB-N-9); Bottom center: Category 3 (<10%) (LB-S-12).

Phase 1 2016 Floodplain Woody Vegetation Cover Categories

Top left: Category 1 (>30%) (SW04A); Top right: Category 2 (10 to 30%) (SW08); Bottom center: Category 3 (<10%) (OM01).

Phase 1 2016 Floodplain Herbaceous Vegetation Cover Categories

Top left: Category 1 (>80%) (Transect 2, wetland herbaceous slope); Top right: Category 2 (50-80%) (Transect 2, herbaceous behind bank); Lower Left: Category 3 (20-50%) (Transect 5, herbaceous); Lower right: Category 4 (<20%) (Transect 5, directly behind bank).

Phase 1 2016 Woody Vegetation Survival Categories

Top left: Category 1 (>80%) (OM12); Top right: Category 2 (50 to 80%) (S116); Bottom center: Category 3 (<50%) (TS07).

Phase 1 2017 Streambank Woody Vegetation Cover Categories

Top left: Category 1 (>40%) (RB-N-29 PV); Top right: Category 2 (10 to 40%) (RB-N-14 DVSL)
Bottom: Category 3 (<10%) (LB-N-51 SVSL on left bank of side channel outlet)

Phase 1 2017 Floodplain Woody Vegetation Cover Categories

Top left: Category 1 (>30%) (SW04); Top right: Category 2 (10 to 30%) (S036); Bottom center: Category 3 (<10%) (S033).

Phase 1 2017 Floodplain Herbaceous Vegetation Cover Categories

Top left: Category 1 (>80%) (Emergent wetland in SW01); Top right: Category 2 (50-80%) (herbaceous cover within MC02); Middle Left: Category 3 (20-50%) (access road on left bank); Middle right: Category 4 (<20%) (directly behind bank of OM10); Bottom: Category 1 (>80%) (alfalfa in floodplain upstream of bridge).

Phase 1 2017 Woody Vegetation Survival Categories

Top left: Category 1 (>80%) (OM19, 2013); Top right: Category 2 (50 to 80%) (s108); Bottom center: Category 3 (<50%) (ts07).

Phase 1 2017 Vegetation Miscellaneous Photographs

Photos 1-4. Point bar conditions in Phase 1 in 2017: Photo 1: herbaceous; Photo 2: island point bar with dense willow seedlings; Photo 3: Mix of herbaceous and woody vegetation; Photo 4: Fine sediment deposition on point bar.

Photos 5-8. Willow expansion in areas inundated by high flows in Phase 1 in 2017. Photo 5: swale near backwater area left bank upstream of bridge; Photo 6: SCS04 area; Photo 7: right bank 2014 flood activated floodplain area; Photo 8: planting unit SW11 activated by 2014 flood.

Photos 9-10. Photo 9: Planting Unit OM19 planted in Fall 2013, protected with individual plant protectors and with high survival and woody vegetation cover. Photo 10: Planting Unit OM19(N) located just upstream of OM19, planted in Fall 2014 and protected with 48-inch wire fence. Photo 9 also shows high cover of redtop that has colonized the constructed floodplain surface from the adjacent intact willow stand.

Photo 11. Heavy browse on birch in Unit MC-03.

Photos 12-14. Planting units in the large floodplain area on the west side of the river near the center of the Phase 1 project reach. Survival of woody vegetation in this area is very low due to excessive deer browse. The large net exclosures has been ineffective in this area and has not excluded deer. Photo 12: planting unit S056; Photo 13: planting unit S062; Photo 14: planting unit S121.






Photos 15-21. Conditions of wetlands in Phase 1 in 2017. Photo 15: SW05; Photo 16: S121; Photo 17 and Photo 18: SW09; Photo 19: SW01; Photo 20: SW07; Photo 21: SW11.

Photos 22-25. Side Channels and backwater features. Photo 22: SCS02; Photo 23: SCS03; Photo 24 and Photo 25: SCS04A.

Photos 26-28. Photo 26: Seeded sagebrush and rabbitbrush in reclaimed access road on west side of Phase 1. Photo 27: Seeded bitterbrush in west floodplain at downstream end of project. Photo 28: High forb cover near planting unit OM19(N).

Photo 29. Reed canarygrass colonizing point bar across from LB-S-3. Reed canarygrass cover is highest on point bars upstream of the bridge. There are several dense stands upstream of the Phase 1 project site.

Photo 30. Aster species that has significant cover in several areas of the floodplain. Photo also shows precipitation of salts that continue to occur in this area because it becomes so saturated in the spring.

Attachment E – Phase 1 QRA Vegetation Results

Streambank Woody Vegetation Cover

Streambank Treatment ID	Bank	Treatment Type	2015	2016	2017
LB-S-1-2	Left	DVSL	2	2-	2
LB-S-3	Left	BT	2+	2+	2+
LB-S-3A	Left	PV	N/A	N/A	1
LB-S-4	Left	DVSL	2	2	2
LB-S-5	Left	BT	2	2+	1
LB-S-6	Left	DVSL	2	2+	2-
LB-S-7	Left	DVSL	2-	2	2-
LB-S-9	Left	PV	N/A	1	1
LB-S-10	Left	DVSL	2+	1	2
LB-S-11	Left	BT	3	3	1
LB-S-12	Left	DVSL	2	3	2+
LB-N-1	Left	BT	2	2	1
LB-N-2	Left	DVSL	2+	2-	2+
LB-N-3	Left	PV	1	1	1
LB-N-4	Left	DVSL	2-	1	2
LB-N-6	Left	PV	1	1	1
LB-N-7	Left	DVSL	3	2	2-
LB-N-8	Left	PV	1	1	1
LB-N-9	Left	BT	1	2	1
LB-N-10	Left	PV	1	1-	1
LB-N-11	Left	BT	1	1-	1
LB-N-11.5	Left	DVSL	2	2+	2+
LB-N-14-16	Left	PV	1	1	1
LB-N-17	Left	DVSL	2	2+	1
LB-N-18	Left	BT	2	1	1
LB-N-19	Left	BT	1	1	1
LB-N-20	Left	DVSL	2+	2	1
LB-N-21	Left	DVSL	2	2-	2+
LB-N-22	Left	PV	1	1	1
LB-N-23	Left	BT	3	2	2
LB-N-25	Left	DVSL	2-	2	1
LB-N-26	Left	BT	2	1	1
LB-N-27-28-29	Left	DVSL	2	2	2+
LB-N-30	Left	BT	2	2	1
LB-N-31	Left	DVSL	2-	3	1
LB-N-32	Left	PV	1	2	1
LB-N-33	Left	DVSL	2	2	2

Streambank Treatment ID	Bank	Treatment Type	2015	2016	2017
LB-N-34	Left	SVSL	1	1	1
LB-N-35	Left	DVSL	2	2	2+
LB-N-36	Left	PV	1	1	1
LB-N-37	Left	SVSL	2	2+	1
LB-N-38	Left	SVSL	2	2-	1
LB-N-39	Left	PV	1	1	1
LB-N-40	Left	DVSL	2	2	2+
LB-N-41	Left	BT	1	2+	2+
LB-N-43	Left	DVSL	2	1	1
LB-N-44	Left	SVSL	2	2	2
LB-N-45	Left	PV	2	1	1
LB-N-46	Left	BT	2	3	1
LB-N-48	Left	DVSL	2	2	1
LB-N-49	Left	PV	1	1	1
LB-N-50	Left	SVSL	3	3	2
LB-N-51	Left	SVSL	3	3	3
RB-S-1	Right	DVSL	2	2+	2
RB-S-1a	Right	PV	1	-	-
RB-S-2	Right	DVSL	2	1	2
RB-S-3	Right	DVSL	2	-	2+
RB-S-4	Right	BT	2	1	1
RB-S-5	Right	DVSL	2	2	2+
RB-N-1	Right	DVSL	2	2	2+
RB-N-2	Right	PV	2	-	1
RB-N-5	Right	DVSL	3	3	2
RB-N-6	Right	PV	2	-	1
RB-N-7	Right	DVSL	2	3	2-
RB-N-8	Right	BT	2	2	1
RB-N-9	Right	DVSL	1	2	1
RB-N-10	Right	SVSL	2	1	1
RB-N-11	Right	DVSL	1	2-	2-
RB-N-12	Right	SVSL	1	-	-
RB-N-14	Right	DVSL	2+	2-	2
RB-N-15	Right	PV	2	1	-
RB-N-16	Right	BT	2-	2	1
RB-N-17	Right	DVSL	2	2	1
RB-N-18	Right	BT	2	2	-
RB-N-19	Right	DVSL	2-	2	1
RB-N-20	Right	PV	2	-	1
RB-N-22	Right	BT	2	-	1

Streambank Treatment ID	Bank	Treatment Type	2015	2016	2017
RB-N-23	Right	DVSL	2-	2	2
RB-N-24	Right	BT	2+	-	-
RB-N-25	Right	BT	2+	1	1
RB-N-26	Right	DVSL	3	2-	2
RB-N-27	Right	PV	2	-	1
RB-N-28	Right	BT	2	2	1
RB-N-29	Right	PV	1	-	1
RB-N-30	Right	DVSL	2-	1	2+
RB-N-31	Right	PV	1	-	1
RB-N-32	Right	BT	1	-	-
RB-N-34	Right	PV	1	-	1
RB-N-35	Right	BT	2	1	1
RB-N-36	Right	BT	2	1	1
RB-N-37	Right	DVSL	3	3	2+
RB-N-38	Right	PV	1	-	1
RB-N-39	Right	BT	3	3	1
RB-N-40	Right	PV	1	3	1
RB-N-41	Right	PV	2	3	1
RB-N-42	Right	BT	1-	-	1
RB-N-44	Right	DVSL	3+	2	2+
RB-N-45	Right	PV	N/A	N/A	1
RB-N-47	Right	DVSL	3	3	2-
RB-N-48	Right	PV	1	-	1
RB-N-49	Right	BT	2	1	-
RB-N-50	Right	PV	3	2	-

N/A indicates the bank is herbaceous or not likely to become dominated by woody vegetation

- indicates no data collected

DVSL: double vegetated soil lift

SVSL: single vegetated soil lift

PV: preserve vegetation

BT: brush trench

Floodplain Woody Vegetation Cover

Survival Plot ID	Streambank	Year Planted	Plant Protection Measure Installed	2015	2016	2017
S004	Left	2014	8 ft net exclosure	3	3	3
S021	Left	2014	48 inch wire	3	-	2-
S040	Left	2014	48 inch wire	3	3	3
S048	Left	2014	None	3	3	3
OM09	Left	2014	48 inch wire	3	3	3
S121	Left	2014	8 ft net exclosure	3	3	3
SCS03	Left	2014	8 ft net exclosure	3	3	2
SCE01	Left	2014	None	3	3	3
S085	Left	2014	48 inch wire	3	3	3
OM19	Left	2014	48 inch wire	3	3	3
OM19	Left	2013	Individual	3	2	1
SCS04A	Left	2014	8 ft net exclosure	2-	1+	1+
SW10	Left	2013	8 ft net exclosure	1	1+	1+
SW10	Left	2014	8 ft net exclosure	3	3	2-
S118	Left	2014	8 ft net exclosure	3	3	3
SCS04	Left	2014	8 ft net exclosure	3	3	2
S116	Left	2014	8 ft net exclosure	3	3	2
SW09	Left	2014	8 ft net exclosure	1	1+	1
SCS04B	Left	2014	8 ft net exclosure	1	1+	1
OM20	Left	2013	Individual	-	2	1-
S108	Left	2013	8 ft net exclosure	-	3	2
S103	Left	2013	8 ft net exclosure	-	3	2
OM01	Right	2014	8 ft net exclosure	3	3	3
TS02	Right	2014	8 ft net exclosure	3-	3	3-
SW01	Right	2014	8 ft net exclosure	3	-	3
OM06	Right	2013	Individual	2	-	1
SW02	Right	2013	8 ft net exclosure	3	-	2
S033	Right	2013	8 ft net exclosure	3	-	3-
S036	Right	2013	8 ft net exclosure	3	-	2
MC02	Right	2013/2014	8 ft net exclosure	3	-	2-
OM10	Right	2013	Individual	3	-	2+
TS07	Right	2014	Individual	3-	-	3-
OM12	Right	2013	Individual	2+	1	1+
SW04	Right	2013	8 ft net exclosure	1	1	1+
SW07	Right	2013	8 ft net exclosure	3	3	2-
SW08	Right	2013	8 ft net exclosure	3	2+	2
S081	Right	2014	8 ft net exclosure	3	3	3
OM13	Right	2013	Individual	2+	2+	1

Survival Plot ID	Streambank	Year Planted	Plant Protection Measure Installed	2015	2016	2017
OM16	Right	2013	Individual	2	1	1
S099	Right	2013	8 ft net exclosure	3	2	2+
S088	Right	2013	8 ft net exclosure	3	2	1+
OM18	Right	2013	Individual	2-	2	1+
S083	Right	2013	Individual	3	-	2+
S092	Right	2013	Individual	3	1	1+
OM21	Right	2013	Individual	3	2	2+
OM22	Right	2013	Individual	3	2	1-
SW11	Right	2013	8 ft net exclosure	1	1	1+
OM24	Right	2013	Individual	3	2	2+

- indicates no data collected

Woody Vegetation Survival

Plot ID	Bank	Upstream or Downstream of Bridge	Year Planted	Plant Protection Measure Installed	2015	2016	2017
SO04	Left	Up	2014	8 ft net exclosure	1	1+	3-
S021	Left	Up	2014	48 inch wire	1	-	2+
S040	Left	Down	2014	48 inch wire	1-	2	2-
S048	Left	Down	2014	None	2	2	3-
OM09	Left	Down	2014	48 inch wire	1-	2-	3
S121	Left	Down	2014	8 ft net exclosure	2+	2	3
SCS03	Left	Down	2014	8 ft net exclosure	1	2+	2
SCE01	Left	Down	2014	None	2	2-	3+
S085	Left	Down	2014	48 inch wire	2	2	3-
OM19	Left	Down	2014	48 inch wire	1-	2+	3
OM19	Left	Down	2013	Individual	1	1+	1+
SCS04A	Left	Down	2013	8 ft net exclosure	1+	1+	1
SW10	Left	Down	2013	8 ft net exclosure	1+	2	2-
S118	Left	Down	2013	8 ft net exclosure	1	1	2+
SW10	Left	Down	2014	8 ft net exclosure	1	1+	2-
SCS04	Left	Down	2014	8 ft net exclosure	1-	1	2-
S116	Left	Down	2013	8 ft net exclosure	2-	2	2-
SW09	Left	Down	2013	8 ft net exclosure	1	1+	1+
SCS04B	Left	Down	2013	8 ft net exclosure	1	1+	2+
OM20	Left	Down	2013	Individual	-	1+	1
S108	Left	Down	2013	8 ft net exclosure	-	3	2
S103	Left	Down	2013	8 ft net exclosure	-	1	1
OM01	Right	Up	2014	8 ft net exclosure	1	3-	3
TS02	Right	Up	2014	8 ft net exclosure	3	3	3-
SW01	Right	Up	2014	8 ft net exclosure	1	2	2
OM06	Right	Down	2013	Individual	1	1	1
SW02	Right	Down	2013	8 ft net exclosure	1-	2	2
S033	Right	Down	2013	8 ft net exclosure	2-	2	2
S036	Right	Down	2013	8 ft net exclosure	2-	2	2
MC02	Right	Down	2013/2014	8 ft net exclosure	2	2+	2+
OM10	Right	Down	2013	Individual	2+	2	2+
TS07	Right	Down	2014	Individual	2-	3	3-
OM12	Right	Down	2013	Individual	1	1	1
SW04	Right	Down	2013	8 ft net exclosure	1	1	1-
SW07	Right	Down	2013	8 ft net exclosure	3+	2	2+
SW08	Right	Down	2013	8 ft net exclosure	1	1	2+
S081	Right	Down	2014	8 ft net exclosure	2	2	2

Plot ID	Bank	Upstream or Downstream of Bridge	Year Planted	Plant Protection Measure Installed	2015	2016	2017
OM13	Right	Down	2013	Individual	1+	1	1-
OM16	Right	Down	2013	Individual	1	1	1
S099	Right	Down	2013	8 ft net exclosure	2	2	2+
S088	Right	Down	2013	8 ft net exclosure	2	2	2
OM18	Right	Down	2013	Individual	1	1	2
S083	Right	Down	2013	Individual	2	-	1+
S092	Right	Down	2013	Individual	2+	1	2+
OM21	Right	Down	2013	Individual	2	1	2+
OM22	Right	Down	2013	Individual	2	1	1-
SW11	Right	Down	2013	8 ft net exclosure	1	1	1
OM24	Right	Down	2013	Individual	2-	2	2

- indicates no data collected

Floodplain Herbaceous Vegetation Cover

Transect	Stream bank	Cover Type or Transect Segment	2015 Distance (ft)	2015 Cover Class	2015 Dominant Species
1	Left	Depositional	2	4	none
1	Left	Colonizing herbaceous	5	3	spikerush
1	Left	Shrub - bank treatment	2	3	willow
1	Left	Colonizing woody	10	4	birch
1	Left	Riparian shrub	20	4	willow
1	Left	Herbaceous	134	1	slender wheatgrass, alfalfa, yarrow
1	Left	Herbaceous	12	2-	redtop, bluegrass, bluejoint
1	Left	Wetland herbaceous	30	4	cattails, bare ground
1	Left	Shrub	12	3	willow, bluejoint reedgrass
1	Left	Herbaceous	149	4	clover, yarrow
1	Right	Shrub-bank treatment	2	4	
1	Right	Bare alluvium	4	4	
1	Right	Herbaceous	199	2	clover
2	Left	Shrub-bank treatment	2	2	willow
2	Left	Colonizing woody	3	4	birch
2	Left	Herbaceous	44	2	slender wheatgrass, redtop, timothy
2		CHANNEL		N/A	
2	Right	Bare alluvium	26	4	
2	Right	Shrub-bank treatment	3	3	willows
2	Right	Herbaceous	8	3	
2	Right	Herbaceous	378	1+	yarrow, alfalfa, sage
2	Right	Colonizing woody	27	2	
2	Right	Wetland herbaceous	24	1	
2	Right	Open water	62	N/A	
2	Right	Wetland herbaceous	20	2	
2	Right	Herbaceous	52	1+	
3	Left	Shrub - bank treatment	2	2	
3	Left	Herbaceous	26	4	
		CHANNEL		N/A	
3	Right	Channel to bank treatment	5	1+	
3	Right	Bare alluvium	16	4	
3	Right	Wetland herbaceous	5	3	cattails
3	Right	Bare ground	18	4	
3	Right	Herbaceous	45	3	slender wheatgrass
3	Right	Colonizing woody	185	2	slender wheatgrass and clover
3	Right	Colonizing woody	280	1	slender wheatgrass and clover (alfalfa getting more dense)
3	Right	Herbaceous	42	1	different grasses than above

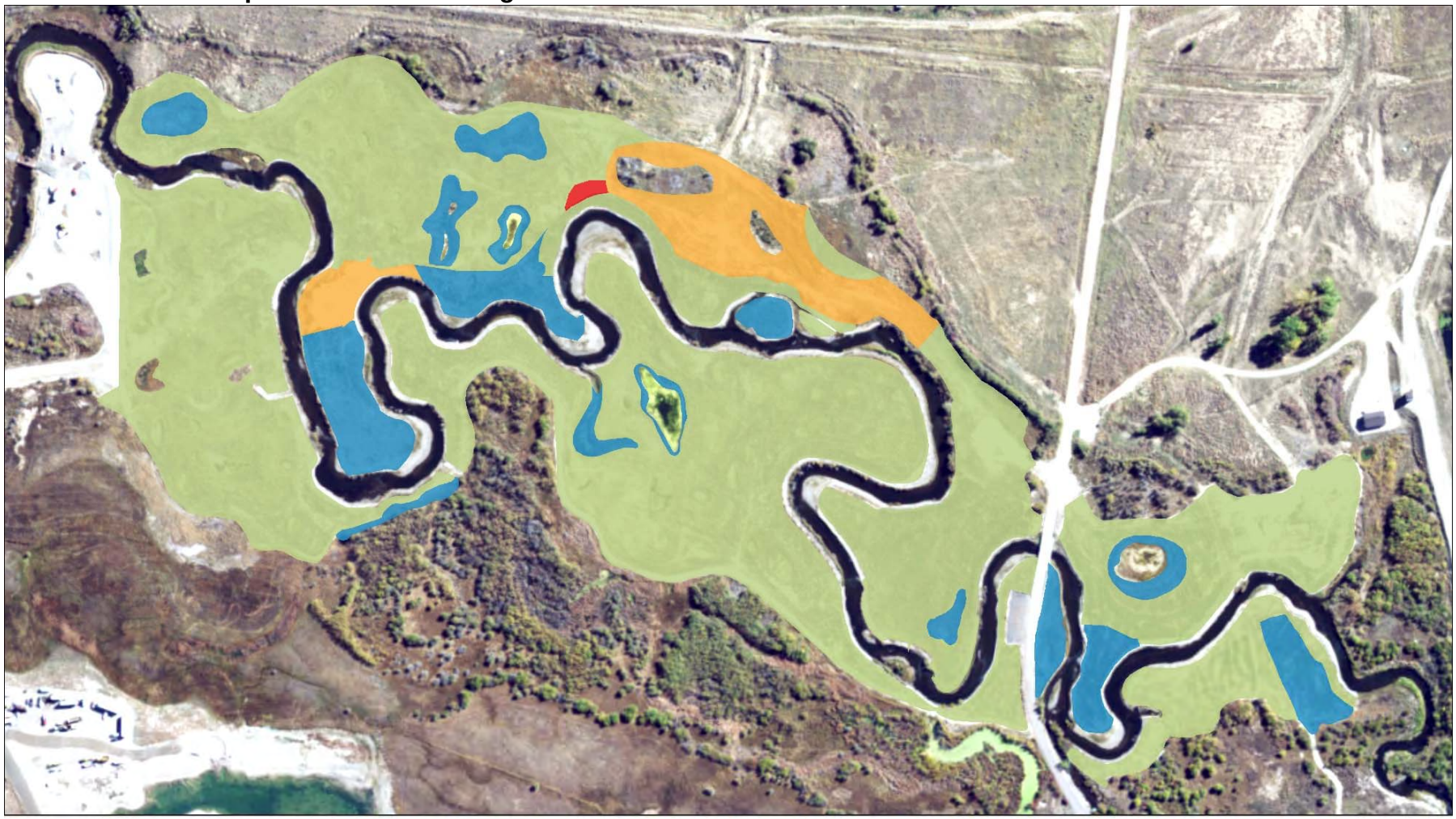
Transect	Stream bank	Cover Type or Transect Segment	2015 Distance (ft)	2015 Cover Class	2015 Dominant Species
3	Right	Herbaceous	28	2	
3	Right	Herbaceous	114	3	
3	Right	Herbaceous	20	2	
3	Right	Herbaceous	54	1	
5	Left	Shrub - bank treatment	2	1	
5	Left	Colonizing woody	15	4	
5	Left	Herbaceous	483	1	slender wheatgrass, yarrow
5	Left	Herbaceous	154	2-	slender wheatgrass
5		CHANNEL		N/A	
5	Right	Shrub - bank treatment	4	4	
5	Right	Bare alluvium	7	4	
5	Right	Colonizing woody	98	1	willow
5	Right	Bare ground	11	4	
5	Right	Herbaceous	37	3	
6	Left	Shrub - bank treatment	2	3	spikerush, mint
6	Left	Colonizing woody	15	2	birch
6	Left	Herbaceous	97	1	slender wheatgrass
6	Left	Wetland shrub	33	2	sandbar willow, kochia, slender wheatgrass
6	Left	Wetland herbaceous	79	1	bulrush, sedge, cattail
6	Left	Wetland herbaceous	10	2	redtop, goosefoot
6	Left	Herbaceous	165	1	kochia, slender wheatgrass
7	Left	Depositional	26	4	
7	Left	Wetland	53	3+	sedges, rushes, birch, naturally recruited willow
7	Left	Herbaceous	207	1	slender wheatgrass
7		CHANNEL		N/A	
7	Right	Shrub - bank treatment	2	4	
7	Right	Bare alluvium	12	4	
7	Right	Colonizing woody	20	2	tansy and yarrow
7	Right	Bare ground	64	4	
7	Right	Herbaceous	136	2	
7	Right	Wetland herbaceous	49	1	
7	Right	Herbaceous	71	3	
8	Left	Cobble toe	2	4	
8	Left	Shrub - bank treatment	2	2	willow
8	Left	Colonizing woody	10	4	birch
8	Left	Herbaceous	55	1	slender wheatgrass
8	Left	Herbaceous	10	3	slender wheatgrass
8		CHANNEL		N/A	

Transect	Stream bank	Cover Type or Transect Segment	2015 Distance (ft)	2015 Cover Class	2015 Dominant Species
8	Right	Bare alluvium	20	4	
8	Right	Shrub - bank treatment	37	3	
8	Right	Herbaceous	120	2	yarrow
8	Right	Open water	32	N/A	
8	Right	Colonizing woody	54	2	
8	Right	Wetland herbaceous	12	4	
8	Right	Colonizing woody	24	2	
8	Right	Herbaceous	175	1	
8	Right	Herbaceous	78	2	
8	Right	Herbaceous	57	1	
8	Right	Wetland herbaceous	20	3	
8	Right	Bare ground	15	4	
8	Right	Herbaceous	39	3	
8	Right	Herbaceous	55	2	
9E	Left	Shrub - bank treatment	2	2	willow
9E	Left	Colonizing woody	10	4	
9E	Left	Herbaceous	76	2	slender wheatgrass
9		CHANNEL		N/A	
9	Right	Bare alluvium	25	4	
9	Right	Colonizing woody	212	3-	mixed bare ground/veg (willow)
9	Right	Bare alluvium	15	4	
9		CHANNEL		N/A	
9W	Left	Shrub - bank treatment	2	2	willow
9W	Left	Colonizing woody	10	4	
9W	Left	Herbaceous	52	2-	mustard
9W	Left	Herbaceous wetland	47	1	sedges, foxtail barley
9W	Left	Herbaceous	14	2	kochia
9W	Left	Shrub wetland	42	2	willow
9W	Left	Herbaceous wetland	120	2	bulrush, sedges, foxtail barley
9W	Left	Shrub wetland	30	2	greasewood, slender wheatgrass, foxtail barley
9W	Left	Herbaceous	16	1	kochia, slender wheatgrass
9W	Left	Shrub wetland	39	2	redtop, bluejoint reedgrass, willow
9W	Left	Herbaceous	39	1	slender wheatgrass
10	Left	Shrub - bank treatment	2	2	willow
10	Left	Colonizing woody	10	3	grasses, spikerush
10	Left	Shrub	38	2	willows
10	Left	Herbaceous	222	2	slender wheatgrass, alfalfa, kochia, sage

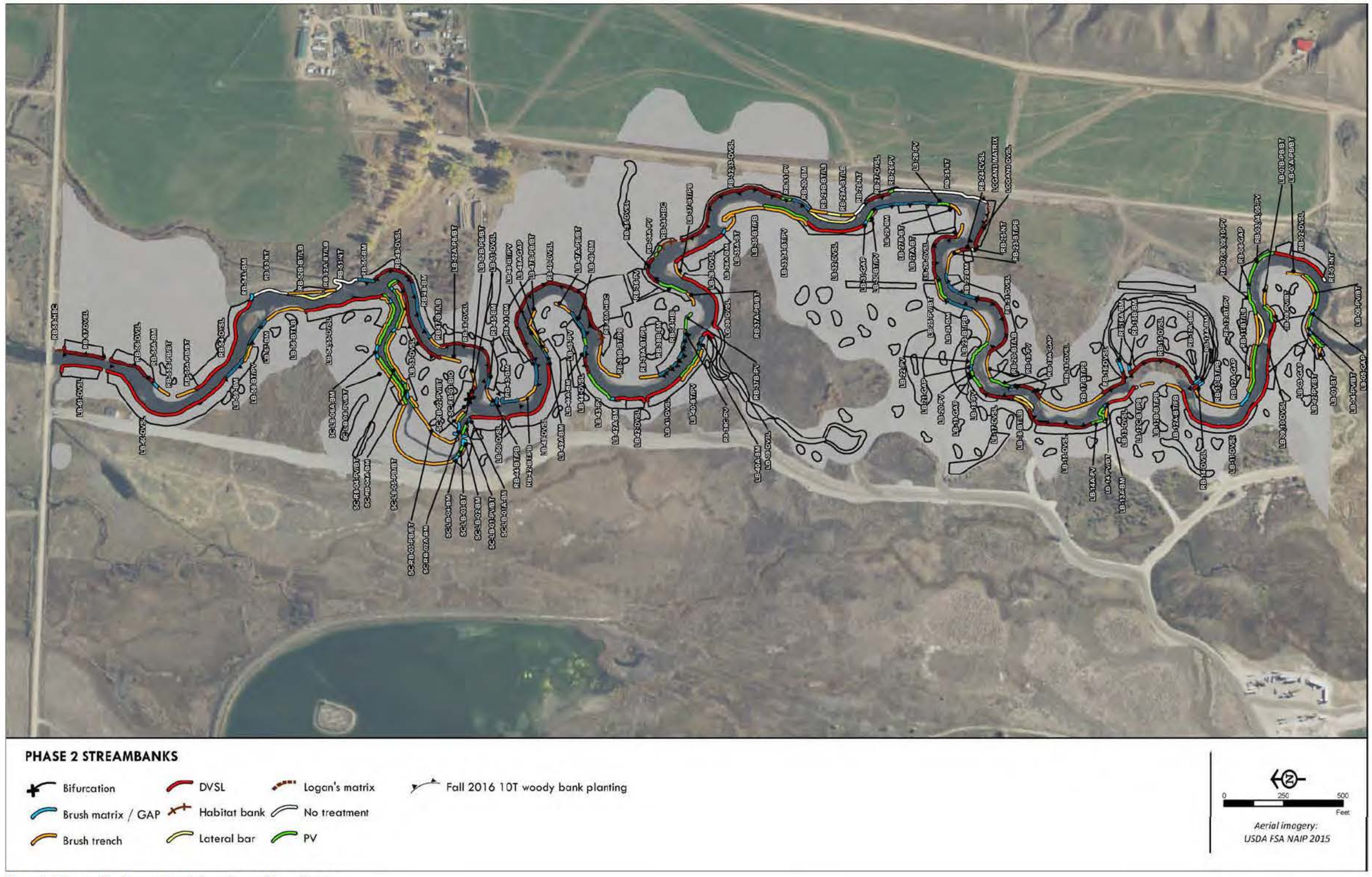
Transect	Stream bank	Cover Type or Transect Segment	2015 Distance (ft)	2015 Cover Class	2015 Dominant Species
10	Left	Shrub wetland	54	2-	sandbar willow, wet grasses
10	Left	Herbaceous	79	2	slender wheatgrass
10	Left	Herbaceous wetland	177	1	bluejoint reedgrass, cattail, sedges
10	Left	Herbaceous	151	2+	slender wheatgrass, kochia, yarrow
10		CHANNEL		N/A	
10	Right	Large cobble	3	4-	large cobble (6 to 10 in)
10	Right	Colonizing woody	22	4	
10	Right	Herbaceous	39	3	
10	Right	Herbaceous	20	2	yarrow
10	Right	Herbaceous	26	3	
10	Right	Bare ground	23	4	
10	Right	Herbaceous	107	2	

Transect	Stream bank	Cover Type or Transect Segment	2016 Distance (ft)	2016 Cover Class	2016 Dominant Species
2	Left	Shrub-bank treatment	2	-	willows
2	Left	Colonizing woody	5	4+	colonizing shrubs, coarse material
2	Left	Herbaceous	32	2	yarrow, redtop, tickle grass, licorice, foxtail barley, some thistle and colonizing willows
2		CHANNEL		N/A	
2	Right	Colonizing depositional	18	2	willow, spikerush, reed canarygrass, field mint
2	Right	Riparian shrub	338	1	alfalfa, yarrow, slender wheatgrass, intermediate wheatgrass, shrubs
2	Right	Wetland slope	73	1	Intermediate wheatgrass, slender wheatgrass, alfalfa, yarrow, basin wild rye
2	Right	Wetland herbaceous	34	1	Northwest Territory sedge, baltic rush, wooly sedge, Nebraska sedge
2	Right	Open water	54	2	hardstem bulrush, panicled bulrush
2	Right	Wetland herbaceous	15	1	Northwest Territory sedge, Baltic rush, other rush sp.
2	Right	Herbaceous	63	1	Intermediate wheatgrass, yarrow, great basic wild rye, alfalfa
5	Left	Road	17	4	PV bank lots of veg with colonizing woodies
5	Left	Herbaceous	27	3	wheatgrass and yarrow
5	Left	Herbaceous	129	2	ticklegrass, wheatgrass, foxtail barley
5	Left	Wetland herbaceous	60	2	rush sp., cattail, foxtail barley, some planted shrubs
5	Left	Herbaceous	390	3	yarrow, sage, alfalfa, wheatgrass, 1 leafy spurge plant
5	Left	Herbaceous	30	3	yarrow, sage, alfalfa, wheatgrass,
5	Left	Woody – bank treatment	4	1	redtop, wheatgrass, bare ground
5		CHANNEL		N/A	
5	Right	Colonizing depositional	10	4	sandbar willow, alder, slender wheatgrass
5	Right	Riparian shrub/Herbaceous	92	2+	mustard, sandbar willow, basin wild rye
5	Right	Colonizing depositional	17	4	alfalfa, baltic rush, willow, other grasses
5	Right	Side channel – wetland herbaceous	8	3	foxtail barley, spikerush, willow
5	Right	Riparian shrub/Herbaceous	41	2	Yarrow, licorice, slender wheatgrass, alfalfa

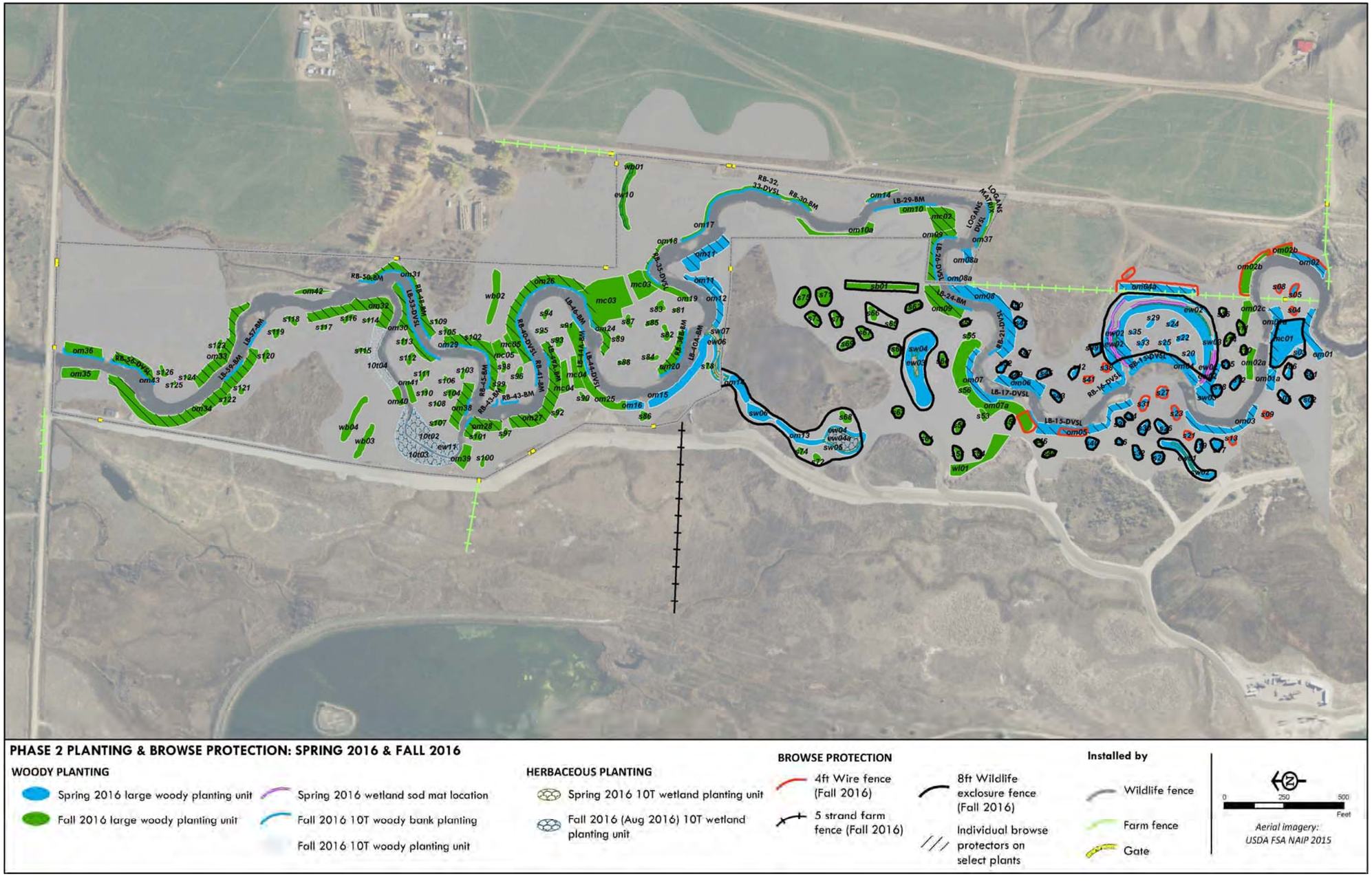
Phase 1 2017 Floodplain Herbaceous Vegetation Cover



Attachment F – Phase 2 Treatment Locations



Map 1. Phase 2 streambank treatment locations.



Map 2. Location of Phase 2 planting locations.

Attachment G – Phase 2 Geomorphology Photos
2017






Photos 1-6. Indicators of June 2017 overbank flows.






Photos 7-12. Examples of vegetation establishment on point bars.




Photos 13-16. Examples of willow sprouting in brush matrix treatments.

Photo 17. View downstream of floodplain erosion, 85+00L.

Photo 18. View downstream of bank LB-11 identified for continued monitoring.

Photo 19. Fine grained deposition at toe of brush matrix.

Photo 20. Vegetation expansion in DVSL, Phase 2.

Attachment H – Phase 2 Geomorphology QRA Results

Channel Stability

Category	Score
Category 1: Likely Degrading	1
Category 2: Largely Stable/Trending	2 to 4
Category 3: Likely Aggrading	5

Year	2017
Location	Phase 2
Parameter	**Score**
Riffle Substrate Consolidation	3
Point Bar Morphology	3
Bank Failure Mechanism	3
Bar Development	4
Bank Erosion Extent	4
Width:Depth Ratio	4
Channel Pattern	3
Constructed Bank Toe Height	2
Sediment Source or Sink	3
Field Stability Rating	3.2
Over all Category	**Category 2: Largely Stable/Trending**
Notes	**No evidence of systemic instability**

Floodplain Connectivity

Year[1]	Station	Observation
2017	5+00	Floodplain wood mobilization
2017	21+00	Floodplain wood mobilization
2017	23+00	Overbank sediment deposition
2017	24+00	High water mark left bank 0.5 ft
2017	51+00	Overbank sediment deposition
2017	69+00	Floodplain wood racked on point bar brush trench; sand accumulations
2017	90+00	Left floodplain sheet erosion = low surface
2017	86+00	High water mark left bank 0.4 ft
2017	105+00	No meander core overflow 2017
2017	165+00	Floodplain wood mobilization

[1] Floodplain connectivity was evaluated in 2017 because flows exceeded bankfull design flows of 584 cfs. The highest recorded flow in 2017 at the USGS 12323800 Galen Station was 878cfs on June 14, 2017.

Streambank Condition

Year	Streambank Treatment ID[1]	Issue	Recommended Management Action
2017	LB-11 DVSL	Slumping, toe gone, cracks in bankline	Monitor

[1]All locations where streambank treatment condition had changed since construction were recorded.

Attachment I – Phase 2 QRA Vegetation Photos

Phase 2 2017 Streambank Woody Vegetation Cover Categories

**Top left: Category 1 (>40%) (RB-2); Top right: Category 1 (>40%) (LB-13A);
Middle left: Category 2 (10 to 40%) (RB-18); Middle right: Category 2 (10 to 40%) (RB-43);
Bottom left: Category 3 (<10%) (RB-12a); Bottom right: Category 3 (<10%) (LOGAN MATRIX)**

Phase 2 2017 Floodplain Woody Vegetation Cover Categories

Top left: Category 1 (>30%) (om30); Top right: Category 2 (10 to 30%) (s101); Bottom center: Category 3 (<10%) (s125).

Phase 2 2017 Floodplain Herbaceous Vegetation Cover Categories

Top left: Category 1 (>80%) (irrigated hayfield on right bank, owner seeded); Top right: Category 2 (50-80%) (within om08 on right bank); Lower Left: Category 3 (20-50%) (downstream end of left bank along fence); Lower right: Category 4 (<20%) (pump area on right bank near om14).

Phase 2 2017 Woody Vegetation Survival Categories

Top left: Category 1 (>80%) (om32); Top right: Category 2 (50 to 80%) (s97); Bottom center: Category 3 (<50%) (s16).

Phase 2 2017 Vegetation Miscellaneous Photographs

Photos 1-3. Point bar conditions in Phase 2 in 2017. Photo 1: point bar across from om04 with sparse vegetative cover; Photo 2: point bar across from om17 with willow, cottonwood and herbaceous wetland vegetation cover; Photo 3: Preserve vegetation area within point bar across from om17 with diverse wetland vegetation and small stand of reed canarygrass.

Photo 4. Fine sediment deposited along streambank alluvium from slope erosion from irrigation prior to seed establishment.




Photos 5-8. Herbaceous cover in Phase 2. Photo 5: high cover of seeded slender wheatgrass on west floodplain near mc01; Photo 6: high cover of yarrow in floodplain between om03 and om05; Photo 7: high cover of seeded forbs on island; Photo 8: high cover of seeded forbs in om29.


Photos 9-10. Irrigated hayfields within construction limits.

Photos 11-14. West floodplain between om07 and om11 where woody vegetation survival is very low and either herbaceous vegetation cover is very low or cover is dominated by invasive species. Photo 11: low herbaceous cover near om07; Photo 12: sb01 with no woody planted woody vegetation alive and high cover of invasive species; Photo 13: s71 with no woody planted woody vegetation alive and high cover of invasive species; Photo 14: area along the channel where no soil was used with very low cover.





Photos 15-19. Swales in Phase 2. Photo 15: s23 with high survival and cover of woody vegetation; Photo 16: s46 with high survival and cover of woody vegetation; Photo 17: s75 with low woody vegetation survival and colonization of cattails in the bottom of the swale; Photo 18: s96 with moderate woody vegetation survival and cover and wet conditions in the bottom; Photo 19: s116 with standing water in bottom and ring of sandbar willow seedlings in a 1-foot band around the swale bottom above the open water.







Photos 20-27. Wetland conditions in Phase 2 in 2017. Photo 8: sw02; Photo 9: sw04 with high cover of weeds on wetland slopes but high cover of sedges and rushes on wetland bottom - this wetland is much drier than other wetlands; Photos 10 and 11: wetland sw07 that connects to the Clark Fork River channel; Photo 12: sw05 and ew04 showing a narrow fringe of wetland vegetation and an area that has standing water most of the growing season; Photo 13: the secondary channel and ew11 located on the secondary channel; Photos 14 and 15: oxbow wetland.


Photos 28-29. Photo 16: Windbreak 01 (wb01) with herbaceous wetland plants installed in the bottom; Photo 17: Windbreak 04 (wb04) with high survival of planted trees and shrubs.

Attachment J – Phase 2 QRA Vegetation QRA Results

Streambank Woody Vegetation Cover

Streambank Treatment ID	Streambank	Streambank Treatment Type	2017
LB-1	Left	BT	1
LB-2	Left	PV	2
LB-3	Left	Gap	3
LB-4	Left	PV	1
LB-5	Left	Gap	3+
LB-6	Left	PV	1
LB-7	Left	PB/BT	2+
LB-8	Left	PV/BT	2+
LB-9	Left	DVSL	1
LB-10	Left	DVSL	1
LB-11	Left	DVSL	2+
LB-12a	Left	PB/BT	2-
LB-12b	Left	PB/BT	2
LB-12c	Left	PB/BT	2+
LB-13	Left	DVSL	1
LB-13a	Left	BM	1
LB-14	Left	PV/BT	1
LB-14a	Left	PV	1
LB-15	Left	DVSL	2
LB-16	Left	LB/BT	2
LB-17	Left	DVSL	2
LB-18	Left	PV	1
LB-19	Left	GAP	3
LB-20	Left	PV	1
LB-21	Left	GAP	3
LB-22	Left	PV	1
LB-23	Left	PB/BTT	2
LB-24	Left	BM	2
LB-25	Left	PV/BT	1
LB-26	Left	DVSL	2
LB-27a	Left	BT	1
LB-27b	Left	BT	1
LB-29	Left	BM	2
LB-30	Left	PV/BT	1
LB-31	Left	GAP	2+
LB-32	Left	DVSL	1

Streambank Treatment ID	Streambank	Streambank Treatment Type	2017
LB-33 -34	Left	PV/BT	1
LB-35	Left	PB/BT	1
LB-35a	Left	BT	1
LB-36a	Left	BM	1
LB-36	Left	DVSL	2+
LB-37	Left	PV/BT	2+
LB-38	Left	DVSL	2
LB-39	Left	DVSL	2
LB-40	Left	BM	1
LB-41	Left	DVSL	2
LB-42	Left	DVSL	2
LB-42a	Left	BM	3
LB-43	Left	PV	1
LB-44	Left	DVSL	2-
LB-44a	Left	BM	3
LB-45	Left	PV	1
LB-46	Left	BM	2
LB-47a	Left	PV/BT	1
LB-47b	Left	PB/BT	1
LB-48a	Left	GAP	1
LB-48	Left	PV/BT	1
LB-49a	Left	BM	2-
LB-49	Left	DVSL	2
LB-50	Left	DVSL	2
LB-51	Left	DVSL	2
LB-52a	Left	PB/BT	1
LB-52b	Left	PB/BT	1
LB-53	Left	DVSL	1
LB-54	Left	DVSL	1
LB-55	Left	DVSL	1
LB-56	Left	LB/BT	2-
LB-57	Left	BM	2-
LB-58	Left	PV/BT	1
LB-59	Left	BM	2-
LB-60	Left	DVSL	1
LB-61	Left	DVSL	1
RB-1	Right	NT	
RB-2	Right	DVSL	1
RB-3 to RB5	Right	PV	1

Streambank Treatment ID	Streambank	Streambank Treatment Type	2017
RB-6	Right	BM	3
RB-7 to RB10	Right	PV	1
RB-11	Right	PB/BT	1
RB-12	Right	PV	1
RB-12a	Right	GAP	3
RB-13	Right	PB/BT	2
RB-14	Right	DVSL	1
RB-15	Right	DVSL	2
RB-15b	Right	BM	1
RB-16	Right	DVSL	1
RB-17	Right	PB/BT	1
RB-18	Right	DVSL	2
RB-19a	Right	GAP	3
RB-19	Right	PV	1
RB-20	Right	LB/BT	1
RB-21	Right	DVSL	2
RB-22	Right	BM	2
RB-23	Right	PB/BT	1
RB-24	Right	DVSL	1
Logan's DVs	Right	DVSL	2
Logan's Matrix	Right	Matrix	3
RB-26	Right	PV	1
RB-27	Right	DVSL	2
RB-29a	Right	LB/BT	2
RB-30	Right	BM	2
RB-31	Right	PV	1
RB-32 to RB-33	Right	DVSL	1
RB-34a	Right	PV	1
RB-34	Right	Habitat	2
RB-35	Right	DVSL	2
RB-36	Right	PV	1
RB-37a	Right	PB/BT	1
RB-37b	Right	PV	1
RB-38c	Right	PV	1
RB-34	Right	Habitat	3
RB-38b	Right	BM	1
RB-39a	Right	PB/BT	2+
RB-39b	Right	PB/BT	2
RB-40a	Right	Habitat	3

Streambank Treatment ID	Streambank	Streambank Treatment Type	2017
RB-40a	Right	DVSL	2-
RB-41	Right	BM	3
RB-42	Right	PB/BT	1
RB-43	Right	BM	2
RB-44	Right	PB/BT	2
RB-45	Right	BM	2-
RB-46	Right	DVSL	2-
RB-47	Right	BT	1
RB-48	Right	BM	2+
RB-49	Right	DVSL	2-
RB-50	Right	BM	1
RB-52a	Right	LB/BT	1
RB-52b	Right	LB/BT	1
RB-54	Right	DVSL	1
RB-55a	Right	PB/BT	2
RB-56a	Right	BM	2
RB-56	Right	DVSL	1
SCRB-01	Right Side Channel	Bif	1
SCRB-02	Right Side Channel	PV/BT	1
SCRB-02a	Right Side Channel	BM	2
SCRB-03	Right Side Channel	PV/BT	1
SCRB-04a	Right Side Channel	BM	3
SCRB-04	Right Side Channel	PV	1
SCLB-01	Left Side Channel	BM	1
SCLB-04a	Left Side Channel	BM	1
SCLB-05	Left Side Channel	PB/BT	2
SCLB-06	Left Side Channel	PV/BT	1
SCLB-06a	Left Side Channel	BM	1

- indicates no data collected
DVSL: double vegetated soil lift
SVSL: single vegetated soil lift
PV: preserve vegetation
BT: brush trench
GAP: woody brush matrix
BM: brush matrix
NT: no treatment
Habitat: live willows
LB: lateral bar
PB: point bar
Bif: bifurcation

Floodplain Woody Vegetation Cover

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2017
s02	Left	2016	8 ft net exclosure	2+
om01	Left	2016	Select individual	2-
om03	Left	2016	Select individual	2-
sw02	Left	2016	8 ft net exclosure	2
s27	Left	2016	48 inch wire	1
s36	Left	2016	8 ft net exclosure	2+
wl01	Left	2016	None	2
om09	Left	2016	Select individual	2-
s62	Left	2016	8 ft net exclosure	2-
sb01	Left	2016	8 ft net exclosure	3-
s70	Left	2016	8 ft net exclosure	2-
s71	Left	2016	8 ft net exclosure	3
om10a	Left	2016	None	2-
om11	Left	2016	Select individual	2
sw07	Left	2016	8 ft wire fence	2
om15	Left	2016	8 ft wire fence	2
mc04	Left	2016	8 ft wire fence	2
s92	Left	2016	8 ft wire fence	2
s97	Left	2016	8 ft wire fence	2
s101	Left	2016	8 ft wire fence	2
s100	Left	2016	8 ft wire fence	3
om39	Left	2016	8 ft wire fence	2+
om28	Left	2016	8 ft wire fence, Select individual	2
s107	Left	2016	8 ft wire fence	2-
om30	Left	2016	8 ft wire fence, Select individual	1+
wb04	Left	2016	8 ft wire fence	1
10t04	Left	2016	8 ft wire fence	3
s115	Left	2016	8 ft wire fence	2+
om32	Left	2016	8 ft wire fence, Select individual	2
s117	Left	2016	8 ft wire fence	2+
s118	Left	2016	8 ft wire fence	2
s122	Left	2016	8 ft wire fence	2
om34	Left	2016	8 ft wire fence, Select individual	3
om35	Left	2016	8 ft wire fence	3+
om2b	Right	2016	48 inch wire	3-
s12	Right	2016	8 ft net exclosure	2
s24	Right	2016	8 ft net exclosure	2
om04	Right	2016	Select individual	2-

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2017
s33	Right	2016	8 ft net exclosure	2
s16	Right	2016	8 ft net exclosure	3+
s45	Right	2016	8 ft net exclosure	1+
s50	Right	2016	8 ft net exclosure	2
om08	Right	2016	Select individual	2-
om37	Right	2016	8 ft wire fence, Select individual	3-
om17	Right	2016	8 ft wire fence, Select individual	3
wb01	Right	2016	8 ft wire fence	3+
mc03	Right	2016	8 ft wire fence	2
s83	Right	2016	8 ft wire fence	2-
s88	Right	2016	8 ft wire fence	3
wb02	Right	2016	8 ft wire fence	3+
om29	Right	2016	8 ft wire fence, Select individual	3
s96	Right	2016	8 ft wire fence	3
om42	Right	2016	8 ft wire fence	3+
s123	Right	2016	8 ft wire fence	3-
s125	Right	2016	8 ft wire fence	3-
om43	Right	2016	8 ft wire fence, Select individual	3+

- indicates no data collected

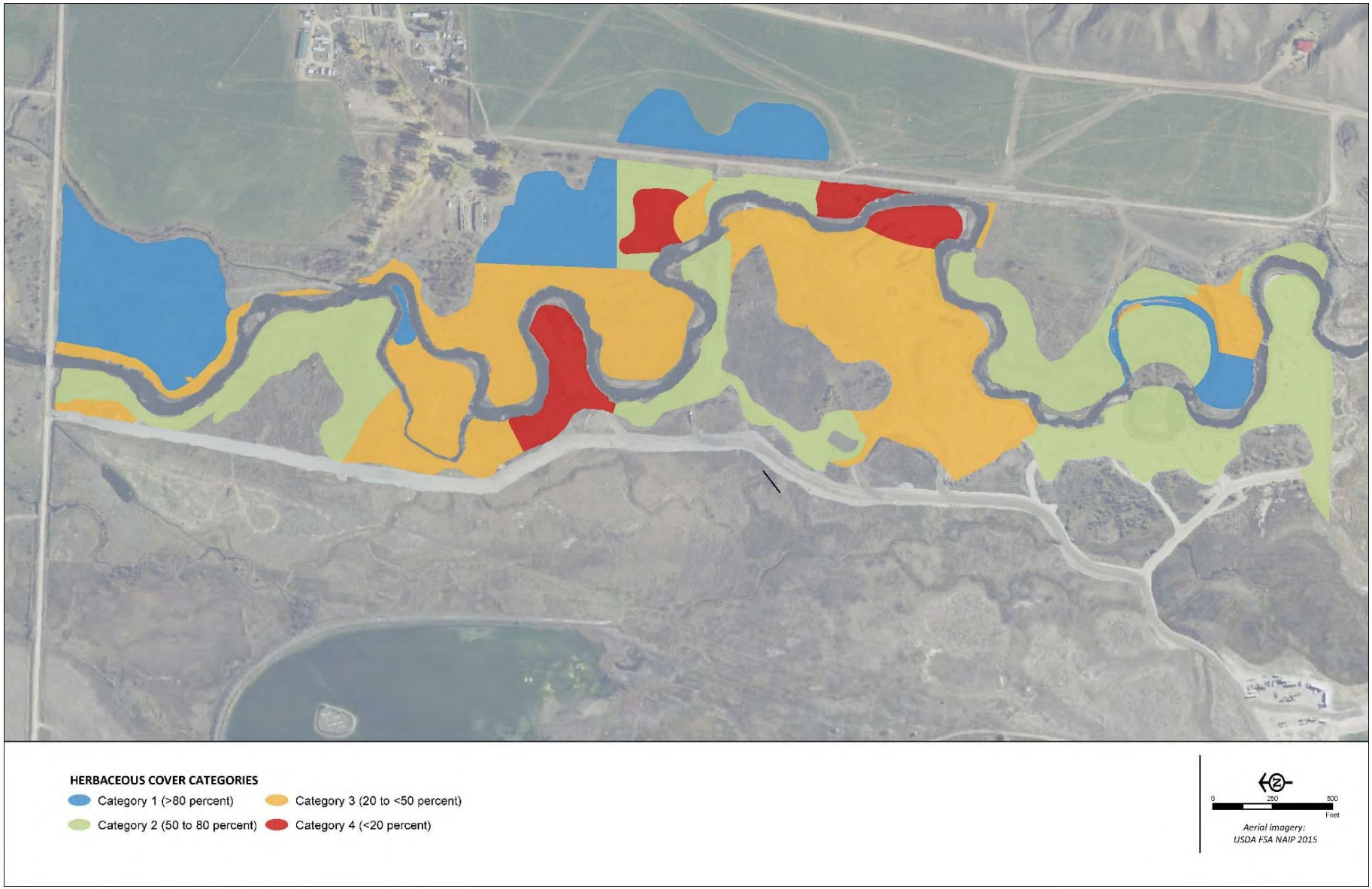
Planted Woody Vegetation Survival

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2017
s02	Left	2016	8 ft net exclosure	2+
om01	Left	2016	Select individual	1-
om03	Left	2016	Select individual	1-
sw02	Left	2016	8 ft net exclosure	2
s27	Left	2016	48 inch wire	1
s36	Left	2016	8 ft net exclosure	1
wl01	Left	2016	None	2
om09	Left	2016	None	2+
s62	Left	2016	8 ft net exclosure	2
sb01	Left	2016	8 ft net exclosure	3-
s70	Left	2016	8 ft net exclosure	2-
s71	Left	2016	8 ft net exclosure	3
om10a	Left	2016	None	2
om11	Left	2016	Select individual	1
sw07	Left	2016	8 ft wire fence	2
om18	Left	2016	8 ft wire fence	2
mc04	Left	2016	8 ft wire fence	1-
s92	Left	2016	8 ft wire fence	1-
s97	Left	2016	8 ft wire fence	2
s101	Left	2016	8 ft wire fence	1
s100	Left	2016	8 ft wire fence	2+
om39	Left	2016	8 ft wire fence	1+
om28	Left	2016	8 ft wire fence, Select individual	1-
s107	Left	2016	8 ft wire fence	1
om30	Left	2016	8 ft wire fence, Select individual	1+
wb04	Left	2016	8 ft wire fence	1
10t04	Left	2016	8 ft wire fence	1
s115	Left	2016	8 ft wire fence	1
om32	Left	2016	8 ft wire fence, Select individual	1+
s117	Left	2016	8 ft wire fence	1+
s118	Left	2016	8 ft wire fence	1+
s122	Left	2016	8 ft wire fence	1
om34	Left	2016	8 ft wire fence, Select individual	1+
om35	Left	2016	8 ft wire fence	1+
om2b	Right	2016	48 inch wire	2+
s12	Right	2016	8 ft net exclosure	1
s24	Right	2016	8 ft net exclosure	1
om04	Right	2016	Select individual	2

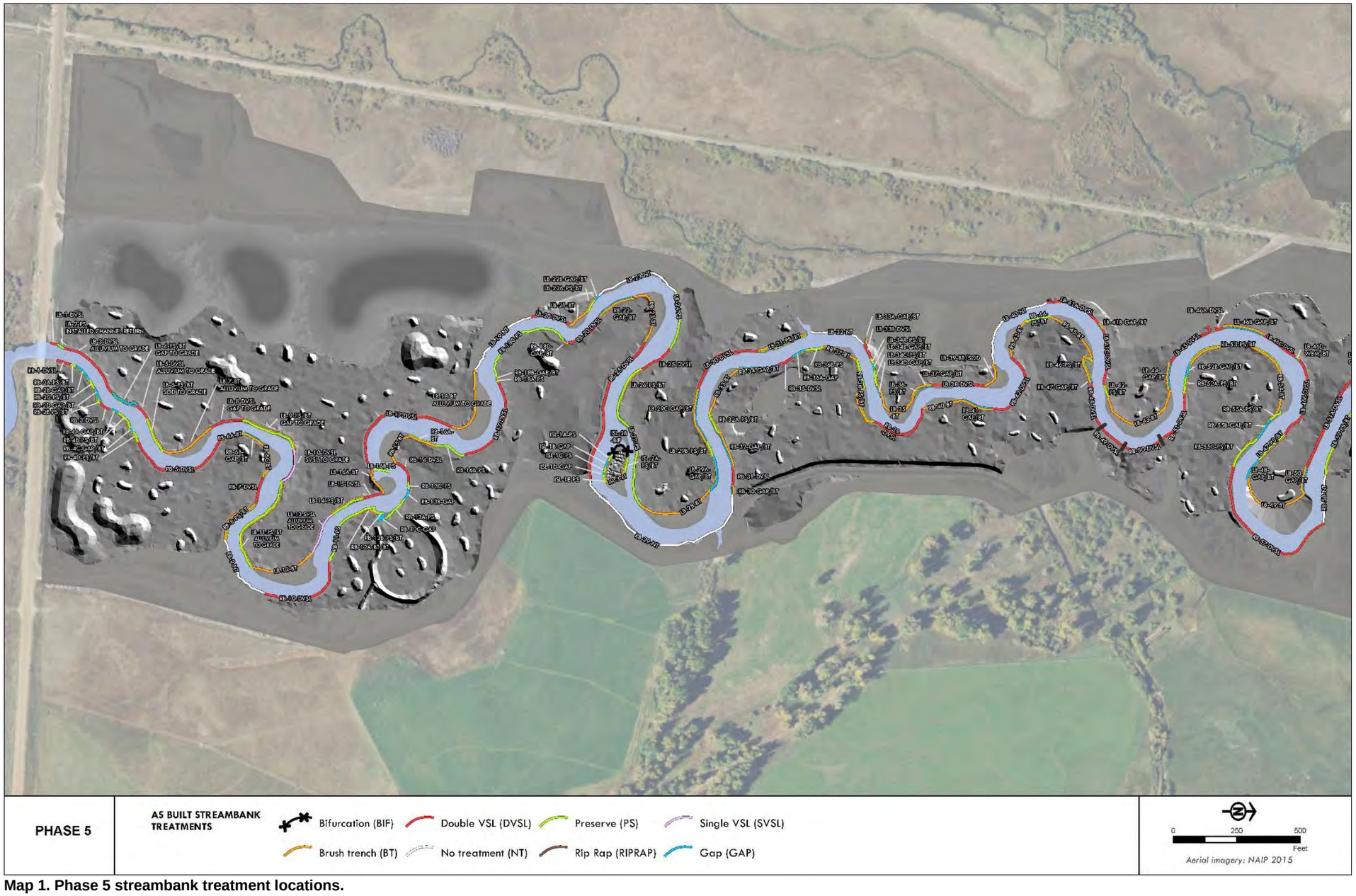
Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2017
s33	Right	2016	8 ft net exclosure	1
s16	Right	2016	8 ft net exclosure	1-
s45	Right	2016	8 ft net exclosure	1-
s50	Right	2016	8 ft net exclosure	1
om08	Right	2016	Select individual	1
om37	Right	2016	8 ft wire fence, Select individual	1+
om17	Right	2016	8 ft wire fence, Select individual	1
wb01	Right	2016	8 ft wire fence	1-
mc03	Right	2016	8 ft wire fence	1
s83	Right	2016	8 ft wire fence	1
s88	Right	2016	8 ft wire fence	1
wb02	Right	2016	8 ft wire fence	1
om29	Right	2016	8 ft wire fence, Select individual	1
s96	Right	2016	8 ft wire fence	1
om42	Right	2016	8 ft wire fence	1
s123	Right	2016	8 ft wire fence	1
s125	Right	2016	8 ft wire fence	1
om43	Right	2016	8 ft wire fence, Select individual	1-

- indicates no data collected

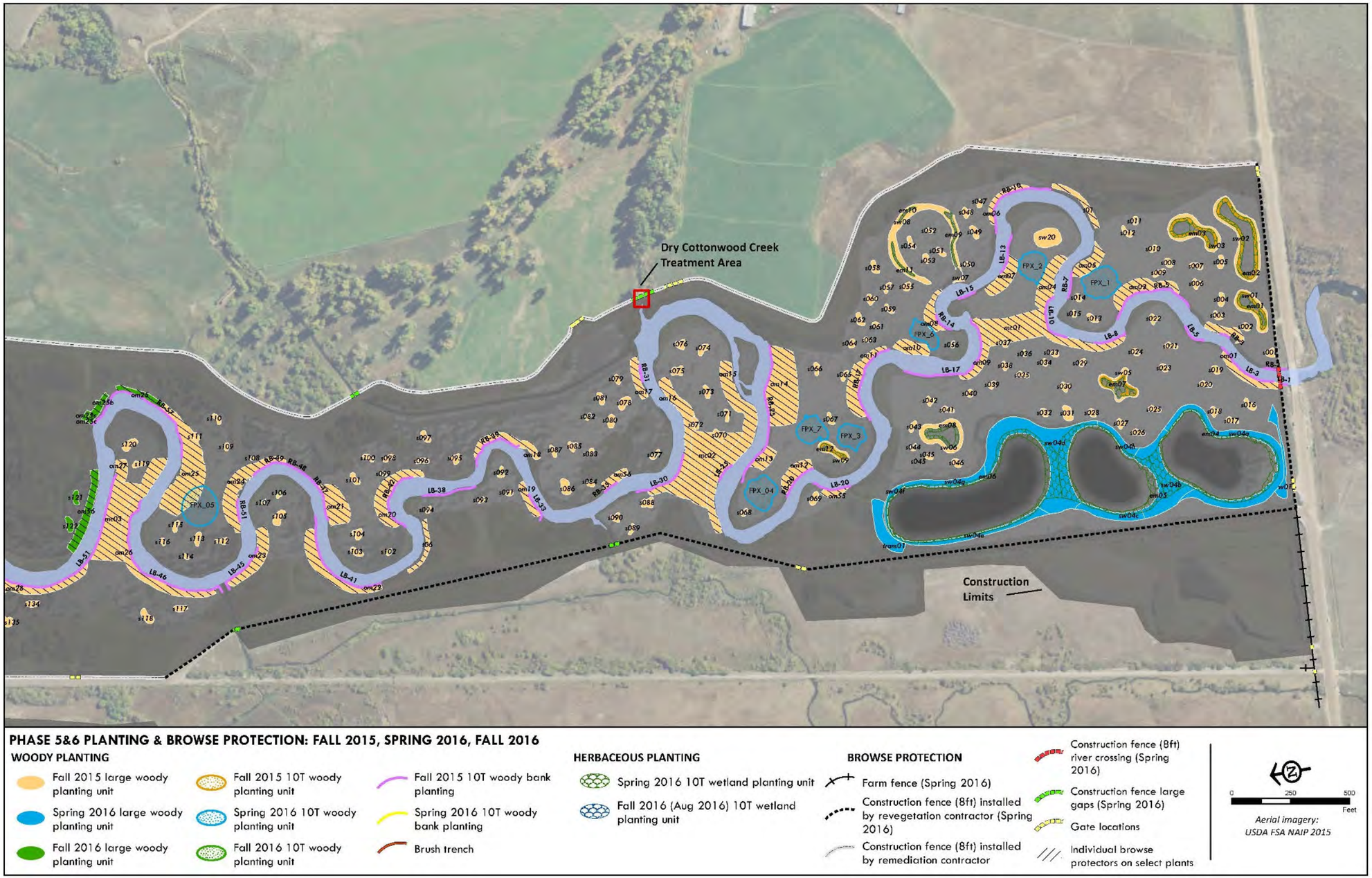
Herbaceous Vegetation Cover Phase 2 2017



Attachment K – Phases 5 and 6 Treatment Locations

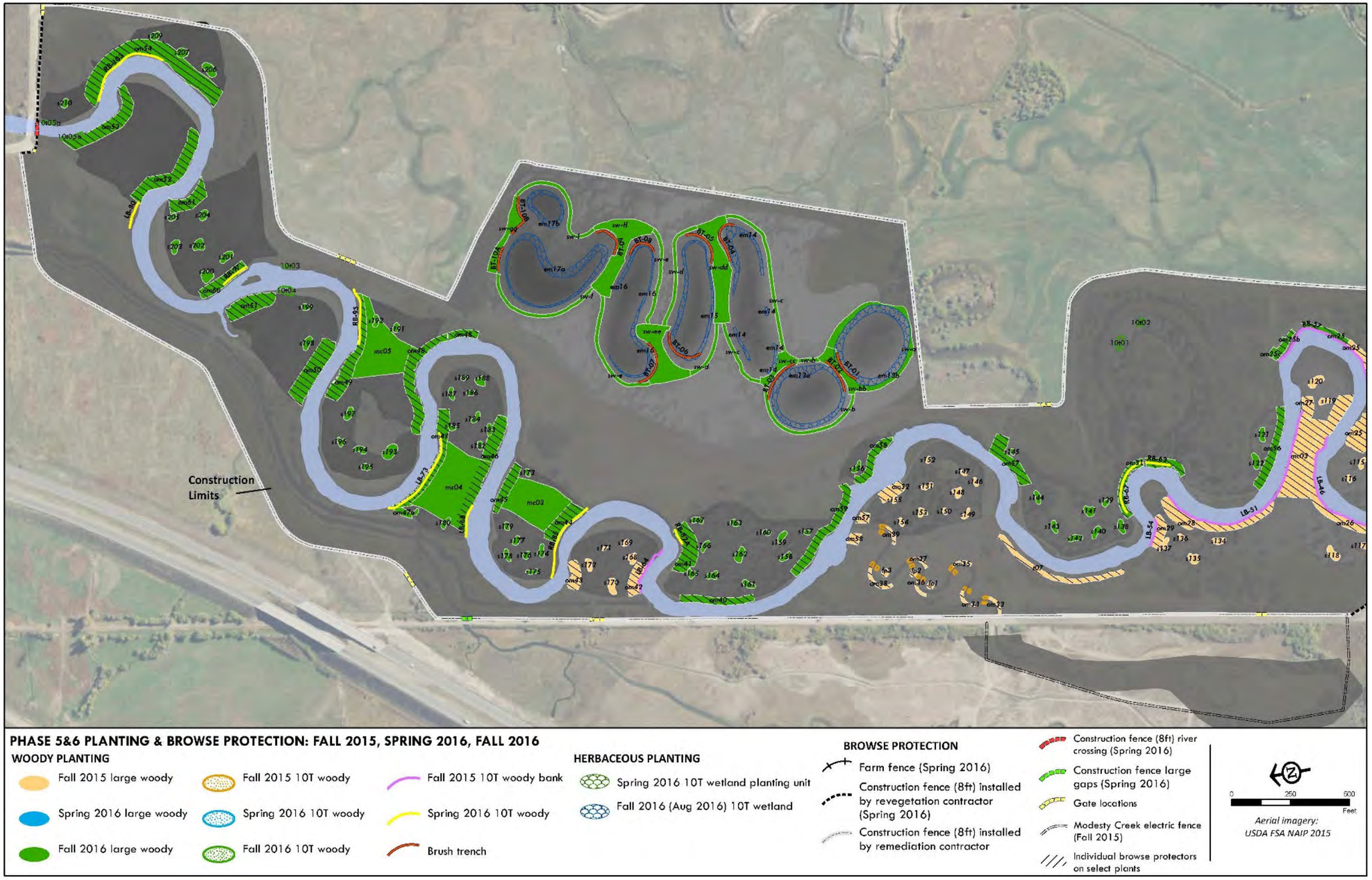


Map 1. Phase 5 streambank treatment locations.



Map 2. Phase 5 planting locations.

Map 3. Phase 6 streambank treatment locations.



Map 4. Phase 6 planting locations.

Attachment L – Phase 5 and 6 Geomorphology Photos
2017






Photos 1-3. High water indicators from 2017 that indicate approximately bankfull conditions in Phase 5-6 (only localized floodplain overflow).




Photos 4-7. Examples of vegetation establishment on point bars, Phase 5-6, 2017.

Photos 8-11. Examples of willow sprouting in brush matrix treatments, Phase 5-6, 2017.

Photo 12. In-stream fine grained deposition, Phase 5.

Photo 13. Bank RB-14 identified for continued monitoring.

Photo 14. Bank RB-17 identified for continued monitoring.

Photo 15. Bank LB-46E identified for continued monitoring.

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Photo 16. Actively eroding No Treatment bank (LB-40).

Photo 17. Vegetation expansion in DVSL.

Attachment M - Phases 5 and 6 Geomorphology QRA Results

Channel Stability

Category	Score
Category 1: Likely Degrading	1
Category 2: Largely Stable/Trending	2 to 4
Category 3: Likely Aggrading	5

Year	2016	2017
Location	Phases 5 and 6	Phases 5 and 6
Parameter	**Score**	**Score**
Riffle Substrate Consolidation	4	4
Point Bar Morphology	3	4
Bank Failure Mechanism	4	3
Bar Development	3	3
Bank Erosion Extent	4	3
Width:Depth Ratio	4	5
Channel Pattern	3	3
Constructed Bank Toe Height	3	3
Sediment Source or Sink	4	3
Field Stability Rating	3.6	3.4
Over all Category	**Category 2: Largely Stable/Trending**	**Category 2: Largely Stable/Trending**
Notes	**2016 field indicators of fine sediment deposition in slackwater areas**	**No evidence of systemic instability**

Floodplain Connectivity

Year[1]	Station	Observation
2017	4+00	Floodplain wood mobilization
2017	9+50	Floodplain wood mobilization
2017	14+00	Floodplain wood mobilization
2017	18+00	High water mark left bank 0.9 ft
2017	25+00	High water mark left bank 1.4 ft
2017	49+00	No meander core overflow 2017
2017	86+00	High water mark left bank 0.4 ft
2017	105+00	No meander core overflow 2017
2017	165+00	Floodplain wood mobilization

[1] Floodplain connectivity was evaluated in 2017 because flows exceeded bankfull design flows of 641 cfs for the Top reach and 682 cfs for the lower reach. The highest recorded flow in 2017 at the USGS 12323800 Galen Station was 878 cfs on June 14, 2017.

Streambank Condition

Year	Streambank Treatment ID[1, 2]	Issue	Recommended Management Action
2016	RB-4C-BM	Alluvium washing out and exposing brush material	Monitor
2016	LB-11-BM	Brush Matrix weak on woody material	Reassess for growth in next QRA
2016	RB-14-DVSL	Good 10ts. Some degradation on lower lift but fabric still strong. Sediment deposition on bottom lift.	Monitor
2016	RB-17-DVSL	Some loss of toe with slumping; especially lower 150' (native clay toe); brush trenches and veg look good	Monitor
2016	RB-32-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-29A-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-29C-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-34-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-36A-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-33A-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-33B-DVSL	Native soil at bottom of DVSL has high Fe content and no veg	Monitor
2016	LB-34B-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-34D-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-37-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-41-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-41B-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-47-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-48-51-DVSL	Slumping of DVSL due to ice damage at toe	Monitor
2016	LB-41C-DVSL	Some fabric abraded by ice. Approximately 10 lf of DVSL with no vegetation at Station 91+00.	Monitor
2016	LB-44-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-46B-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-46D-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-46E-DVSL	Toe loss due to ice both lifts sagging	Monitor
2016	RB-57-DVSL	Slumping of DVSL due to ice damage to toe above deeper pools	Monitor
2016	LB-51B-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA

Year	Streambank Treatment ID[1, 2]	Issue	Recommended Management Action
2016	RB-62-DVSL	Approximately 2 lf of sacrificial toe missing in front of DVSL	None
2016	RB-67-DVSL	Slumping of DVSL due to ice damage to toe avove deeper pools. Tearing of fabric over bottom coir log	Monitor
2016	RB-68-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-56-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-72-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-74-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-76A-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-77-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-64-DVSL	Minor fabric tears due to ice; poor willow growth approximately 50' d/s of treatment start	None
2016	RB-85-DVSL	Low willow survival in lifts	Reassess for growth in next QRA
2016	RB-87A-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	LB-75-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-97-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-102-BM	Little or no live veg in brush matrix	Reassess for growth in next QRA
2016	RB-103-DVSL	Torn/damaged fabric on small portion of bottom coir log in DVSL	None

[1]All locations where streambank treatment condition had changed since construction were recorded. Additional details were recorded for streambanks that shows substantial change (see 2016 Streambank Evaluation Form below).

[2] In Phases 5 and 6 Brush Matrix (BM) treatments were identified as GAP/BT treatments.

Year	Streambank Treatment ID[1, 2]	Issue	Recommended Management Action
2017	RB-4C-BM	On steep riffle-- holding up to high energy site conditions	None
2017	LB-11-BM	Good growth	None
2017	RB-14-DVSL	Two major slumps; outside bend, toe loss	Monitor
2017	RB-17-DVSL	Some slumping and lost logs; great willows downstream of lift loss	Monitor
2017	RB-32-BM	Good low flow cover	Reassess for growth in next QRA
2017	LB-29A-BM	Some spreading in BM	None
2017	LB-29C-BM	Poor spreading; deposition on top	Reassess for growth in next QRA
2017	RB-34-BM	Great BT Growth	None
2017	RB-36A-BM	Good low flow cover	Reassess for growth in next QRA

Year	Streambank Treatment ID[1, 2]	Issue	Recommended Management Action
2017	LB-33A-BM	Some willows in BM, BT OK	None
2017	LB-33B-DVSL	Willows on top log, some bare areas	None
2017	LB-34B-BM	Willows in BM, BT OK	None
2017	LB-34D-BM	Toe deposition, willows/grasses, BT ok	None
2017	LB-37-BM	No growth in BM but OK	Reassess for growth in next QRA
2017	RB-41-BM	Robust BT	None
2017	LB-41B-BM	Stable but no growth in BM	Reassess for growth in next QRA
2017	RB-47-BM	OK-- draped on clay toe	Reassess for growth in next QRA
2017	RB-48-51-DVSL	Minor slumping-- all good	None
2017	LB-41C-DVSL	Some fabric damage, willows OK	None
2017	LB-44-BM-	Grasses in BM also willows, BT ok	None
2017	LB-46B-BM	Some deposition, BT OK	Reassess for growth in next QRA
2017	LB-46D-BM	Willows ok, some veg in BM	None
2017	LB-46E-DVSL	Bottom log missing over ~30 ft, willows ok but high avulsion risk	Monitor
2017	RB-57-DVSL	Minor slumping, one 15' section log lost; pretty good willow density but low vigor	Monitor
2017	LB-51B	BT ok, no substantial growth in BM	Reassess for growth in next QRA
2017	RB-62-DVSL	Somewhat anemic willows but stable	None
2017	RB-67-DVSL	Some slumping but stable; woodies expanding	None
2017	RB-68-BM	Good stability, low flow cover	Reassess for growth in next QRA
2017	LB-56-BM	No growth in BM	Reassess for growth in next QRA
2017	RB-72-BM	Good low flow cover	Reassess for growth in next QRA
2017	RB-74-BM	Good-- stable with willows starting to come in	None
2017	RB-76A-BM	Some sprouting	None
2017	RB-77-BM	Pretty good sprouting	None
2017	LB-64-DVSL	Some fabric ripped; toe ok, willows small.	None
2017	RB-85-DVSL	~4ft willows, stable constructed toe with minor slumping	None
2017	RB-87A-BM	Low bank, stable	Reassess for growth in next QRA
2017	LB-75-BM	Some growth in BM	None
2017	RB-97-BM	Some sprouting	None
2017	RB-102-BM	Good sprouting	None
2017	RB-103-DVSL	High bank with low willow growth on face	None

[1]All locations where streambank treatment condition had changed since construction were recorded. There were no banks recorded for detailed issues in 2017.

[2] In Phases 5 and 6 Brush Matrix (BM) treatments were identified as GAP/BT treatments.

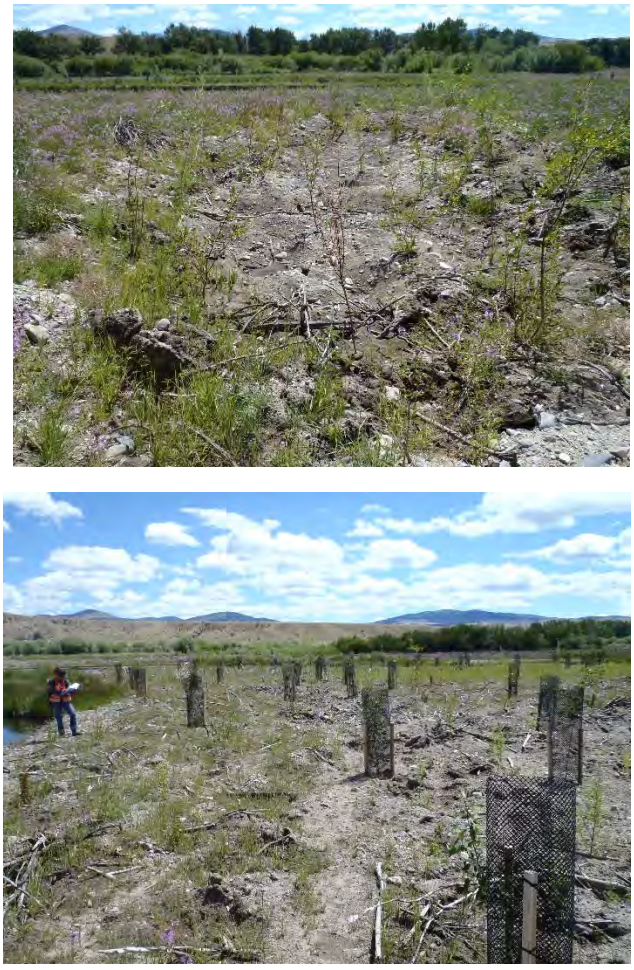
Phases 5 and 6 2016 Streambank Evaluation Form and Streambanks with Potential Risk and Documented Using QRA Streambank Form	
Streambank	**LB-46E-DVSL**
Year	2016
As-Built Treatment	DVSL
Channel Feature	Downstream limb of long bendway.
Nature of Bank Change	Localized toe loss and slumping over clay toe.
Toe Material Size	Clay
Toe Constructed	No
Undercutting (ft)	Approx. 1.5 ft
Fabric Condition	Good shape
Vegetation Condition	Moderate to sparse; there are approximately 10-ft gaps with dead willows. Other willows are short and small.
Potential Cause of Change	There are localized areas where the clay toe failed against a deep hole. May be in part driven by ice.
Risk Associated with Change	None
Possible Management Actions	None
Access	N/A
Implications for Future Design	If there is a deep hole against a clay layer at the treatment location, build toe with brush matrix AND break up long DVSL structures in the process. Viable, correctly sized willow cuttings should also be used.
Action Recommended	No

Attachment N – Phases 5 and 6 QRA Vegetation Photos

Phases 5 and 6 2016 Streambank Woody Vegetation Cover Categories

Top left: Category 1 (>40%) (LB-79A); Top right: Category 2 (10 to 40%) (LB-73); Bottom center: Category 3 (<10%) (RB-103).

Phases 5 and 6 2016 Floodplain Woody Vegetation Cover Categories



Top: Category 2 (10 to 30%) (S105); Bottom: Category 3 (<10%) (OM29).

Phases 5 and 6 2016 Woody Vegetation Survival Categories

Top left: Category 1 (>80%) (S094); Top right: Category 2 (50 to 80%) (S006); Bottom: Category 3 (<50%) (OM16).

Phases 5 and 6 2017 Streambank Woody Vegetation Cover Categories

Top left: Category 1 (>40%) (RB-7); Top right: Category 2 (10 to 40%) (LB-83C); Bottom center: Category 3 (<10%) (LB-46E).

Phases 5 and 6 2017 Floodplain Woody Vegetation Cover Categories

Top left: Category 1 (>30%) (s20); Top right: Category 2 (10 to 30%) (sw09); Bottom center: Category 3 (<10%) (s043).

Phases 5 and 6 2017 Floodplain Herbaceous Vegetation Cover Categories

Top left: Category 1 (>80%) (overview looking toward channel from preserved oxbow on right bank); Top right: Category 2 (50-80%) (access road along west side of Phase 5 borrow ponds); Bottom center: Category 3 (20-50%) (area behind om57 on right bank).

Phases 5 and 6 2017 Woody Vegetation Survival Categories

Top left: Category 1 (>80%) (om48); Top right: Category 2 (50 to 80%) (om14); Bottom: Category 3 (<50%) (s183).

Phases 5 and 6 2017 Miscellaneous Vegetation Photographs

Photos 1-5. Point bar conditions in Phases 5 and 6 in 2017. Photo 1: point bar below RB-15-BT with high cover of willow seedlings; Photo 2: PB LB-12-BT with high cover of invasives but also high cover of willow seedlings and native wetland vegetation, also lots of sediment storage in downstream end where existing surface was preserved; Photo 3: PB LB-28-BT with dense wetland vegetation in the preserved portion of the surface; Photo 4: PB RB-23-BT with dense cover of willow seedlings; Photo 5: PB RB-43-BT with sparse cover of herbaceous vegetation.





Photos 6-10. Wetland conditions in Phases 5 and 6 in 2017. Photo 6: wetland sw02; Photo 7: wetland sw03; Photo 8: oxbow wetland, sw08; Photo 9: sw06, em08; Photo 10: sw09.

Photos 11-14. Phase 5 borrow pond conditions.

Photos 15-18. Phase 6 borrow pond conditions.

Photos 19-21. Ponding from Galen Creek beaver dams and surface water return flow into the river.


Photos 22-29. Herbaceous cover in Phases 5 and 6 west floodplain in 2017. Photo 22: high cover of seeded species in reclaimed borrow area near Galen Road; Photo 23: high cover of invasive species around planted swale with high cover of seeded species in adjacent floodplain; Photo 24: s072 with wetland vegetation colonizing the bottom; Photo 25: cover of seeded species after two growing seasons between micro/broadcast seeding in photo left and drill seeding in photo right; Photo 26: high cover of invasive species in mc02 area; Photo 27: mix of seeded species and exotic species in mc04 area; Photo 28: low total cover but high cover of seeded forbs closer to the channel in mc04 area; Photo 29: Low overall cover and low cover of seeded species in om55 area.

Photos 30-36. Herbaceous cover in Phases 5 and 6 east floodplain in 2017. Photo 30: high cover of seeded species in floodplain area downstream of Galen Road; Photo 31: mix of seeded species and invasive species north of oxbow; Photo 32: high cover of seeded species near om11; Photo 33: high cover of invasive species near OM56; Photo 34: high cover of seeded species (wheatgrass) in om30 area; Photo 35: low cover in seeded road area; Photo 36: mix of seeded and invasive species near om54.

Photos 37-40. Modesty Creek.

Photos 41-42. Dry Cottonwood Creek.

Attachment O - Phases 5 and 6 Vegetation QRA Results

Streambank Woody Vegetation Cover

Streambank Treatment ID	Streambank	Streambank Treatment Type	2016	2017
LB-1	Left	NT	1	1
LB-2	Left	PV	-	1
LB-3	Left	DVSL	2	2+
LB-4	Left	PS/BT	3	1
LB-5	Left	DVSL	2	1
LB-6	Left	PS/BT	2	1
LB-7	Left	PB/BT	2	1
LB-8	Left	DVSL	2	1
LB-9	Left	PS/BT	1	1
LB-10	Left	DVSL	2	2+
LB-11	Left	PS/BT	1	1
LB-12	Left	PB/BT	2	1
LB-13	Left	SVL	2-	2
LB-14	Left	PS/BT	1	1
LB-15	Left	DVSL	1	1
LB-16A	Left	PB/BT	2+	1
LB-16B	Left	PS	-	1
LB-17	Left	DVSL	1-	1
LB-18	Left	PB/BT	1-	1
LB-19	Left	NT	-	-
LB-20	Left	DVSL	1	1
LB-21	Left	PB/BT	2+	1
LB-22A	Left	PS/BT	1	1
LB-22B	Left	BM	2+	2+
LB-24	Left	PS	1+	1
LB-25	Left	DVSL	1	1
LB-26	Left	PS/BT	1	1
LB-27	Left	PS	1	1
ISL-2B	Left	BIF	2-	1
ISL-2A	Left	PS/BT	2+	-
ISL-3	Left	PB/BT	2	-
LB-28	Left	PB/BT	1-	-
LB-29A	Left	BM	1-	2+
LB-29B	Left	PS/BT	1	1
LB-29C	Left	BM	1	2+
LB-30	Left	DVSL	1	1

Streambank Treatment ID	Streambank	Streambank Treatment Type	2016	2017
LB-31	Left	PS/BT	2+	-
LB-33A	Left	BM	2+	2+
LB-33B	Left	DVSL	2-	2-
LB-34A	Left	PS/BT	N/A, 3	1
LB-34B	Left	BM	2	1
LB-34C	Left	PS/BT	2+	1
LB-34D	Left	BM	1-	2+
LB-35	Left	PB/BT	2-	1
LB-36	Left	PS/BT	2+	1
LB-37	Left	BM	2	2-
LB-38	Left	DVSL	1+	1
LB-39	Left	PB/BT	1	2+
LB-40	Left	NT	-	-
LB-41A	Left	DVSL	2-	2
LB-41B	Left	BM	2+	2
LB-41C	Left	DVSL	2-	2
LB-42	Left	PS/BT	1-	1
LB-43	Left	PB/BT	2	1
LB-44	Left	BM	3+	1
LB-45	Left	DVSL	3	2
LB-46A	Left	DVSL	3	2
LB-46B	Left	BM	3+	2
LB-46C	Left	DVSL	3	2
LB-46D	Left	BM	2	2+
LB-46E	Left	DVSL	3	3
LB-47	Left	PS/BT	2+	1
LB-48	Left	BM	2	2+
LB-49	Left	PS/BT	2+	1
LB-50	Left	BM	2	1
LB-51A	Left	DVSL	2	2
LB-51B	Left	BM	2+	2
LB-51C	Left	DVSL	3+	2
LB-52	Left	PB/BT	2+	1
LB-53	Left	PS	3, N/A	1
LB-54	Left	DVSL	3	2-
LB-55	Left	NT	-	--
LB-55 (After)	Left	BM	2+	2-
LB-56	Left	PS/BT	2+	-
LB-57	Left	PS/BT	3-	1

Streambank Treatment ID	Streambank	Streambank Treatment Type	2016	2017
LB-58	Left	BM	1-	1
LB-59	Left	PS/BT	3+	1
LB-60	Left	PB/BT	2	1
LB-61	Left	BM	2	2
LB-62AA	Left	PS/BT	2	1
LB-62AB	Left	BM	3-	2-
LB-62AC	Left	PS/BT	3+	1
LB-62B	Left	PS/BT	2+	1
LB-63	Left	NT	-	-
LB-64	Left	DVSL	3	2+
LB-65	Left	PB/BT	3	1-
LB-66	Left	PS/BT	2	1
LB-67	Left	NT	-	-
LB-68	Left	DVSL	2	1
LB-69	Left	PS/BT	1	1
LB-70A	Left	PS	2+	1
LB-70B	Left	BM	2+	1
LB-70C	Left	PS	2-	1
LB-71	Left	PB/BT	2+	1
LB-72	Left	PS/BT	2	1
LB-73	Left	DVSL	2	2+
LB-74	Left	NT	-	-
LB-75	Left	BM	1-	2
LB-76	Left	PB/BT	2-	1
LB-77	Left	PS/BT	1-	1
LB-78	Left	NT	-	-
LB-79A	Left	DVSL	1	1
LB-79B	Left	PS	1+	1
LB-80	Left	DVSL	3-	2
LB-81	Left	PS/BT	1	1
LB-82	Left	PB/BT	2+	1
LB-83A	Left	BM	2	1-
LB-83B	Left	PS/BT	2	1
LB-83C	Left	BM	3	2
LB-83D	Left	PS/BT	2-	1
LB-83E	Left	BM	2+	2
LB-83F	Left	PS/BT	N/A, 3	1
LB-83G	Left	BM	2-	2
LB-83H	Left	PS/BT	2	1

Streambank Treatment ID	Streambank	Streambank Treatment Type	2016	2017
LB-83I	Left	BM	2	2-
RB-1	Right	DVSL	1	1
RB-2A	Right	PS/BT	-	N/A
RB-2B	Right	GAP/BT	1	1
RB-2C	Right	PS/BT	1	-
RB-2D	Right	GAP/BT	1	-
RB-2E	Right	PS/BT	2	-
RB-3	Right	DVSL	2	2
RB-4A	Right	GAP/BT	2	-
RB-4B	Right	PS/BT	1	1
RB-4C	Right	GAP/BT	2	1
RB-4D	Right	PS/BT	1	-
RB-5	Right	DVSL	2+	2+
RB-6A	Right	BT	1	1
RB-6B	Right	GAP/BT	1	1
RB-6C	Right	BT	1	1
RB-7	Right	DVSL	1	1
RB-8	Right	PS/BT	1	1
RB-10	Right	DVSL	1	1
RB-11	Right	PS	-	-
RB-12A	Right	PS/BT	1	1
RB-12B	Right	PS	-	1
RB-12C	Right	GAP	3	-
RB-13A	Right	PS	-	1
RB-13B	Right	GAP	3	3
RB-13C	Right	PS	-	1
RB-14	Right	DVSL	1	2
RB-15	Right	BT	1	2
RB-16A	Right	PS/BT	1	1
RB-16B	Right	PS	-	1
RB-17	Right	DVSL	1	1
RB-18A	Right	PS	-	1
RB-18B	Right	GAP/BT	1	1
RB-18C	Right	PS	-	1
RB-20	Right	DVSL	1	1
RB-22	Right	GAP/BT	1	1
RB-23	Right	BT	1	1
RB-25	Right	DVSL	2	1
RB-31	Right	DVSL	1	2+

Streambank Treatment ID	Streambank	Streambank Treatment Type	2016	2017
RB-32	Right	GAP/BT	1	1
RB-32A	Right	PS/BT	-	1
RB-33	Right	BT	1	1
RB-34	Right	GAP/BT	1	1
RB-35	Right	DVSL	1	1
RB-36A	Right	GAP/BT	2+	1
RB-36B	Right	PS/BT	-	1
RB-37	Right	BT	1	1
RB-38	Right	PS/BT	-	1
RB-39	Right	DVSL	2	1
RB-40	Right	BT	1	1
RB-41	Right	GAP/BT	1	1
RB-42	Right	DVSL	1	1
RB-43	Right	BT	1	1
RB-44	Right	PS/BT	-	1
RB-45	Right	BT	1	1
RB-46	Right	PS/BT	1	1
RB-47	Right	GAP/BT	2	1
RB-48	Right	DVSL	-	2+
RB-49	Right	DVSL	1-	1
RB-50	Right	DVSL	1-	1
RB-51	Right	DVSL	1-	1
RB-52A	Right	PS/BT	-	1
RB-52B	Right	GAP/BT	1	1
RB-53	Right	PS/BT	-	1
RB-54	Right	BT	2+	1
RB-55A	Right	PS/BT	-	1
RB-55B	Right	GAP/BT	2	2+
RB-55C	Right	PS/BT	-	1
RB-57	Right	DVSL	2-	2
RB-57	Right	BT	2	2
RB-59	Right	PS/BT	-	1
RB-60	Right	BT	1	1
RB-61	Right	PS	-	1
RB-62	Right	DVSL	2	2+
RB-67	Right	DVSL	2	2+
RB-68	Right	GAP/BT	1	1
RB-69	Right	BT	1	1
RB-70A	Right	PS/BT	-	1

Streambank Treatment ID	Streambank	Streambank Treatment Type	2016	2017
RB-70B	Right	GAP/BT	1	1
RB-70C	Right	PS/BT	1	1
RB-71	Right	BT	2+	1
RB-72A	Right	PS/BT	-	1
RB-72B	Right	GAP/BT	2	1
RB-74	Right	GAP/BT	1	1
RB-75	Right	PS/ALCOVE	-	1
RB-76A	Right	GAP/BT	2	1
RB-76B	Right	PS/BT	-	1
RB-77	Right	GAP/BT	2	1
RB-78	Right	PS/BT	-	1
RB-79	Right	GAP/BT	1	1
RB-80	Right	PS/BT	-	-
RB-81	Right	GAP/BT	2	1
RB-82A	Right	RIPRAP	1	
RB-82B	Right	BT	2	1
RB-83A	Right	PS/BT	-	1
RB-83B	Right	GAP/BT	2	1
RB-83C	Right	DVSL	2	2+
RB-85	Right	DVSL	2	1
RB-86	Right	BT	2	1
RB-87A	Right	GAP/BT	2	1
RB-87B	Right	PS/BT	-	1
RB-88A	Right	GAP/BT	2	3
RB-88B	Right	GAP/BT	2	2
RB-89	Right	PS/BT	-	1
RB-91A	Right	DVSL	1	1
RB-91B	Right	DVSL	1	1
RB-92	Right	PS/BT	-	1
RB-93	Right	BT/SOD	2	1
RB-94A	Right	PS/BT	1	1
RB-94B	Right	GAP/BT	2	1
RB-95	Right	DVSL	1	1
RB-97A	Right	DVSL	2	1
RB-97B	Right	GAP/BT	2	1
RB-98	Right	BT	1	1
RB-99	Right	GAP/BT	1	1
RB-102	Right	GAP/BT	1	1
RB-103	Right	DVSL	3	2

Streambank Treatment ID	Streambank	Streambank Treatment Type	2016	2017
RB-104	Right	BT	2	1
RB-105	Right	PS	-	1

N/A indicates the bank is herbaceous or not likely to become dominated by woody vegetation
-- indicates no data collected
DVSL: double vegetated soil lift
SVSL: single vegetated soil lift
PS: preserve vegetation
BT: brush trench
GAP: woody brush matrix
BM: brush matrix
NT: no treatment

Floodplain Woody Vegetation Cover

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
om04	Left	2015	8 ft wire fence, Select individual	3	-
sw20	Left	2015	8 ft wire fence	2-	1
FPX_2	Left	2015	8 ft wire fence	3/NA	2-
om07	Left	2015	8 ft wire fence, Select individual	3	2
om01	Left	2015	8 ft wire fence, Select individual	3	2
s019	Left	2015	8 ft wire fence	3	2
s017	Left	2015	8 ft wire fence	3	-
sw04a	Left	2016	8 ft wire fence	3	-
w01	Left	2016	8 ft wire fence	3	2-
sw04b	Left	2016	8 ft wire fence	2	
sw05	Left	2015	8 ft wire fence	3	2
s035	Left	2015	8 ft wire fence	3	-
s045	Left	2015	8 ft wire fence	-	2-
s046	Left	2015	8 ft wire fence	3	-
trans01	Left	2016	8 ft wire fence	3	1
sw04d	Left	2016	8 ft wire fence	2	-
sw04e	Left	2016	8 ft wire fence	3	-
sw06	Left	2015	8 ft wire fence	3	2+
s043	Left	2015	8 ft wire fence	3	3
s039	Left	2015	8 ft wire fence	3	2
mc01	Left	2015	8 ft wire fence, Select individual	2-	-
om09	Left	2015	8 ft wire fence, Select individual	3	-
om55	Left	2015	8 ft wire fence, Select individual	3	-
s069	Left	2015	8 ft wire fence	3	-
om15	Left	2015	8 ft wire fence, Select individual	3	3
mc02	Left	2015	8 ft wire fence, Select individual	3	3
s075	Left	2015	8 ft wire fence	3	2
om16	Left	2015	8 ft wire fence, Select individual	3	-
s088	Left	2015	8 ft wire fence	3	-
om19	Left	2015	8 ft wire fence, Select individual	3	2-
s091	Left	2015	8 ft wire fence	-	2
s094	Left	2015	8 ft wire fence	3	2-
t06	Left	2015	8 ft wire fence, Select individual	3	3
om22	Left	2015	8 ft wire fence, Select individual	3+	
s105	Left	2015	8 ft wire fence	2-	2+
om23	Left	2015	8 ft wire fence, Select individual	3+	2
om26	Left	2015	8 ft wire fence, Select individual	3+	2
s117	Left	2015	8 ft wire fence	3+	2

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
mc03	Left	2015	8 ft wire fence, Select individual	2-	2
s120	Left	2015	8 ft wire fence	2	-
om27	Left	2015	8 ft wire fence, Select individual	3+	-
om28	Left	2015	8 ft wire fence, Select individual	3+	-
om29	Left	2015	8 ft wire fence, Select individual	3+	-
t07	Left	2015	8 ft wire fence, Select individual	3	3
s134	Left	2015	8 ft wire fence	-	2
s149	Left	2015	8 ft wire fence	3	2
s152	Left	2015	8 ft wire fence	3+	2-
om32	Left	2015	8 ft wire fence, Select individual	2-	2
om57	Left	2015	8 ft wire fence, Select individual	3+	-
om58	Left	2015	8 ft wire fence, Select individual	3+	2
om42	Left	2015	8 ft wire fence, Select individual	3+	-
s169	Left	2015	8 ft wire fence	2-	-
om43	Left	2015	8 ft wire fence, Select individual	3	2-
s171	Left	2015	8 ft wire fence	-	2
s172	Left	2015	8 ft wire fence	-	2
mc04	Left	2016	8 ft wire fence	-	3
s183	Left	2016	8 ft wire fence	-	3
s187	Left	2016	8 ft wire fence	-	2
om51	Left	2016	8 ft wire fence, Select individual	-	2
s199	Left	2016	8 ft wire fence	-	2
om53	Left	2016	8 ft wire fence, Select individual	-	2-
om02	Right	2015	8 ft wire fence, Select individual	3	2-
s006	Right	2015	8 ft wire fence	3	2-
om03	Right	2015	8 ft wire fence, Select individual	3	-
s015	Right	2015	8 ft wire fence	3	3
om05	Right	2015	8 ft wire fence, Select individual	3	2-
t01	Right	2015	8 ft wire fence, Select individual	3	3-
sw03	Right	2015	8 ft wire fence	3	2-
sw02	Right	2015	8 ft wire fence	3	2
sw01	Right	2015	8 ft wire fence	3	2
om06	Right	2015	8 ft wire fence, Select individual	3	-
s050	Right	2015	8 ft wire fence	3	3
sw07	Right	2015	8 ft wire fence	3	2
sw08	Right	2015	8 ft wire fence	3	3
om08	Right	2015	8 ft wire fence, Select individual	3	3
s054	Right	2015	8 ft wire fence	-	3
s056	Right	2015	8 ft wire fence	3	3+

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
FPX_6	Right	2015	8 ft wire fence	3	3
om10	Right	2015	8 ft wire fence, Select individual	3	-
om11	Right	2015	8 ft wire fence, Select individual	3	3-
s061	Right	2015	8 ft wire fence	3	3+
FPX_3	Right	2015	8 ft wire fence	3	3-
sw09	Right	2015	8 ft wire fence	3	2
om12	Right	2015	8 ft wire fence, Select individual	3	-
s068	Right	2015	8 ft wire fence	3	-
FPX_4	Right	2015	8 ft wire fence	3	3
om13	Right	2015	8 ft wire fence, Select individual	3	-
om14	Right	2015	8 ft wire fence, Select individual	3	3
s066	Right	2015	8 ft wire fence	3	-
om17	Right	2015	8 ft wire fence, Select individual	3	-
s078	Right	2015	8 ft wire fence	2	-
om56	Right	2015	8 ft wire fence, Select individual	1	3
s077	Right	2015	8 ft wire fence	3	3-
s082	Right	2015	8 ft wire fence	-	2
om18	Right	2015	8 ft wire fence, Select individual	3	-
om20	Right	2015	8 ft wire fence, Select individual	3	3
s096	Right	2015	8 ft wire fence	3	3+
s102	Right	2015	8 ft wire fence	3	3
om21	Right	2015	8 ft wire fence, Select individual	3	-
om24	Right	2015	8 ft wire fence, Select individual	3	3-
FPX_5	Right	2015	8 ft wire fence	3	-
s116	Right	2015	8 ft wire fence	3	3
om25	Right	2015	8 ft wire fence, Select individual	3	-
s109	Right	2015	8 ft wire fence, Select individual	3	-
om56	Right	2016	8 ft wire fence, Select individual	-	3
s122	Right	2016	8 ft wire fence	-	2+
om30	Right	2016	8 ft wire fence, Select individual	-	3
s141	Right	2016	8 ft wire fence	-	3-
om58	Right	2016	8 ft wire fence, Select individual	-	3
s162	Right	2016	8 ft wire fence	-	3
om40	Right	2016	8 ft wire fence, Select individual	-	3+
s162	Right	2016	8 ft wire fence	-	3
om44	Right	2016	8 ft wire fence, Select individual	-	3
s177	Right	2016	8 ft wire fence	-	3
om48	Right	2016	8 ft wire fence, Select individual	-	3
s197	Right	2016	8 ft wire fence	-	3-

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
om49	Right	2016	8 ft wire fence, Select individual	-	3
s201	Right	2016	8 ft wire fence	-	2-
om61	Right	2016	8 ft wire fence, Select individual	-	3
s206	Right	2016	8 ft wire fence	-	3

- indicates no data collected

Planted Woody Vegetation Survival

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
om04	Left	2015	8 ft wire fence, Select individual	2	-
sw20	Left	2015	8 ft wire fence	1+	1+
FPX_2	Left	2015	8 ft wire fence	1	1
om07	Left	2015	8 ft wire fence, Select individual	2	1
om01	Left	2015	8 ft wire fence, Select individual	2	-
s019	Left	2015	8 ft wire fence	2	1
s017	Left	2015	8 ft wire fence	2	-
sw04a	Left	2016	8 ft wire fence	1+	-
w01	Left	2016	8 ft wire fence	1+	1+
sw04b	Left	2016	8 ft wire fence	1+	-
sw05	Left	2015	8 ft wire fence	1-	1
s035	Left	2015	8 ft wire fence	1+	-
s046	Left	2015	8 ft wire fence	1-	-
s045	Left	2015	8 ft wire fence	-	2+
trans01	Left	2016	8 ft wire fence	1+	1+
sw06	Left	2015	8 ft wire fence	1+	1
s043	Left	2015	8 ft wire fence	2-	2-
s039	Left	2015	8 ft wire fence	1-	1-
mc01	Left	2015	8 ft wire fence, Select individual	1-	-
om09	Left	2015	8 ft wire fence, Select individual	2+	-
om55	Left	2015	8 ft wire fence, Select individual	1-	-
s069	Left	2015	8 ft wire fence	1	-
om15	Left	2015	8 ft wire fence, Select individual	2-	3-
mc02	Left	2015	8 ft wire fence, Select individual	2-	31
s075	Left	2015	8 ft wire fence	2	1-
om16	Left	2015	8 ft wire fence, Select individual	3+	-
s088	Left	2015	8 ft wire fence	1-	-
om19	Left	2015	8 ft wire fence, Select individual	2	2+
s091	Left	2015	8 ft wire fence	-	1-
s094	Left	2015	8 ft wire fence	1+	1-
t06	Left	2015	8 ft wire fence, Select individual	1	2-
om22	Left	2015	8 ft wire fence, Select individual	2+	-
s105	Left	2015	8 ft wire fence	1	1
om23	Left	2015	8 ft wire fence, Select individual	1+	1-
om26	Left	2015	8 ft wire fence, Select individual	1	1-
s117	Left	2015	8 ft wire fence	1+	1
mc03	Left	2015	8 ft wire fence, Select individual	1+	1-
s120	Left	2015	8 ft wire fence	1+	-

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
om27	Left	2015	8 ft wire fence, Select individual	1	-
om28	Left	2015	8 ft wire fence, Select individual	1	-
om29	Left	2015	8 ft wire fence, Select individual	1+	-
t07	Left	2015	8 ft wire fence, Select individual	2	3-
s134	Left	2015	8 ft wire fence	-	2+
s149	Left	2015	8 ft wire fence	1+	1
s152	Left	2015	8 ft wire fence	1	2
om32	Left	2015	8 ft wire fence, Select individual	1	1-
om57	Left	2015	8 ft wire fence, Select individual	1	-
om58	Left	2015	8 ft wire fence, Select individual	1+	1-
om42	Left	2015	8 ft wire fence, Select individual	1+	-
s169	Left	2015	8 ft wire fence	1+	-
s171	Left	2015	8 ft wire fence	-	1-
s172	Left	2015	8 ft wire fence	-	1-
om43	Left	2015	8 ft wire fence, Select individual	1+	1-
mc04	Left	2016	8 ft wire fence	-	3-
s183	Left	2016	8 ft wire fence	-	3
s187	Left	2016	8 ft wire fence	-	1
om51	Left	2016	8 ft wire fence, Select individual	-	2+
s199	Left	2016	8 ft wire fence	-	1
om53	Left	2016	8 ft wire fence, Select individual	-	1
om02	Right	2015	8 ft wire fence, Select individual	1	2
s006	Right	2015	8 ft wire fence	2	1-
om03	Right	2015	8 ft wire fence, Select individual	2	-
s015	Right	2015	8 ft wire fence	1	3-
om05	Right	2015	8 ft wire fence, Select individual	1	3+
t01	Right	2015	8 ft wire fence, Select individual	1	3-
sw03	Right	2015	8 ft wire fence	1	1
sw02	Right	2015	8 ft wire fence	1	1-
sw01	Right	2015	8 ft wire fence	1	1-
om06	Right	2015	8 ft wire fence, Select individual	1	-
s050	Right	2015	8 ft wire fence	1	2+
sw07	Right	2015	8 ft wire fence	1	-
sw08	Right	2015	8 ft wire fence	1-	3
om08	Right	2015	8 ft wire fence, Select individual	1	2-
s054	Right	2015	8 ft wire fence	-	3-
s056	Right	2015	8 ft wire fence	1	2+
FPX_6	Right	2015	8 ft wire fence	-	3
om10	Right	2015	8 ft wire fence, Select individual	1	-

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
om11	Right	2015	8 ft wire fence, Select individual	1	3
s061	Right	2015	8 ft wire fence	1	2
FPX_3	Right	2015	8 ft wire fence	-	3
sw09	Right	2015	8 ft wire fence	2	2+
om12	Right	2015	8 ft wire fence, Select individual	2	-
s068	Right	2015	8 ft wire fence	1	-
FPX_4	Right	2015	8 ft wire fence	3	3
om13	Right	2015	8 ft wire fence, Select individual	2	-
om14	Right	2015	8 ft wire fence, Select individual	1	2
s066	Right	2015	8 ft wire fence	1	-
om17	Right	2015	8 ft wire fence, Select individual	1	-
s078	Right	2015	8 ft wire fence	1	-
om56	Right	2015	8 ft wire fence, Select individual	3	2
s077	Right	2015	8 ft wire fence	1	1-
s082	Right	2015	8 ft wire fence	-	2
om18	Right	2015	8 ft wire fence, Select individual	2	-
om20	Right	2015	8 ft wire fence, Select individual	2	3+
s096	Right	2015	8 ft wire fence	1	1-
s102	Right	2015	8 ft wire fence	1	1-
om21	Right	2015	8 ft wire fence, Select individual	1	-
om24	Right	2015	8 ft wire fence, Select individual	2	3
FPX_5	Right	2015	8 ft wire fence	3	-
s116	Right	2015	8 ft wire fence	1	3+
om25	Right	2015	8 ft wire fence, Select individual	1	-
s109	Right	2015	8 ft wire fence, Select individual	1	-
om56	Right	2016	8 ft wire fence, Select individual	-	2
s122	Right	2016	8 ft wire fence	-	1-
om30	Right	2016	8 ft wire fence, Select individual	-	1
s141	Right	2016	8 ft wire fence	-	1-
om58	Right	2016	8 ft wire fence, Select individual	-	1
s162	Right	2016	8 ft wire fence	-	1
om40	Right	2016	8 ft wire fence, Select individual	-	1
s162	Right	2016	8 ft wire fence	-	1
om44	Right	2016	8 ft wire fence, Select individual	-	1
s177	Right	2016	8 ft wire fence	-	1
om48	Right	2016	8 ft wire fence, Select individual	-	1+
s197	Right	2016	8 ft wire fence	-	2
om49	Right	2016	8 ft wire fence, Select individual	-	1-
s201	Right	2016	8 ft wire fence	-	1-

Planting Unit ID	Streambank	Year Planted	Protection Measure Installed	2016	2017
om61	Right	2016	8 ft wire fence, Select individual	-	1
s206	Right	2016	8 ft wire fence	-	1

- indicates no data collected

2017 Floodplain Herbaceous Cover Phase 5

2017 Floodplain Herbaceous Cover Phase 6