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TECHNICAL MEMORANDUM

DATE:	December 19, 2023
TO:	John Raftopoulos, Gene Riordan and Agency Team
FROM:	Julie Ash, PE, Johannes Beeby, and Karin Emanuelson, Stillwater, and Jon Dauzvardis, PWS, ECOS
SUBJECT:	Vermillion Creek Restoration at Diamond Peak Ranch - 2023 Adaptive Management Phase 1 and 2

1 INTRODUCTION

The final Monitoring and Adaptive Management Plan (MAM Plan) dated April 11, 2022, defined specific phases for Adaptive Management and Monitoring efforts for the Vermillion Creek Restoration Project (Project). The large flood event that occurred in October 2022 during the construction implementation, compounded by subsequent high flow runoff events occurring in Spring 2023, necessitated adjustment to some timelines estimated in the MAM Plan. Adjusted timeline information is conveyed in the phasing definitions below.

The Project design team comprised of Stillwater Sciences and Ecosystem Services, LLC (ECOS) completed site assessment including data collection, directed survey efforts, and prepared this report. An independent functional assessment was completed in 2023 by Johnson Environmental Consulting, LLC (JEC), using the Functional Assessment of Colorado Wetlands method (FACWet). The independent FACWet Report for 2023 is included in Appendix E.

Adaptive Management Phasing

- Phase 1 Adaptive Management construction activities (construction commenced in 2022 prior to the October 2022 flood event and completed in 2023 after the flood) – Activities described in detail in Section 3 – Adaptive Management Phase 1 Activities.
- Phase 2 Adaptive Management construction activities (initial adaptive management activities conducted in 2023 after the flood) - Activities described in detail in Section 4 – Adaptive Management Phase 2 Activities.
- Phase 3 Adaptive Management (anticipated in 2024) – Planned activities described in detail in Section 5 – Adaptive Management Phase 3 Activities.
- Phase 4 Adaptive Management (anticipated in 2025)

Monitoring Phasing

- Phase 1 Monitoring (2024) – Monitoring as per the MAM Plan after completion of Adaptive Management Phases 1 and 2;
- Phase 2 Monitoring (2025) – Monitoring as per the MAM Plan after Adaptive Management Phase 3; and
- Phase 3 Monitoring (2026) – Monitoring as per the MAM Plan after Adaptive Management Phase 4.

As required by the MAM Plan, Diamond Peak Cattle Company (DPCC) is providing a Technical Memorandum (Tech Memo) to the Agency Team by December 31st following completion of Adaptive Management Phases 1 and 2. The MAM Plan further directed that DPCC will provide Monitoring Reports to the Agency Team by December 31st in years following completion of Adaptive Management Phase 3. Monitoring Reports will guide adaptive management activities planned for the following year.

In compliance with MAM Plan-directed reporting, this 2023 Tech Memo meets the reporting requirement upon completion of Adaptive Management Phases 1 and 2. The 2023 Tech Memo is informed by data collection, survey, and site assessment, including a final assessment performed by Stillwater and ecos team members during the last week in August 2023.following compliance with MAM Plan-directed reporting, Monitoring Reports will be provided in 2024, 2025 and 2026, unless early release from annual reporting is provided by the Agency Team based on determination of successful, self-sustaining conditions for the Project.

As noted above, Vermillion Creek experienced a large flood event in October 2022 while construction implementation was in process. The October flood was the largest event observed by the Raftopoulos' since the founding of the ranch in 1924. During a site assessment conducted on May 25, 2023, Stillwater team members measured observable indicators of height of debris flow on a downstream fence line (height at 3feet 2 inches, Photo 13 and 14, Appendix A) and compared the measurement with 1 Dimensional (1D) hydraulic model cross section results, yielding approximation for the October 2022 event between 4000 and 5000 (cubic feet per second (cfs). As such, some Phase 1 activities (i.e., construction activities) planned in 2022 got pushed into 2023 and were completed alongside the Phase 2 Adaptive Management activities in 2023. This adaptation allowed the design team to direct final construction activities to work with system response to the natural processes of the flood.

An overview discussion of the effects of the October 2022 flood event and current state of restoration efforts by the Project is provided here. The intention of the constructed Vermillion Creek inset floodplain design was to set the system up to move along a desired geomorphic trajectory, as conceptualized by the Stream Evolution Model (SEM), towards healthier, more functional SEM stages. The large October 2022 flood progressed the constructed channel farther along the desired geomorphic trajectory than a smaller typical annual flood event would have achieved. More detail on SEM stage is provided in Section 6.7 Qualitative SEM Stage Assessment.

The extensive work completed by the large event shaped diverse macro- and micro-topography within the inset floodplain, increasing riparian and wetland habitat potential. Observations in August 2023 show that planted and recruited vegetation has begun to establish on newly shaped bars within the inset floodplain. Because 2023 was a wetter than average year, water covered the majority of the inset floodplain footprint throughout the growing season. In more average water years, the channel is be expected to notably drier, flowing under low flow conditions in the vicinity of one cfs, which would allow more extensive vegetation establishment along the inset floodplain.

As documented in the independent FACWet Report, the project site is set up to create the necessary wetland habitat. With this assessment of current conditions, planned adaptive management activities for 2024 are minimal at this time. If flow levels during the 2024 growing season are closer to average, vegetation is anticipated to continue to establish across a broader area of the inset floodplain. With continued vegetation establishment, the Project will continue to move along the desired geomorphic trajectory towards healthier, more functional SEM stages, and additionally create larger wetland acreage, as needed for compliance with Project goals.

The design team will monitor the Project in August, 2024, including collecting and analyzing shallow groundwater data, to determine whether additional adaptive management activities are warranted in 2024.

The following Tech Memo sections discuss Phase 1 and 2 Adaptive Management activities, including details on what (if any) adaptive management were implemented, the intent of that action, and the anticipated effect on the project. Additionally, the Tech Memo provides details addressing the Agency Team's list of concerns from the September 19th, 2023, inspection report. Finally, the Tech Memo documents Phase 1 Monitoring results outlined in the MAM Plan, including:

- Topographic Survey Data
- Baseline vegetation assessment
- FACWet Level 2 - Rapid Assessment

2 PROJECT GOALS AND OBJECTIVES

This section is taken from the Vermillion Creek Restoration at Diamond Peak Ranch – Restoration Plan; Basis of Design Report, dated March 28, 2022.

The goal of the Project is to remedy impacts to jurisdictional Waters of the U.S., including wetland habitat, caused by earthwork activities in 2012 that altered channel and floodplain configurations on private property and on BLM lands and reduced aquatic resource area and functions. The private property is the Diamond Peak Ranch (Ranch), currently owned by a limited liability company controlled by John Raftopoulos (Raftopoulos Property).

The objective of the Project is to replace lost functions by restoring Vermillion Creek, its fringe wetlands, and the Little Joe Creek tributary wetland complex. The Project is a result of the settlement of a federal enforcement action. The project will result in a minimum of 8.47 acres of wetlands and return of Vermillion Creek to an alignment very close to pre-disturbance alignment and sinuosity.

The achievement of the specific objectives of the Restoration Plan for the Project are to be measured against Performance Standards as described in the Work Plan. A FACWet analysis based on Regional References was prepared by Dr. Brad Johnson. The FACWet data (Vermillion Creek Functional Assessment 2021-06-01 LR.pptx and Vermillion FACWet – 2021-06-01.xls) were delivered to the Agency Team via email on June 8, 2021, and reviewed in the field on May 26, 2021.

Because the wetlands to be restored are primarily supported by Vermillion Creek and its tributaries, designing for channel and floodplain conditions that are sustainable long-term is critically important. Our Team has applied a process-based restoration approach, similar to Beechie et al. (2010) and Wheaton et al. (2019), which works with natural fluvial and ecological processes because this approach is intended to deliver long-term functionality by adjusting through time with natural fluvial processes in this highly dynamic system.

3 ADAPTIVE MANAGEMENT PHASE 1 ACTIVITIES

3.1 Introduction

As specified in the MAM Plan, the first phase of Project implementation includes the initial excavation of the Vermillion Creek inset floodplain, installation of simulated beaver structures (SBS) within Vermillion Creek, and direct willow transplants within and between those SBS structures. Seeding of the Zone 4 Upland Areas including the elevated floodplain adjacent to the new inset floodplain, access, staging, excavation soil placement areas (e.g., the southern mesa). Seeding of these areas, as well as temporary construction-related disturbance areas, is included in the Phase 1 activities to provide vegetative stabilization, noting that the near-channel area is not expected to remain stable. This phase is specifically dedicated to allowing natural watershed processes to "do the work" of advancing channel evolution along desired geomorphic trajectories. Additionally, Phase 1 construction includes construction of the Little Joe Creek wetland complex, and following completion of earthwork and grading activities, installation of shallow groundwater wells and a crest-stage gage.

Phase 1 activities commenced 2022 but were interrupted due to emergency construction demobilization resulting from the unexpected large flood event in October 2022. Remaining Phase 1 activities were completed in 2023 after spring runoff. The following sections document the as-built conditions of all Phase 1 activities, including documentation of timing of completion for each activity.

3.2 Vermillion Creek Inset Floodplain

All earthwork and grading associated with the Vermillion Creek inset floodplain except for the headcut treatment (see Section 3.4 Headcut Treatment) and backfilling of the existing post-disturbance channel were completed before demobilization in October 2022. Vermillion Creek inset floodplain excavation (Photo 33–34 in Appendix A) was completed according to the planform illustrated in the Restoration Design Planset and specific channel dimensions referenced in the HEC-RAS 1D Model. All as-built design elevations were checked onsite to be within 0.2 feet of proposed elevation. Additionally, the installation of simulated beaver structures (SBS) within Vermillion Creek (Photos 35-36 in Appendix A) with direct willow transplants and brush within and between those SBS structures (Photos 37–38 in Appendix A) were completed according to the planform illustrated in the Restoration Design Planset and with additional clarification provided to the riverine construction contractor, X Field Services, (Appendix F), with one exception as documented below:

- One additional low water crossing was constructed across the channel between Stations 15+00 and 20+00. Prior to construction, the addition of this low water crossing was approved by Scott Schreiber, Wright Water Engineers (WWE)in the field during his site visit August 26th, 2022.

X Field Services conservatively estimated that 2,475 rooted willow clumps were harvested and transplanted throughout the inset floodplain and SBS structures during excavation and grading operations in 2022. Many willow clumps did not have sufficient time to establish and take deep root before the October 2022 flood event and, as such, were lost or buried by sediment during the flood. Observations throughout 2023 showed that many willow clumps withstood the October 2022 flood and 2023 high Spring runoff flows. Additionally, notable natural recruitment was observed throughout 2023 (Photos 26–27 in Appendix A).

X Field Services left the existing post-disturbance channel un-backfilled upon emergency demobilization in October 2022. This strategy was intentional to maximize conveyance capacity during the flood event. When construction remobilization occurred in May of 2022, the existing post-disturbance channel was backfilled, as weather and flows permitted safe access to stockpile areas. Backfilling of the existing post-disturbance channel was completed using the stockpiles from the inset floodplain excavation according to the planform illustrated in the Restoration Design Planset, with one exception as documented below:

- Approximately 20 ft on the downstream side of existing post-disturbance channels were left unfilled to preserve vegetation and create backwater habitat. Scott Schreiber, WWE, approved this change in the field during his site visit August 26th, 2022.

3.3 Little Joe Creek Wetland Complex

Little Joe Creek wetland complex (Photo 40 in Appendix A) was completed as part of remaining Phase 1 construction activities in 2023. Water distribution in the form of headgates (Photo 39 in Appendix A) was added to the construction of Little Joe Creek wetland complex to maximize wetted perimeter throughout the wetland complex. Between the constructed earthern berms, small, rocked flow paths were constructed (Photo 41 in Appendix A) to direct water to more features located just downstream within the complex. Willow clump transplants were initially intended for harvest from Vermillion Creek to transplant into Little Joe Creek wetland complex. Because all available willow transplants were used to create SBS in Vermillion Creek, approximately 3,000 willow cuttings were installed in lieu of transplants in Little Joe Wetland complex. Willow cutting installation in Little Joe Wetland Complex was completed by August 2023. The replacement of cuttings for transplants was approved by the Agency Team during the September 15, 2023, site inspection.

Wetland and adjacent upland seeding with native vegetation did not occur during Phase 1 construction activities in 2022 due to the flood, incomplete grading, as well as seeding and mulching equipment availability issues, followed thereafter by frozen ground that prevented proper seeding and mulching practices. Wetland and adjacent upland seeding was completed by July 10 and October 5, 2023, respectively. Wetland and adjacent upland seeding were completed by July 10 and October 5, 2023, respectively.

3.4 Headcut Treatment

As reported in the design team's July 3, 2023 response to Agency Team inspection report, the approved treatment for the upstream headcut in its original location had not yet been installed when the October 2022 flood occurred. The intent of the headcut treatment is to slow additional migration and expansion of the active headcut, which is a result of base level changes from the Green River that migrated up through the valley, exacerbated by beaver removal. The optimal result of headcut treatment on this site is to slow further migration long enough to allow establishment of wetlands through the project reach before the headcut accesses the intact wetland meadow area located upstream of the project reach. In this scenario, wetland habitat is continually available in the vicinity as the system upstream moves through the same SEM stages as the project reach. This headcut treatment strategy will be most successful long-term because it recognizes that the Vermillion Creek headcuts are a result of impact at a watershed scale, operating on a decadal scale or longer, and cannot be stopped by any reach-scale treatments.

The occurrence of numerous large flow events prior to the implementation of the headcut treatment caused movement of the upstream headcut, as well as expansion in size and a split into two areas (referred to as northern and southern headcut) as it moved upstream. Implementation of modified headcut treatments (i.e., to address the two current headcuts) was completed as part of remaining Phase 1 construction activities in 2023. A rock ramp treatment was installed in the northern headcut where access for heavy equipment was feasible (Photo 44 in Appendix A). Heavy equipment could not access the southern headcut without causing additional harm to the ecosystem due to soft saturated wetland condition. The southern headcut treatment was therefore completed with hand tools and manual labor. Because the full rock ramp treatment could not be constructed via hand tools, large rocks and greasewood were "daisy-chained" for placement in the headcut (Photo 43 in Appendix A). The design team will continue to monitor the southern headcut and adaptively manage this area.

In the recent headcut migration area (between the original location and the current location of the headcut), the channel has widened and downcut. These changes are part of the natural channel evolution that is a result of base level changes from Green River migration up through the valley, exacerbated by beaver removal. Currently, this area is naturally rebounding with rapid revegetation. As part of remaining Phase 1 adaptive management activities in 2023, wetland seed was applied from toe to top of bank and 400 willow stakes were installed in toe slump areas to augment vegetation establishment occurring in the area. Continued sediment deposition and revegetation will help progress this upstream end of the project reach as desired towards SEM stage 3s (Arrested Degradation).

3.5 Upland Seeding Areas

Seeding and mulching of the Zone 4 Upland and Pasture Areas, including the elevated floodplain adjacent to the new inset floodplain, access, staging, excavation soil placement areas (e.g., the southern mesa) and temporary construction-related disturbance areas, was not implemented during Phase 1 construction activities in 2022 due to the emergency construction demobilization caused by the October flood.

As reported in the design team's July 3, 2023, response to the Agency Team inspection report, the site was actively being graded when the October flood hit, making installation of a temporary vegetation cover was not feasible or safe. After the October 2022 flood and localized rain events, the newly graded site remained too wet for seeding and then the exposed soil froze up after first freeze (approximately October 10, 2022) for the remainder of 2022, which prevented any further earthwork and the proper impregnation of seed to achieve temporary or permanent vegetation cover. Active grading of the site re-commenced in the early spring of 2023 after last frost (approximately April 30, 2023) when the soil had become workable again. The timeline that unfolded following the October 2022 flood ultimately precluded the ability and the need for temporary vegetation cover.

Once grading operations were completed in 2023, some Zone 4 Upland Seeding within the 25-buffer was conducted mid-summer, strategically avoiding patches of existing vegetation and access areas that were still in use. This seeding effort left noticeable bare patches, as noted by the Agency Team during the September 19, 2023, site inspection. Previous seeding efforts were impeded by the presence of weeds and other vegetation, therefore brush beating/mowing of weeds and other vegetation was completed to facilitate and improve results of drill seeding. The entire Upland Seeding Area, including reseeding of previously seeded areas, as warranted, was completed by October 5, 2023, utilizing a drill seeder with the specified Upland Mix at the rates indicated in the plans. The Upland Seed was supplied by Granite Seed according to the seed schedules with one modification due to availability issues. Gardner saltbush (*Atriplex garderi*) was not available. Fourwing saltbush (*Atriplex canescens*) was thereby increased by 0.39 PLS/acre to achieve the total PLS/acre rate specified. The Cover Crop seed (Sterile Triticale) was drilled into the soil simultaneously with the Upland Mix at the rates specified on the seed schedules, a measure that is over and above design specifications. Refer to the attached As-built Seeding and Planting Map for locations (Appendix G).

All Zone 3 Riparian Seeding areas between the toe and top of the bank of the inset floodplain were seeded with the specified Upland Seed and Cover Crop (sterile triticale) Mix at the rates indicated on the plans, including those areas were vertical banks had "slumped" toes of slope. Riparian seeding was completed by July 10, 2023, via a hydroseeder with a trace of green hydromulch to track the application (Photo 32 in Appendix A). Riparian hydroseeding was followed by hydromulching (a separate operation) at the rates indicated on the plans to ensure the underlying seed was covered. Refer to the attached As-built Seeding and Planting Map for locations (Appendix G).

Disturbed soil and soil deposition areas adjacent to the 25-foot buffer were seeded with the specified Pasture Mix at the rates indicated in the plans excluding those areas where beneficial vegetation was present and/or vertical terrain prevented effective application. Pasture Seed was supplied by Granite Seed according to the seed schedules with no substitutions. Pasture seeding was completed by October 5, 2023. Refer to the attached As-built Seeding and Planting Map for locations (Appendix G).

Soil amendments were not applied to vertical/steep slopes or wetland/live water areas within the inset floodplain to prevent flushing downstream and ineffective application. The following soil amendments were applied in late fall 2023 to all upland and pasture seeding areas using a small ATV with a spray boom:

- Endo mychorrizal inoculum was applied at a minimum rate of twenty (20) pounds per acre or as a liquid at an equivalent rate as per the specifications.
- Humate was applied at a rate of 500 pounds per acre (dry granules) or as a liquid using Quantum Organic VSC at a rate of 4 gallons/acre as per the specifications.
- No organic matter/compost (aged manure) was applied as per the specifications.
- An as-built Seeding Map is attached (Appendix G) that shows the location of upland seeding areas where soil amendments were applied.

Following the September 19, 2023 Agency Team site inspection, certified weed free straw was applied to all Upland and Pasture seeding areas followed by crimping by October 5, 2023.

See Section 5 – Adaptive Management Phase 3 Activities for additional soil amendment, seeding and mulching activities planned in 2024.

3.6 Groundwater Well Installation

Groundwater wells were installed as directed by the MAM Plan. Installation of 26 shallow groundwater wells was completed in October 2023 as part of remaining Phase 1 construction activities. Wells were installed at 12 monitoring transects along the outer margins of the Vermillion Creek and two locations within the Little Joe Wetland Complex (Appendix H). Well construction used a 4 ft Merrill drive point well connected with a steel coupler to a steel riser and capped with a well top (Photo 46 in Appendix A). All wells were installed to a depth of 53” to ensure the upper 5-inches are not slotted to reduce the potential for sediment to enter the wells.

Additionally, a bentonite seal using bentonite chips was installed to seal the tops of the wells and to prevent surface water infiltration and sediment from entering the wells (Photo 47 in Appendix A). At this time, no protection against high runoff/debris flows has been installed. The design team will monitor the groundwater wells and install this protection as part of adaptive management activities, if conditions warrant. Installation of data loggers in the groundwater wells is planned to be completed before the start of the 2024 monitoring period (approximately May 17 to September 18).

3.7 Crest-Stage Gage Installation

A USGS crest gage, Type A was purchased from Performance Results Plus, Inc. and installed in October 2023 as part of remaining Phase 1 construction activities (Photo 45 in Appendix A). Due to channel adjustments caused by the migration of the upstream headcut, the original location specified in the MAM Plan for the crest-stage gage was no longer suitable. The crest-stage gage was installed at the nearest suitable location to the original cross section as shown in Appendix H. Additionally, Mr. Raftopoulos will install a weather station with rain gage on the DPCC property to enable monitoring of precipitation events, which provides the trigger for timing of inspection of the crest-stage gage, starting in Spring 2024.

4 ADAPTIVE MANAGEMENT PHASE 2 ACTIVITIES

4.1 Introduction

The October 2022 flood performed extensive work resulting in benefits that allowed the designers to observe channel responses and natural processes, which informed optimal modifications for Phase 2 (2023) construction and revegetation activities. The following sections discuss individual activities that occurred during Phase 2 (2023) in compliance with MAM Plan directives:

4.2 Additional SBS or Similar Structures

To help speed up the stream evolution of Vermillion Creek, Simulated Beaver Structures (SBS) were initially installed along with transplants to accelerate expected disturbance (e.g., localized bank erosion). With this intended function, the SBS were not expected to remain in place long-term. Bank erosion is critical for the channel to progress through SEM stages, as desired and as the increased sediment loading accelerates the channel's progress through its stream evolution trajectory. Specifically the channel will progress along SEM stages including aggradation and widening, eventually arriving at a more functional form. After observing the channel response to the October 2022 flood event and subsequent Spring 2023 high flow runoff events, the design team determined that the SBS performed as intended and were no longer needed to further the intended channel trajectory.

4.3 Wetland Seeding

All Zone 2 Wetland Seeding areas within the bed of the inset Vermillion Creek inset floodplain and the Little Joe Wetland Complex were seeded with the specified Wetland Seed Mix at the rates indicated on the plans. Slumped toes at the base of vertical banks that were seeded with the Upland-Cover Crop Mix were also seeded with the Wetland Mix. The Wetland Seed was supplied by Granite Seed according to the seed schedules with no substitutions. Wetland seeding was completed by July 10, 2023, via a hydroseeder (Photo 30 in Appendix A).

A flood pulse moved through the inset floodplain on August 3, 2023, several days after wetland seeding was performed (Photo 31 in Appendix A). During the August 29, 2023 monitoring inspection, hydromulch was observed to be generally still present, indicating that wetland seed was still in place. Approximately 20 pounds of the Wetland Mix has been reserved in cold storage to perform touch-up seeding in the Spring of 2024 for areas that may experience scour and wetland seed loss. Refer to the attached As-built Seeding and Planting Map for locations (Appendix G).

4.4 Wetland Planting

A total of 12,000 willow cuttings were harvested the week of April 23, 2023, processed, bundled, soaked, and placed in cold storage by May 8, 2023 (Photo 21 in Appendix A). These willow cuttings are in addition to the 2475 willow clumps planted in 2022. ECOS prepared a Willow Planting Layout Detail (modified Typical Main Channel Detail, Planset Sheet 27, Appendix F) to guide the distribution and planting operations, which was implemented as follows:

- 8600 willow cuttings were planted within the Vermillion Creek inset floodplain by June 10, 2023 (Photos 20, 22–24 in Appendix A). To ensure even distribution of the available plant materials throughout the floodplain, approximately 573 willow cuttings were planted along the banks and low point bars between each SBS Structure, using the old SBS locations for reference.

- 3000 willow cuttings were planted in the Little Joe Wetland Complex by August 26, 2023 (Photos 40–42 in Appendix A).
- 400 willow cuttings were planted along the bed and banks of the upstream head cut area by August 26, 2023, to supplement the existing willow present within the slumped banks

Preliminary quantitative vegetation monitoring data collected along transects in August 2023 does not capture observed willow cutting survival. Qualitatively, willow cutting survival appears to be over 80% with little mortality and high success. Given this condition, no major replanting of willow stakes is currently planned. The design team will monitor revegetation, watching for changes that warrant adaptive management action (e.g., massive die-out of willow).

See Section 5 – Adaptive Management Phase 3 Activities for additional willow planting activities planned in 2024.

4.5 Riparian Planting (Cottonwood Planting)

DPCC monitored cotton production, which took place around the last week in June 2023, then collected cotton and hand seeded it concurrently with the Riparian Seeding operations. (Photo 28 in Appendix A).

Either via seeding or natural recruitment, cottonwood seedlings and saplings (assumed to be Freemont cottonwood, *Populus fremontii*) were observed during the August 2023 site assessment throughout the inset floodplain at various stages of growth. (Photo 48–49 in Appendix A). Occurrence and density of cottonwood are greater in the downstream sections of the floodplain starting at approximately 50+00 with the highest density of seedlings downstream of Station 30+00. The higher density downstream is likely attributed to greater source of wind-blown cotton from nearby mature cottonwood in these areas, especially at the downstream-most end of the Project.

DPCC checked availability of Freemont cottonwood (*Populus fremontii*) from nurseries in a 600-mile radius and found that this species is not readily available. Stan Young from Mack, Colorado who is purported to sell Freemont cottonwood poles could not be reached successfully to obtain cottonwood poles from that source, which was suggested by a Bureau of Land Management (BLM) representative.

The decision was made that performance standards are anticipated to be met without fencing or otherwise protecting any one individual or stands of cottonwood seedlings in 2023. Avoiding fencing is preferred because stream flows in Vermillion Creek in 2024 will likely dislodge and damage the fencing, which could harm the cottonwoods.

See Section 5 – Adaptive Management Phase 3 Activities for cottonwood protection and planting activities planned in 2024.

4.6 Weed Management

To assist the DPCC in meeting performance standards regarding Lists A and B noxious weeds, the BLM has agreed to work with the DPCC on weed control issues on BLM-managed public lands within and adjacent to the Restoration Site. The Cooperative Weed Management Agreement described in the MAM Plan and the Consent Decree states the "BLM is willing to allocate a percentage of its annual weed control funding to address areas adjacent to the Restoration Site. This allocated funding could be used to pay the same contractor that DPCC hires so that treatments are conducted in a coordinated manner. Mr. Raftopoulos, DPCC, and BLM have agreed to work out the details of this coordinated weed management effort."

To facilitate coordination and cooperation with the BLM, the design team, in coordination with DPCC, has prepared a detailed Weed Management Plan (WMP) vetted by Outlaw Environmental Services (Outlaw), a certified herbicide applicator licensed by the State of Colorado Department of Agriculture and a Federally Registered Contractor who will be conducting weed management activities on the Project Site. A draft final WMP was provided to Christina Rhyne, Rangeland Management Specialist with the BLM Little Snake Field Office on December 6, 2023 for review, comment, and collaboration. Refer to Appendix B, Draft Final Weed Management Plan. BLM review comments are anticipated to be received in the near future, which will enable a Final WMP to be ready for implementation in 2024.

During the September 19, 2023 site inspection, the Agency Team noted a great deal of alfalfa cover (within the floodplain correlated to higher moisture levels) and expressed concerned to the design team that alfalfa may out-compete the emerging grasses and wetland plants if not managed (e.g., cut or weed-whacked). The design team consulted DPCC and learned that DPCC has not encountered problems with alfalfa out-competing other grasses. Literature says alfalfa does not tolerate being cut or grazed below 4–6 inches. Additional relevant information includes the understanding that alfalfa is highly desired by livestock in limited quantities (to prevent bloating), however release of cattle into the restoration area to graze it, as cattle are not selective and will eat everything, is not considered a possible strategy.

The design team reviewed multiple literature sources finding that "Alfalfa and grasses have different canopy and root structures, nutrient requirements, and microclimate preferences that minimize their competition with each other" (Kim Cassida, Michigan State University Extension, August, 2022) and alfalfa has value for rehabilitation of disturbed sites (USDA Species Profile of Medicago Sativa, December, 2023) The design team recommends monitoring progress of alfalfa versus 2023 grass/wetland herb seeding in 2024. If the seeded grasses and wetland herbs, which are better adapted to wetland soils and hydrology, germinate and willow will co-habitate with the alfalfa in 2024, no adaptive management actions may be required. For these reasons, and additionally noting that alfalfa is often used by ranchers and mixed with pasture grasses as a companion crop, the design team recommends that management of tamarisk and other weeds be given priority over alfalfa.

5 ADAPTIVE MANAGEMENT PHASE 3 ACTIVITIES

Based on design team assessment and the independent 2023 FACWet Report (see Section 6.4 FACWet Level 2 – Rapid Assessment), the following adaptive management activities are currently planned for Phase 3:

- DPCC will monitor for bare spots where germination of native seed may be insufficient and will apply additional soil amendment, upland, and pasture seeding and mulching.
- DPCC plans to harvest and cold store an additional 300 willow cuttings in early Spring 2024 to backfill any areas where willow density may be thin.
- DPCC will monitor cottonwood seedling growth and vigor in 2024 to select and protect seedlings with greatest survivability promise. In addition to observing, nurturing and protecting young cottonwood recruits next season, DPCC plans to harvest dormant native poles derived from nearby private land within the Vermillion Creek watershed and plant them along the entire length of Vermillion Creek in early Spring 2024 ensuring that at least 54 are located on BLM land. DPCC will also re-attempt contact with Stan Young from Mack, Colorado in continued search for Freemont cottonwood poles for installation in Spring 2024.

6 MONITORING ACTIVITIES

As specified in the MAM Plan, Phase 1 monitoring will start in 2024 and will include the following activities:

- resurvey at least 12 of the previously established valley-wide topographical cross sections to establish as-built conditions as baseline condition to compare any potential future change;
- locate and survey longitudinal topographic transect (i.e., longitudinal profile) to establish as-built conditions as baseline condition to compare any potential future change;
- use the valley-wide topographical cross sections and longitudinal topographic transect and shallow groundwater well data at representative intervals to estimate lateral extents of water distribution;
- establish photo points and provide photographic documentation of as-built conditions;
- review and summarize the data and recommended adjustments that may be necessary to maintain a trajectory toward a functional Creek that will support the required wetland acreage and a FACWet Composite FCI score of 81;
- perform a baseline, FACWet Level 2 - Rapid Assessment; and
- perform a visual, qualitative SEM stage assessment.

The following sections discuss details of monitoring activities completed in 2023, present data collected in 2023, and discuss planned activities for 2024.

6.1 Topographic Survey

Topographic survey data was not yet completed before the October 2022 flood event., therefore no survey data was collected to establish as-built conditions. The October 2022 flood performed extensive work that assisted in natural channel development resulting in changes to the channel planform that was created prior to the October flood. As best available information, the design team will rely on the proposed design elevations as the baseline condition when using the monitoring survey data to track changes. As mentioned in Section 3.2 Vermillion Creek Inset Floodplain, all elevations were checked at completion of excavation to be within 0.2 feet of design specifications.

On June 29, 2023, a drone was flown by a certified Professional Land Surveyor (PLS) from Epp & Associates to obtain initial information on changes to the channel planform resulting from the large flood in October 2022, as well as high flows associated with 2023 Spring runoff. This survey data captures the top of water rather than channel bottom for inundated areas within the inset floodplain. The drone flight was completed using a DJI Phantom 4 Pro and was processed using Pix4d. Drone data was contoured to 1 ft intervals. These data were provided to the Agency Team on July 31, 2023.

More comprehensive topographic survey data was collected in November 2023, including resurvey of the monitoring and control cross sections, survey of a longitudinal profile, survey of the groundwater well locations, and survey of the crest-stage gage datum and cross section (Appendix H). A PLS from Epp & Associates completed a drone flight on November 9th, 2023, using DJI Mavic 3 Enterprise RTK, and processed drone data using Pix4d. Drone data were contoured to 1-ft intervals. Additionally, survey of the monitoring, control, and crest-stage gage cross sections, longitudinal profile, groundwater well locations, and crest-stage gage datum was completed with a RTK GPS on November 9 and 14,2023 to capture the channel bottom topography that was inundated with water during the earlier drone flight. All cross sections were surveyed from top of bank to top of bank. The longitudinal profile followed the channel thalweg. These survey data were then merged with the drone survey data to develop valley-wide cross sections. Cross sections and longitudinal thalweg profiles comparing the November 2023 survey data with the proposed design elevations (referred to as "Constructed Sept 2022") is presented in Appendix C.

6.2 Lateral Extents of Water Distribution

Shallow groundwater well data and stream stage data were not collected during 2023 because high runoff prevented the installation of the groundwater wells and crest-stage gage prior to the start of the 2023 monitoring period. As described in Section 3.6 Groundwater Well Installation, data loggers are planned to be installed in established groundwater wells before the start of the 2024 monitoring period (approximately May 17 to September 18). This approach provides a full season of data, rather than partial season.

6.3 Photographic documentation of as-built conditions

As-built conditions of the Vermillion Creek channel grading, SBS structures, Little Joe Creek wetland complex, headcut treatments, groundwater wells, and crest-stage gage are presented in the Photo Log (Appendix A).

As per the MAM Plan, photo points at each monitoring transect were established as part of the Phase 1 Monitoring efforts, when quantitative vegetation sampling was performed (discussed in Section 6.5 Quantitative Vegetation Sampling). Locations of photo points are presented in Appendix H and were located in the center of the as-built inset floodplain at each transect for consistency. Photos at each photo point are included in the USACE Monitoring Report Forms presented in Appendix D. These photos were consistently taken upstream, downstream (perpendicular to the transect), and left and right (parallel with the transect) to fully capture current conditions of the aquatic resource and adjacent upland buffers at that location. Each photo point and photo in the USACE Monitoring Report Form documents the photo point number, the georeferenced photo file number where the original photo is stored, the date the photo was taken, the compass and cardinal direction, the latitude and longitude of the georeferenced photo, and the photographer's name.

6.4 FACWet Level 2 – Rapid Assessment

Dr. Brad Johnson of JEC conducted an independent FACWet Level 2 - Rapid Assessment to evaluate and rate the condition of the Project's aquatic resources. The FACWet Report describes the findings of a site assessment conducted on August 29, 2023. Refer to Appendix E. **The composite score of the restoration at the time of this assessment was a C- (72) as compared to the C+ (78) regional reference, which is 9 points short of a target score of 81 (B-) and better than the typical regional condition.** Results from this report informed adaptive management activities planned for Phase 3 in 2024 (see Section 5 - Adaptive Management Phase 3 Activities).

6.5 Quantitative Vegetation Sampling

A preliminary quantitative vegetation sampling of native and naturalized plant cover was conducted in 2023 at 12 sampling transects (6 using the transect/plot method and 6 using the transect/point intercept method) to assess initial natural recruitment, wetland, riparian and upland seeding, willow planting, and weed invasion. The following composite vegetation list illustrates plant species encountered during the vegetation sampling:

Composite Vegetation List (2023)

Symbol	Common Name	Scientific Name	Indicator Status	Weed Type
ALO ARU	Creeping Meadow-foxtail	*Alopecurus arundinaceus*	FAC	
AMA RET	Pigweed	*Amaranthus retroflexus*	FACU	Common
ART TRI	Wyoming sagebrush	*Artemisia tridentata*	UPL	
ASC SPE	Showy milkweed	*Asclepias speciosa*	FAC	
BRO TEC	Cheatgrass	*Bromus tectorum*	NI	C
CHE RUB	Red goosefoot	*Chenopodium rubrum*	FACW	Common
CHR VIS	Yellow rabbitbrush	*Chryothamnus viscidiflorus*	UPL	
CIR VUL	Bull thistle	*Cirsium vulgare*	FACU	B
CON CAN	Horseweed	*Conyza canadesis*	NI	Common
DIS SPI	Saltgrass	*Distichlis spicata*	FAC	
ECH CRU	Barnyardgrass	*Echinochloa crus-galli*	FACW	Common
ELY TRA	Slender wheatgrass	*Elymus trachycaulus*	FACU	
EQI ARV	Field Horsetail	*Equisetum arvense*	FAC	
GLY LEP	Wild licorice	*Glycyrrhiza lepidota*	FAC	
GRI SQU	Curlycup gumweed	*Grindelia squarrosa*	FACU	Common
IVA AXI	Povertyweed	*Iva axillaris*	FACU	Common
JUN BAL	Baltic rush	*Juncus balticus*	FACW	
KOC SCO	Kochia	*Kochia scoparia*	NI	Common
LAC SER	Prickly lettuce	*Lactuca serriola*	FACU	Common
MED SAT	Alfalfa	*Medicago sativa*	UPL	
PAS SMI	Western wheatgrass	*Pascopyrum smithii*	FAC	
PHA ARU	Reed canarygrass	*Phalaris arundinacea*	FACW	Naturalized
PHR AUS	Common reed	*Phragmites australis*	FACW	Naturalized
POL LAP	Smartweed	*Polygonum lapathifolium*	FACW	Common
POL MON	Rabbitfoot grass	*Polypogon monspeliensis*	FACW	
POP FRE	Fremont cottonwood	*Populus fremontii*	FAC	
RUM CRI	Curly dock	*Rumex crispus*	FAC	Common
SAL EXI	Sandbar willow	*Salix exigua*	FACW	
SAL TRA	Russian thistle	*Salsola tragus*	FACU	Common
SAR VER	Greasewood	*Sarcobatus vermiculatus*	FACU	
SCH PUN	Three-square bulrush	*Schoenoplectus pungens*	OBL	
SCH TAB	Soft-stem bulrush	*Schoenoplectus tabernaemontani*	OBL	
SET PUM	Yellow bristlegrass	*Setaria pumila*	FAC	
TAM PAR	Tamarisk	*Tamarix parviflora*	FAC	B
THI INT	Intermediate wheatgrass	*Thinopyrum intermedium*	NI	
TYP LAT	Cattail	*Broadleaf cattail*	OBL	

Preliminary quantitative sampling revealed the following results across all transects:

Overall Absolute Percent Cover of Dominant Wetland Species (OBL, FACW or FAC) within the 25-foot Buffer and Inset Floodplain = 15.4 %

Overall Absolute Percent Cover by Strata:

- Upland Shrubs and Grasses = 5.5%
- Riparian Trees = 0.0 %
- Wetland Shrubs = 6.3%
- Wetland Herbs = 9.1 %
- Weeds (List A, B, C and Common) = 15.2%
- Open Water = 14.3%
- Bare Ground = 49.6 %

Overall Absolute Percent Cover of Dominant Wetland Species (OBL, FACW or FAC) within the Inset Floodplain:

- Wetland Species = 9.0%
- Open Water = 34.7%
- Bare Ground = 39.8%
- Non-Wetland Species = 15.5%

Overall Absolute Percent Cover of Weeds within the 25-foot Buffer:

- Noxious Weeds (List A) = 0.0%
- Noxious Weeds (List B) = 0.2%
- Noxious Weeds (List C) = 4.8%
- Common Weeds = 10.2%

Note: (Absolute percent cover can be greater than or less than 100%).

Refer to photos in Appendix D, USACE Monitoring Report Form for a visual reference of the vegetation conditions noted above at each monitoring transect.

6.6 Qualitative Vegetation Observations

Quantitative data (vegetation hits along transects and sample plots) did not completely represent visual observations:

- Overall vegetation cover of seeded and planted materials is immature but expected to rise in subsequent growing seasons.
- Herbaceous wetland species density is thin and present in small percentages. Determination of successful emergence of wetland grass-like species from the designed wetland seed mix or by natural recruitment via seeds and roots already present in the watershed and soil is premature. The site appears to be on track to meet the 72% cover of herbaceous species performance standard.

- Natural recruitment of willow is significant, including overbanks areas outside of the inset floodplain.
- Very few willows cuttings showed mortality. Planted willow cutting survival within the inset floodplain appears to be over 80%. The site appears to be on track to exceed the 72% cover of willow (shrub) species performance standard and may likely reduce herbaceous cover.
- Natural recruitment of cottonwood seedlings is significant, especially in the lower reaches (downstream of the low water crossing at 50+00) where existing, cotton producing cottonwood trees are located. The site appears to be on track to meet the 10% cover of trees (cottonwood), including 54 on BLM land and 27 on private land over 3–5 years.
- Early successional invasion of ruderal weeds in recently disturbed soil that have little competition for water, light and nutrients is as expected. Dormant seeding of upland grasses performed in the summer and late fall 2023 combined with weed management in 2024 is expected to start bringing the site into balance as grasses germinate and establish.
- Natural recruitment (invasion) of tamarisk seedlings, a List B Noxious Weed, is significant, especially in the lower reaches where existing, mature tamarisk are/were pervasive prior to the project. Weed management of this regional and landscape scale species will require significant private and public resources to meet the 10% List B cover by year 5 performance standard unless this performance standard is relaxed.

Refer to photos in Appendix D, USACE Monitoring Report Form for a visual reference of the vegetation conditions noted above at each monitoring transect.

6.7 Qualitative SEM Stage Assessment

The design approach for Vermillion Creek is based on an understanding of the system as a whole and the channel's stream evolution trajectory. The initial channel geometry was designed to create the needed acreage of wetlands while understanding that the trajectory of the channel would continue to sustain the wetlands over the long-term. The design "channel" was constructed as a new inset floodplain without a defined channel along this newly created valley bottom. The channel was constructed is a SEM stage 2 (Channelized) (Cluer and Thorne 2014[1]) (Figures 1 and 2). This constructed channel was not expected to stay as a SEM 2, but rather move along the stream evolution towards SEM stage 6 (Quasi Equilibrium), SEM stage 7 (Laterally Active), or SEM stage 8 (Anastomosed, if beaver moved back in). For the channel to progress from SEM stage 2 to 6, the channel needs to incise or widen or both. Eventually, the new channel will be wide enough to decrease sediment transport capacity to a point at which aggradation starts to occur. The channel would then continue to aggrade and widen until it eventually reached a new dynamic equilibrium (SEM stage 6).

[1] Cluer, Brian & Thorne, Colin. (2014). A Stream Evolution Model Integrating Habitat and Ecosystem Benefits. River Research and Applications. 30. 10.1002/rra.2631.

Figure 1. Post-construction channel (left photo) was SEM stage 2 (Channelization). Note the trapezoidal channel shape with no defined channel. SBS and transplants were installed to create disturbance including bank erosion to help push the channel further along the evolution trajectory. Post-flood channel (right photo) has widened and aggraded, moving towards SEM between Stage 5 and 6.

Figure 2. Post-construction channel (left photo) was SEM stage 2 (Channelization). Note the trapezoidal channel shape with no defined channel. SBS and transplants were installed to create disturbance including bank erosion to help push the channel further along the evolution trajectory. Post-flood channel (right photo) has incised, widened, and is beginning to aggrade to move towards SEM stage 5.

To help speed up the stream evolution of Vermillion Creek from SEM stage 2 to SEM stage 6, Simulated Beaver Structures (SBS) were installed along with transplants to accelerate expected disturbance, like bank erosion. These SBS were not expected to remain in place long-term but instead cause bank erosion over the short-term. Bank erosion is critical for the channel to progress through SEM stage 3 (Degradation) and SEM stage 4 (Degradation and Widening), to reach SEM stage 5 (Aggradation and Widening) on the way towards SEM stage 6. The increased sediment loading from bank erosion accelerates the channel's progress through its stream evolution trajectory.

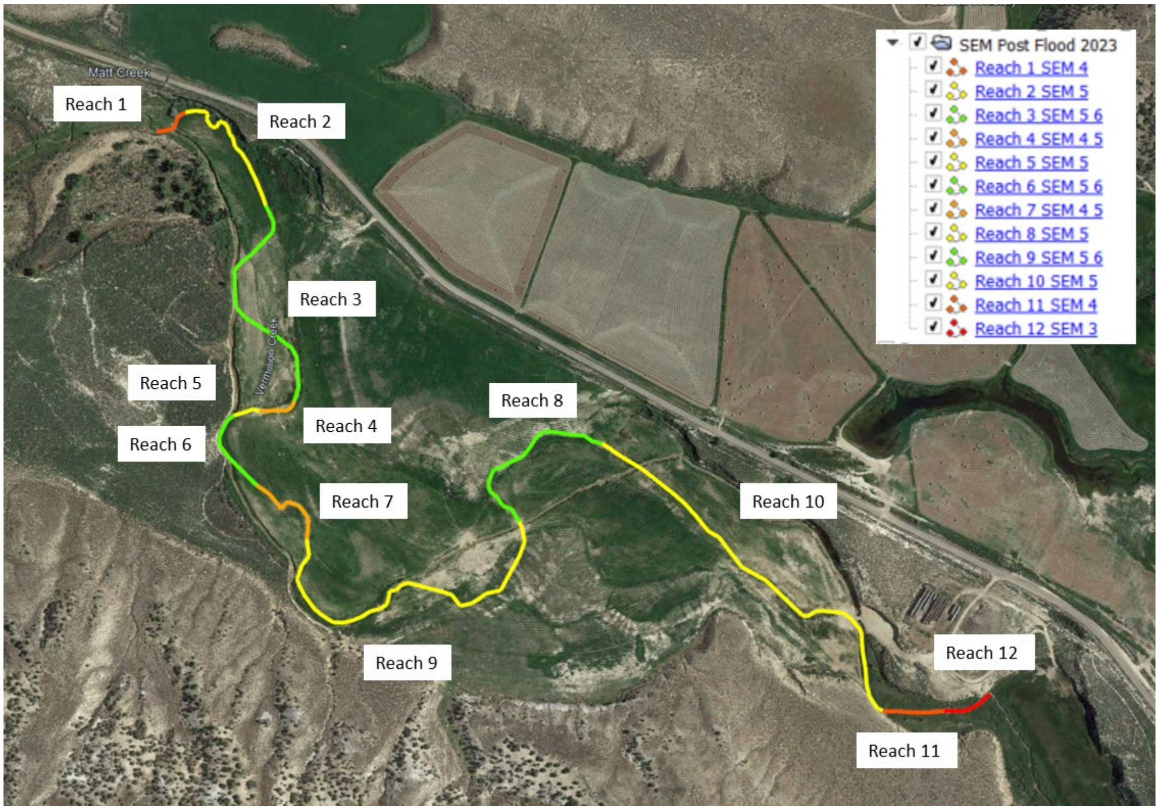

Figure 3. Results from the SEM assessment of the project area post-flood. The majority of the reach is currently in SEM stage 5 or between SEM stage 5 and SEM stage 6.

A SEM assessment was conducted as part of the post-flood assessment to determine whether Vermillion Creek is moving along the expected SEM trajectory described above. The results show that the channel has moved from SEM stage 2, through SEM stage 3 and SEM stage 4 in most areas, and is currently at SEM stage 5, or between SEM stage 5 and SEM stage 6, in most of the project reach (Figures 3 and 4).

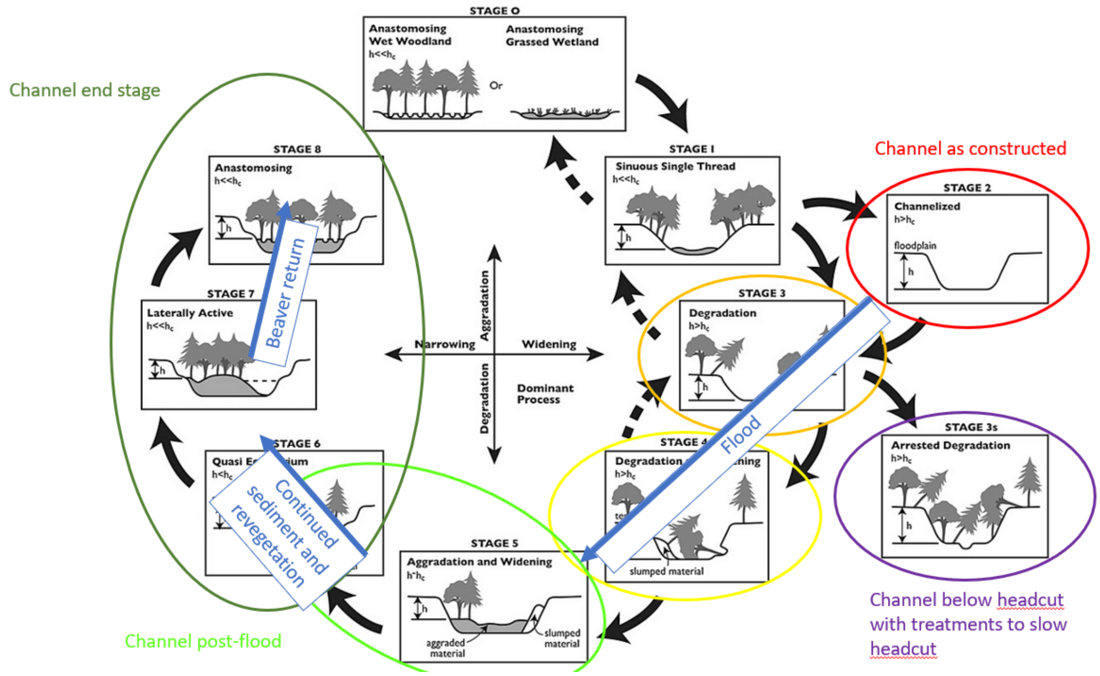

Figure 4. Work conducted by recent flood events has helped progress the channel from its constructed SEM stage 2 (Channelization) to SEM stage 5 in some areas and between SEM stage 5 and 6 in most areas. Continued sediment deposition and revegetation will keep moving the channel towards dynamic equilibrium. The upstream end of the reach with active headcuts is anticipated to move towards SEM stage 3s (Arrested Degradation) once treatments are installed to help slow the headcuts.

Upstream of the low water crossing at Station 52+20 the channel has incised, widened, and migrated, creating the needed sediment deposition locally and in the reach downstream of the low water crossing. New point bars and mid-channel bars are forming. Eroding banks appear to be stabilizing at the toe where sloughed material is remaining and becoming vegetated. Downstream of the low water crossing reach is observed to be currently at SEM stage 5, or between SEM stage 5 and SEM stage 6, with aggradation and widening occurring. While future channel migration may continue, this downstream section is expected to finalize at SEM stage 7.

The downstream reach, being mainly aggraded and widened in post-flood conditions, is slightly further along the SEM trajectory compared to the upstream reach. Once the channel becomes vegetated and roughness increases, continued aggradation is expected to occur, which will push the channel towards SEM stage 6. Photos 1 through 12 in the photo log presents the SEM assessment visually with explanatory captions.

Cross sectional survey data were collected and analyzed for channel adjustment to add another line of evidence for the Project's SEM trajectory. Repeat cross sectional data from pre- and post-flood show the channel has mainly incised and widened upstream of the low water crossing at Station 52+20 and aggraded and widened downstream of the low water crossing (Figure 5 and Appendix C). This data comparison reinforces field assessment observations that indicate the flood has moved Vermillion Creek along the stream evolution as intended.

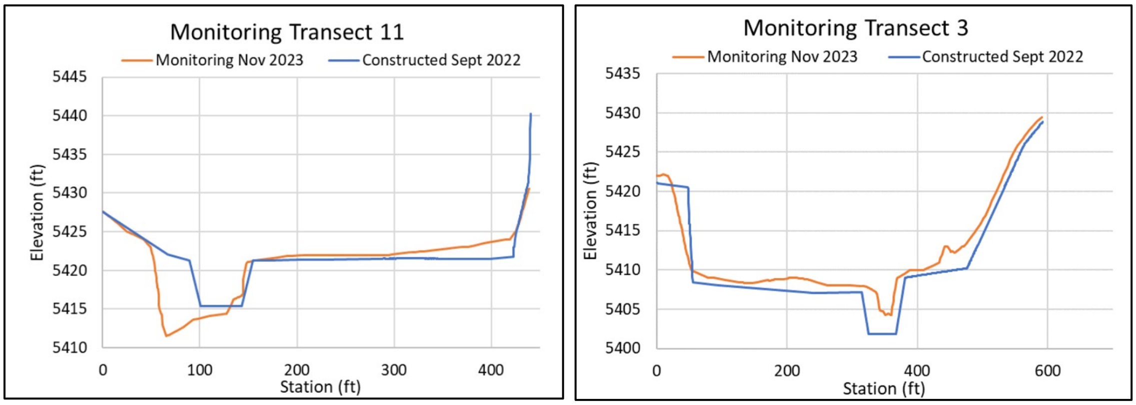

Figure 5. Repeat cross sectional survey data show the channel has incised and widened upstream of the low water crossing structure at Station 52+20 (left, transect 11 near Station 69+00) and aggraded and widened downstream (right, transect 3 near Station 22+00).

7 ADAPTIVE MANAGEMENT ACTIVITIES

The October 2022 flood and subsequent high Spring runoff flows in 2023 have significantly progressed the Vermillion Creek channel along the SEM trajectory, setting up the constructed inset floodplain with diverse macro- and micro-topography to strengthen riparian and wetland habitat potential. Observations in August 2023 show that planted and recruited vegetation has begun to establish on newly shaped bars within the inset floodplain. Because 2023 was a wetter than average year, water covered the majority of the inset floodplain footprint throughout the growing season. In more average water years, the channel is be expected to notably drier, flowing under low flow conditions in the vicinity of one cfs, which would allow more extensive vegetation establishment along the inset floodplain.

As documented in the independent FACWet Report, the project site is set up to create the necessary wetland habitat and is in need of continued vegetation establishment. With this assessment of current conditions, planned adaptive management activities for 2024 are minimal at this time. If flow levels during the 2024 growing season are closer to average, vegetation is anticipated to continue to establish across a broader area of the inset floodplain. With continued vegetation establishment, the Project will continue to move along the desired geomorphic trajectory towards healthier, more functional SEM stages, and additionally create larger wetland acreage, as needed for compliance with Project goals.

The design team will monitor the Project in 2024, including collecting and analyzing shallow groundwater data, to determine whether additional adaptive management activities are warranted in 2024.

Planned adaptive activities were called out previously in Section 5 – Adaptive Management Phase 3 Activities. Adaptive management activities identified by the Agency Team that were completed in 2023 are listed below.

- Fencing was added to preclude cows from entering the site from the upstream end of the project reach, near the headcut (Photo 50, Appendix A).
- Native coarse bed material was added to the upstream low water crossing to reduce potential barriers to fish passage (Photo 51, Appendix A).

APPENDIX A
Photo Log

Photo log

Photo 1: 5/25/2023 Reach 12 SEM score of 3. Viewing the current location of the headcuts.

Photo 2: 5/25/2023 Reach 11 SEM score of 4

Photo 3: 5/25/2023 Reach 10 SEM score of 5

Photo 4: 5/25/2023 Reach 9 SEM score of 5.5

Photo 5: 5/25/2023 Reach 8 SEM score of 5

Photo 6: 5/25/2023 Reach 7 SEM score of 4.5

Photo 7: 5/25/2023 Reach 6 SEM score of 5.5

Photo 8: 5/25/2023 Reach 5 SEM score of 5

Photo 9: 5/25/2023 Reach 4 SEM score of 4.5

Photo 10: 5/25/2023 Reach 3 SEM score of 5.5

Photo 11: 5/25/2023 Reach 2 SEM score of 5

Photo 12: 5/25/2023 Reach 1 SEM score of 4

	
Photo 13: 5/25/23 Visual observations of debris flow near cross section STA 2+40	Photo 14: 5/25/23 Height of high flow debris measurement near cross section STA 2+40
	
Photo 15: 6/16/2023 Downstream Check Dam BMP repaired	Photo 16: 6/29/2023 Volunteer vegetation establishing on inset floodplain.

Photo 17: 5/25/2023 Revegetating bank

Photo 18: 5/25/2023 Volunteer vegetation along slumped toe.

Photo 19: 5/25/2023 Willow recruitment along slumped toe and vertical banks.

Photo 20: 6/7/2023 Willow staking in channel according to plan

	
Photo 21: 5/6/2023 Willows in cold storage awaiting planting	Photo 22: 6/29/2023 Willows stakes on inset floodplain resprouting
	
Photo 23: 6/29/2023 Willows stakes on inset floodplain resprouting.	Photo 24: 6/29/2023 Willows stakes and SBS transplants on inset floodplain resprouting. Volunteer vegetation along slump toe.

Photo 25: 5/25/23 Willow sprouting from SBS transplants in inset floodplain.

Photo 26: 6/29/23 SBS in channel with willow sprouting from SBS transplants.

Photo 27: 5/25/2023 Willow sprouting from SBS transplants.

Photo 28: 6/29/2023 Cottonwood "cotton" collected from the downstream reach of the site.

	
Photo 29: 6/17/2023 Concrete debris has been removed.	Photo 30: 7/31/2023 Wetland seed applied to the inset floodplain
	
Photo 31: 8/3/2023 Three days after wetland seed was applied	Photo 32: 8/7/2023 Upland seed applied to the bank at the entrance by stock yard.


Photo 33: 8/17/2022 Completed channel excavation grading in lower reach.


Photo 34: 8/18/2022 Completed channel excavation grading in upper reach.

Photo 35: 8/2/2022 Completed SBS with direct transplants.


Photo 36: 8/25/2022 Completed SBS with direct transplants and willow transplants upstream and downstream of SBS.


Photo 37: 8/25/2022 Willow transplants between installed SBS.


Photo 38: 8/25/2022 Completed SBS with direct transplants and willow transplants upstream and downstream of SBS.

Photo 39: 8/17/2023 Little Joe Creek wetland complex water distribution.

Photo 40: 9/18/2023 Little Joe Creek wetland complex complete with water flowing through.

Photo 41: 9/18/2023 Little Joe Creek wetland complex connection between wetland cells.

Photo 42: 9/18/2023 Little Joe Creek wetland complex connection to Vermillion Creek

Photo 43: 9/18/2023 Headcut treatment completed in the southern headcut.

Photo 44: 9/18/2023 Headcut treatment in completed the northern headcut.

	
Photo 45: 10/17/2023 Staff gauge installed in the channel thalweg.	Photo 46: 10/17/2023 Assembled Drive Point Groundwater Well before installation.
	
Photo 47: 10/17/2023 Groundwater well installed at the toe of the channel.	Photo 48: 5/25/2023 Cottonwood seedlings.

	
Photo 49: 8/28/2023 Cottonwood sapling	Photo 50: 12/17/2023 Fence extenders to preclude cows from entering site
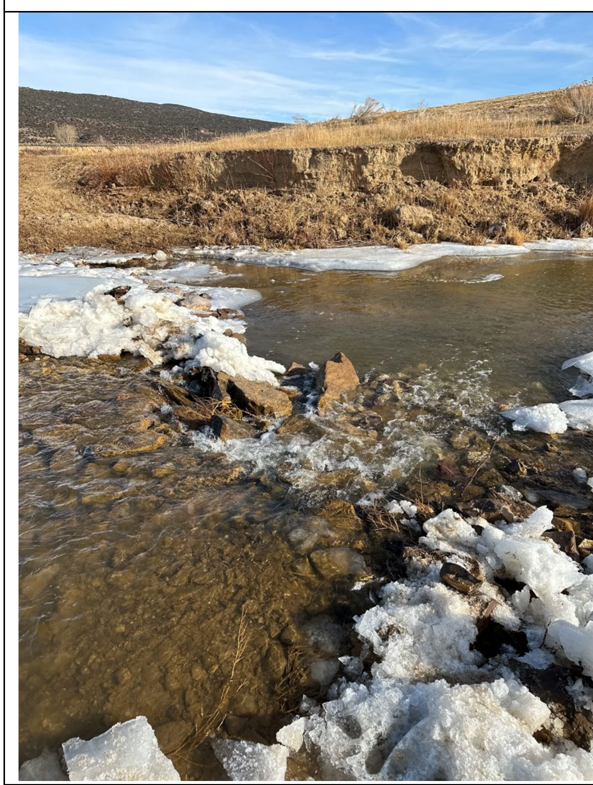	
Photo 51: 12/17/2023 Added native cobble to upstream low water crossing to reduce fish passage barriers.	

APPENDIX B

Draft Final Weed Management Plan

DRAFT FINAL (FOR BLM REVIEW)

Vermillion Creek Restoration Project
Weed Management Plan

December 6, 2023

Prepared for:

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Project Number: 2022-19-6

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 PURPOSE OF THIS PLAN

The primary purpose of this Weed Management Plan (WMP) is to provide the land managers of the Diamond Peak Cattle Company (DPCC) and Bureau of Land Management (BLM) and their designated contractors with a guidance document on how to control noxious and common weeds that may impede the DPCC from achieving the Performance Standard (PS) established for the Vermillion Creek Restoration Project (Project) on both private and BLM managed lands within and adjacent to the Project Site.

2.0 PROJECT/RESTORATION SITE

The Project Site is defined as the as-built inset floodplain of Vermillion Creek and the Little Joe Wetland plus a 25-foot buffer, including any upland and riparian areas, stream channels or wetlands contained therein (i.e., the Restoration Site). For the purpose of this WMP, the Restoration Site is the Weed Management Site. Refer to Figure 1, Weed Management Site Map.

3.0 PERFORMANCE STANDARD

The Performance Standard (PS) and weed management criteria established in the Monitoring and Adaptive Management Plan (MAM Plan) and Restoration Plans govern this WMP and any weed management activities that may occur on DPCC and BLM land as follows:

- The DPCC will ensure target absolute cover of listed noxious weeds including trees and shrubs (combined strata), grasses, and herb cover does not exceed the percent cover that is characteristic of the site or reference conditions by year 5 (by the end of the Monitoring Period) within the Restoration Site.

More specifically, the DPCC and BLM will:

- Eliminate List A and reduce List B species to less than 10% mean foliar cover; and
- Eliminate List B species within the Restoration Site that have been designated in Moffat County, including salt cedar, diffuse knapweed, houndstongue, perennial pepperweed, dalmatian toadflax, hoary cress, bull thistle, musk thistle, scotch thistle, jointed goatgrass, and Russian-olive.

Figure 1 - Weed Management Site Map

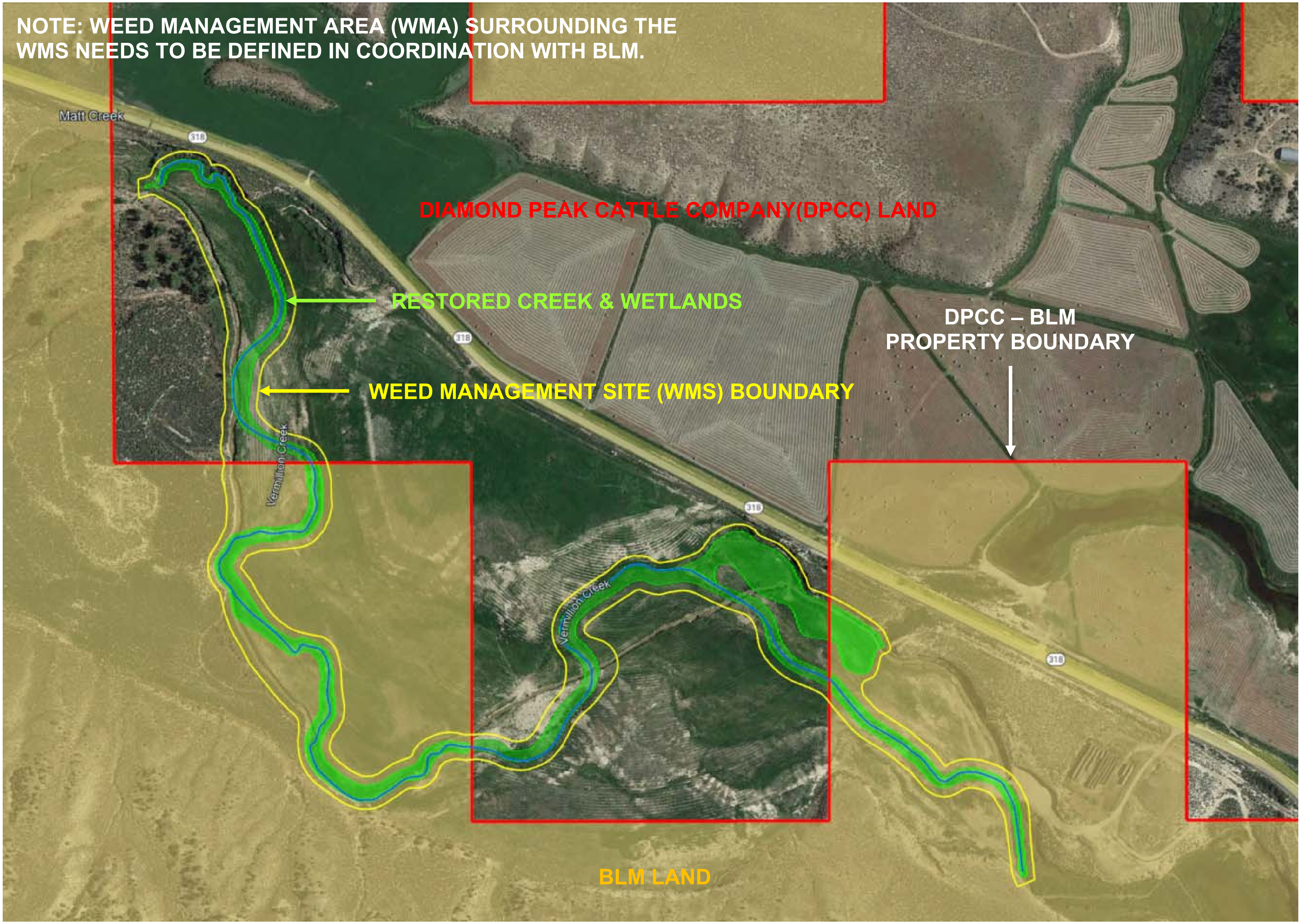

Figure 1 WEED MANAGEMENT SITE MAP

4.0 WEED CATEGORIES

The Colorado Department of Agriculture (CDA) defines four categories of noxious weeds:

- List A: Rare noxious that are designated for eradication statewide.
- List B: Discretely distributed noxious weeds that must be eradicated, contained, or suppressed, depending on their location, to stop their continued spread.
- List C: Species that are well-established in Colorado. Species management plans are designed to support the efforts of local governing bodies to facilitate more effective integrated weed management. The goal of such plans is not to stop the continued spread of these species, but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species.
- Watch List Species: Species that may pose a potential threat to the agricultural productivity and environmental values. The Watch List is intended to serve advisory and educational purposes only. Its purpose is to encourage the identification and reporting of these species to the Commissioner in order to assist in determining which species should be designated as noxious weeds.

For the purposes of this WMP, the following definition applies:

- Common Weeds: Undesirable plants (weeds) not on any of the above lists that may be an impediment to establishing desirable plant communities (i.e., those designed in the Restoration Plans).

5.0 COOPERATIVE WEED MANAGEMENT AGREEMENT

In order to assist the DPCC in meeting performance standards regarding Lists A and B noxious weeds, the BLM has agreed to work with the DPCC on weed control issues on BLM-managed public lands within and adjacent to the Restoration Site. The Cooperative Weed Management Agreement described in the MAM Plan and the Consent Decree states the "BLM is willing to allocate a percentage of its annual weed control funding to address areas adjacent to the Restoration Site. This allocated funding could be used to pay the same contractor that Mr. Raftopoulos hires so that treatments are conducted in a coordinated manner, e.g., the same time of year. Mr. Raftopoulos and BLM have agreed to work out the details of this coordinated weed management effort."

The secondary purpose of this WMP is, therefore, to provide the BLM with the necessary information to reach a collaborative agreement that includes the following principles:

1. This WMP will guide weed management activities on DPCC and BLM land;
2. The Performance Standards and Criteria outlined herein will apply to both DPCC and BLM;
3. Weed management activities on DPCC and BLM land will be carried out according to this WMP with the same level management, rigor, diligence and care regardless of who is doing the work; and
4. The BLM will contract for weed management work on BLM land separately from DPCC land whether said work is conducted by a contractor appointed by the DPCC or the BLM.

6.0 GENERAL WEED MANAGEMENT PLAN

The General Weed Management Plan (GWMP) includes a noxious weed watchlist, as outlined in the Restoration Plans and MAM Plan and provides the overall structure and outline for a Specific Weed Management Plan to follow below. The GWMP as outlined in the Restoration

Plans is as follows:

1. The performance criteria of weed management is to comply with the Colorado Noxious Weed Management Act (CNWA) to eliminate List A and reduce List B species to less than 10% mean foliar cover.

   To meet this goal, the objectives of weed management are to break the above and below ground weed seed and root spreading cycle of undesirable plants (weeds) so that they do not regenerate from seed, propagules or roots that will emerge the following year(s) and to stress undesirable, common weeds to a point where they are outcompeted by desirable plants.

2. CNWA List A and B noxious weeds shall be monitored and controlled by the DPCC using a qualified weed management specialist familiar with control of said weeds where they prevent the establishment of native or naturalized stands of vegetation.

3. This GWMP outlines general weed control measures and timing. A Weed Management Specialist (WMS) shall prepare a specific weed management plan based on actual observed weeds that emerge on the site.

   The WMS shall be a certified herbicide applicator who will conduct weed treatment using herbicides registered with EPA. The selected EPA-registered herbicides shall be used in a manner consistent with their labeling. Herbicides that are designated for aquatic use and selected to avoid harm to fish or other aquatic wildlife will be used. Application of herbicides shall comply with all applicable State of Colorado and local laws regarding the proper use of pesticides, including permitting requirements.

   The WMS shall obtain EPA/BLM approvals prior to the application of any Herbicides/chemical controls.

4. Specific performance criteria for tolerable coverage of noxious weeds are outlined in the MAM Plan. The area where weeds shall be managed includes:
   - The active footprint of the project as defined by the outer limits of restored wetlands plus a 25-foot buffer as shown on the plans (i.e., the Restoration Site).

5. Noxious weeds (on CNWA List A and B) shall be monitored and controlled by the BLM on BLM land where weeds and weed vectors prevent the establishment of native or naturalized stands of vegetation within the Restoration Site.

6. For the purpose of this WMP, Colorado state noxious weeds are defined as follows according to rules pertaining to the administration and enforcement of the Colorado Noxious Weed Act (8 CCR 1206-2), effective 10/30/2020:

LIST A

- African Rue (Peganum harmala)
- Camelthorn (Alhagi pseudalhagi)
- Common Crupina (Crupina vulgaris)
- Cypress Spurge (Euphorbia cyparissias)
- Dyer's Woad (Isatis tinctoria)
- Elongated Mustard (Brassica elongata)
- Flowering Rush (Butomus umbellatus)
- Giant Reed (Arundo donax)
- Giant Salvinia (Salvinia molesta)
- Hairy Willow-Herb (Epilobium hirsutum)
- Hydrilla (Hydrilla verticillata)
- Japaneese Knotweed (Fallopia japonica)
- Giant Knotweed (Fallopia sachalinense M)
- Bohemian Knotweed (Fallopia X bohemicum)
- Meadow Knapweed (Centaurea X moncktonii)
- Mediterranean Sage (Salvia aethiopis)
- Medusahead (Taeniatherum Caput-medusae)
- Myrtle Spurge (Euphorbia myrsinites)
- Orange Hawkweed (Hieracium aurantiacum)
- Parrotfeather (Myriophyllum aquaticum)
- Purple Loosestrife (Lythrum salicaria)
- Rush Skeletonweed (Chondrilla juncea)
- Squarrose Knapweed (Centaurea virgata)
- Tansy Ragwort (Senecio jacobaea)
- Yellow Starthistle (Centaurea solstitialis)

LIST B

- Absinth Wormwood (Artemisia absinthium)
- Black Henbane (Hyoscyamus niger)
- Bouncingbet (Saponaria officinalis)
- Bull Thistle (Cirsium vulgare)
- Canada Thistle (Cirsium arvense)
- Chinese Clematis (Clematis orientalis)
- Common Tansy (Tanacetum vulgare)
- Common Teasel (Dipsacus fullonum)
- Corn Chamomile (Anthemis arvensis)
- Cutleaf Teasel (Dipsacus Laciniatus)
- Dalmatian Toadflax, Broad-Leaved (Linaria dalmatica)
- Dalmatian Toadflax, Narrow-Leaved (Linaria genistifolia)
- Dame's Rocket (Hesperis matronalis)
- Diffuse Knapweed (Centaurea diffusa)
- Eurasian Watermilfoil (Myriophyllum spicatum)
- Hoary Cress (Lepidium draba)
- Houndstongue (Cynoglossum officinale)
- Jointed Goatgrass (Aegilops cylindrica)
- Leafy Spurge (Euphorbia esula)
- Mayweed Chamomile (Anthemis cotula)

- Moth Mullein (Verbascum blattaria)
- Musk Thistle (Carduus nutans)
- Oxeye Daisy (Leucanthemum vulgare)
- Perennial Pepperweed (Lepidium latifolium)
- Plumeless Thistle (Carduus acanthoides)
- Russian Knapweed (Rhaponticum repens)
- Russian-Olive (Elaeagnus angustifolia)
- Salt Cedar (Tamarix ramosissima and T. chinesis)
- Scentless Chamomile (Tripleurospermum inodorum)
- Scotch Thistle (Onopordum acanthium)
- Scotch Thistle (Onopordum tauricum)
- Spotted Knapweed (Centaurea Stoebe L. Ssp. micranthos)
- Spotted X Diffuse Knapweed Hybrid (Centaurea X psammogena)
- Sulfur Cinquefoil (Potentilla recta)
- Wild Caraway (Carum carvi)
- Yellow Nutsedge (Cyperus esculentus)
- Yellow Toadflax (Linaria vulgaris)

7. Potential mechanical, chemical, biological or cultural controls to be employed by the WMS may include one or a combination of:

   a. Mechanical mowing entire seeded areas (to control annual weeds prior to flowering & seed set);
   b. Mowing localized infestations with a string trimmer or small equipment;
   c. Hand-pulling of the roots;
   d. Chemical application of water safe or other approved herbicides targeted to the specific suites of annual, biennial or perennial weeds present; or
   e. Controlled burn (if feasible).

8. Timing:

   a. Mechanical treatment (mowing or hand-pulling) of upright annual and biennial weeds in the spring and fall before flower development;
   b. Hand pulling or chemical treatment of ground spreading annual and biennial vine weeds in the spring and fall;
   c. Mechanical treatment (mowing or hand pulling) & chemical treatment of perennial weeds in the spring & fall before flower development;
   d. Chemical treatment of perennials, like thistle in the fall is critical so that they pull the herbicide into their root system as they go dormant; and
   e. Cutting and chemical stump treatment of Russian olive & tamarisk in late summer when they are fully leafed out and actively growing, but before flowering. Burn or dispose of cut noxious and invasive trees immediately after cutting.

7.0 SPECIFIC WEED MANAGEMENT PLAN

The following Specific Weed Management Plan (SWMP) is provided to satisfy the requirements outlined in the GWMP, MAM Plan and the Consent Decree. This SWMP addresses:

1. Goals, Objectives and Performance Standards for Weed Management;
2. What specific weeds are present that need to be managed;
3. Who will do the actual, on-the-ground weed management;
4. Where weeds will be controlled;
5. How mechanical, chemical, biological or cultural controls will be employed, including specific herbicides targeted at specific weeds; and
6. When the control methods will be employed and for how long.

7.1 Goals, Objectives and Performance Standards for Weed Management

The performance criteria for weed management remains the same as outlined in the MAM Plan and Restoration Plans - to comply with the Colorado Noxious Weed Management Act (CNWA) to eliminate Colorado List A species; reduce List B species to less than 10% mean foliar cover; and to eradicate Moffat County List B Species (Item #1 from the GWMP)

To meet this goal, the objectives of weed management are to break the above and below ground weed seed and root spreading cycle of undesirable plants (weeds) so that they do not regenerate from seed, propagules or roots that will emerge the following year(s); and to stress weeds to a point where desirable plants outcompete weeds for water, space, light and nutrients.

7.2 Weed Monitoring and Identification of Specific Weeds

To gather information on specific emerging weed issues and facilitate cooperation with the BLM, the DPCC Restoration Team conducted the first annual monitoring in the Fall of 2023 according to the vegetation sampling protocols identified in the MAM Plan (Item #2 from the GWMP). On August 28, 2023 Ecosystem Services, LLC (ECOS) surveyed 12 pre-defined transects that were identified in the MAM Plan using a point intercept and sample plot methods to identify any noxious weeds within the Restoration Site that appear on the 2020 State of Colorado A, B and C Lists (Item #6 from the GWMP) that could pose immediate, short- and long-term impediments to meeting this PS. ECOS also identified commons weeds during the weed survey that could be an impediment to the establishment of native and naturalized vegetation.

Specific Weeds Identified on Site

The current list of weeds that have been positively identified within the Restoration Site during the Year-1 weed monitoring that appear on the CWNA list (Item #8 from the GWMP) that need to be controlled by the DPCC using a qualified weed management specialist familiar with control of said weeds (Item #3 from the GWMP) is outlined in Table 1 below.

Table 1 – Noxious and Common Weeds Identified on Restoration Site

Symbol	Common Name	Scientific Name	Indicator Status	Weed Status
AMA RET	Pigweed	Amaranthus retroflexus	FACU	Common
CIR VUL	Bull thistle	Cirsium vulgare	FACU	B
CON CAN	Horseweed	Conyza canadensis	NI	Common
BRO TEC	Cheatgrass	Bromus tectorum	NI	C
CHE RUB	Red goosefoot	Chenopodium rubrum	FACW	Common
ECH CRU	Barnyardgrass	Echinochloa crus-galli	FACW	Common
ELA ANG	Russian olive	Elaeagnus angustifolia	FAC	B
IVA AXI	Povertyweed	Iva axillaris	FACU	Common
KOC SCO	Kochia	Kochia scoparia	NI	Common
LAC SER	Prickly lettuce	Lactuca serriola	FACU	Common
LEP LAT	Perennial pepperweed	Lepidium latifolium	FAC	B
*PHA ARU	Reed canarygrass	Phalaris arundinacea	FACW	Common
*PHR AUS	Common reed	Phragmites australis	FACW	C
RUM CRI	Curly dock	Rumex crispus	FAC	Common
SAL TRA	Russian thistle	Salsola tragus	FACU	Common
TAM PAR	Tamarisk	Tamarix parviflora	FAC	B

Note: * indicates weeds that have naturalized and are now prolific in North America and the arid west region. Control and eradication of these weeds is futile and not required as per the MAM Plan or Consent Decree.

Percent Cover of Specific Weeds Identified

Weed data gathered during the Year-1 monitoring indicates following coverages:

- List A: 0% cover (less than 0% goal)
- List B: 0.24% cover (less than 10% goal)
- List C: 4.76% cover (more than 0% goal)
- Common: 10.21% cover (more than 0% goal)

7.3 Weed Management Specialist

The DPCC has identified Outlaw Environmental Services (Outlaw) as their designated Weed Management Specialist (WMS) assisted by ECOS and the BLM in the development of this WMP based on actual observed weeds that emerge on the site (Item #4 from the GWMP).

Outlaw is a certified herbicide applicator, licensed by the State of Colorado Department of Agriculture, and a Federally Registered Contractor who will be conducting weed treatment using herbicides registered with EPA. Outlaw certifies that the selected EPA-registered herbicides shall be used in a manner consistent with their labeling; are designated for aquatic use; and selected to avoid harm to fish or other aquatic wildlife. Application of herbicides shall also comply with all applicable State of Colorado and local laws regarding their proper use, including permitting requirements (Item #5 from the GWMP).

Upon completion and approval of this jointly developed WMP, Outlaw will be permitted by the EPA and BLM to apply any herbicides/chemical controls outlined herein on DPCC or BLM land, if the BLM decides to contract with Outlaw. (Item #6 from the GWMP).

The BLM has identified Christina Rhyne as their designated WMS to monitor, assist, and oversee the control of noxious weeds on BLM land where weeds and weed vectors may prevent the establishment of native or naturalized stands of vegetation within the Restoration Site (Item #7 from the GWMP). Actual, on-the-ground weed management may be conducted by Outlaw (or another contractor of BLM's choice) under the Cooperative Weed Management Agreement discussed above which will be worked out and incorporated during the collaborative development of this WMP. Said agreement may be an attachment or addendum to this WMP.

7.4 Weed Management Site and Area

The Weed Management Site is defined by the limits of the Restoration Site - the as-built inset floodplain of Vermillion Creek and the Little Joe Wetland plus a 25-foot buffer (Item #4 from the GWMP)

To address infestation of weeds that may spread into the Restoration Site from the surrounding landscape, a broader Weed Management Area (WMA) needs to be defined (in coordination with the DPCC and BLM within a reasonable budget). In cooperation with the BLM, the WMA is herein defined as the Restoration Site plus XX feet or the Restoration Site plus all surrounding quarter sections that touch the Restoration Site. (Note: this needs to be established in coordination with BLM.)

Of particular concern is the presence of salt cedar (Tamarisk) that is present on BLM and private land surrounding the Restoration Site. Tamarisk seedlings have already been observed within the Restoration Site after the first/initial growing season where existing mature Tamarisk stands and seed sources are present. If Tamarisk cannot be controlled outside of the Restoration Site, the DPCR will not be able to obtain the PS within the Restoration Site.

Common and noxious weeds occur throughout the Restoration Site in a range of population sizes. Some of the weed species occur as single patches (i.e., cheatgrass and pepperweed). Other species occur in large and established populations (i.e., Russian thistle and salt cedar). Yet other species occur as individuals or very small patches distributed in a scattered pattern across the site (i.e., bull thistle and Russian olive). Regardless of the population size, the presence of historic or recently disturbed ground provided favorable conditions for weed invasion and spread. It is not unreasonable to expect that even the small patches of weeds will not remain small for any length of time if not managed diligently and effectively until such time healthy native plant communities outcompete weeds for available resources (light, water and nutrients).

7.5 Prevention, Mechanical, Chemical, Biological and Cultural Controls

The following weed management controls are based on an integrated weed management (IWM) philosophy. IWM incorporates the concept of using one or a combination of mechanical, chemical, biological and cultural control methods depending on the weed species present. IWM does not necessarily imply that multiple control techniques have to be used or that chemical control options should be avoided (Item #7 from GWMP). IWM consists of:

7.5.1 Definitions of Control Methods

- **Prevention**: The most effective, economical, and ecologically sound management technique. The spread of noxious weeds can be prevented by:
  - cleaning equipment, vehicles, clothing, and shoes before moving to weed free areas;
  - using weed-free sand, soil, and gravel;
  - using certified weed free seed and feed; and
  - not tilling, overturning, scraping, or otherwise disturbing soil that already has good native/naturalized vegetation cover.
- **Mechanical**: Manual or mechanical means to remove, kill, injure, or alter growing conditions of unwanted plants. Methods include mowing, hand pulling, tilling, mulching, cutting, and clipping seed heads.
- **Chemical**: The use of herbicides designed to suppress or kill noxious weeds by disrupting biochemical processes unique to plants.
- **Biological**: The use of an organism such as insects, diseases, and grazing animals to control noxious weeds. Biological controls are especially useful for large, heavily infested areas. They are not an effective method when eradication is the objective but can be used to reduce the impact and dominance of noxious weeds.
- **Cultural**: Promoting and maintaining healthy native or other desirable vegetation. Methods include proper grazing management (prevention of overgrazing) using cattle or goats, re-vegetating or re-seeding, fertilizing, irrigation and controlled burns. If conducted properly and safely, the benefits of controlled burns include:
  - Reduction of hazardous fuels, protecting human communities from extreme fires;
  - Minimization of the spread of pest insects and disease;
  - Removal of unwanted species that threaten species native to an ecosystem;
  - Provision of habitat for foraging wildlife;
  - Improved habitat for threatened and endangered species;
  - Recycling of nutrients back to the soil; and
  - Promotion of the growth of trees, wildflowers, and other plants.

The following are suggested controls for each weed species currently identified on the Restoration Site in priority order, starting with List A, B and C species followed by Common weeds that may be an impediment to establishing desirable plant communities (i.e., those designed in the Restoration Plans).

7.5.2 General Control Measures

The following information provides general measures to prevent introducing new weeds and spreading existing weeds:

1. Apply Esplanade in areas that have more than seventy percent existing native groundcover. This will prevent non-native seeds from sprouting for two to three years, thus preventing weeds from moving into these areas.
2. Develop a mowing (including string-trimming/weed whacking) program to control weeds, before they establish flowers/seeds. If flowers have developed, it is critical to remove, bag and dispose of any weed seed heads before they set and disperse seed so that they do not create another crop the following year. Disposal includes landfilling or burning.
3. When using machinery to manage weeds, equipment should be cleaned to prevent the movement of seeds or root fragments to other uninfested areas.
4. Initiate chemical controls. Canada thistle proliferates via seed and underground roots/rhizomes. In combination with mechanical controls (mowing and picking seed heads), chemicals should be applied to thistle plants and/or patches every year in the fall

until they are eradicated. Chemicals should be applied just before thistle goes dormant so that the plants draw the herbicide into the roots/rhizomes and kills the underground parts.

5. Biological control is a low cost and non-invasive way to begin controlling weeds. Optimum results take 3-5 years. **Contact the Colorado Department of Agriculture Request-A-Bug program at 970-464-7916 to reserve insects, determine the species/quantity needed (depending on target weed species), and discuss release schedules**. At a minimum, insects should be introduced to control the diffuse knapweed. Insects may also be available for yellow toadflax, musk thistle, and Canada thistle. Permits to transport and release insects across state lines may be required.
6. Define maintenance access roads to established routes, limiting any vehicle traffic to just those areas to prevent soil compaction and disturbances of restoration areas.
7. Noxious weeds are currently present and likely others will become established in areas where the native vegetation and soil have been disturbed by construction. Maintaining and then quickly re-establishing desirable vegetation post-construction will minimize weed infestations. Desirable vegetation may consist of native plant communities or landscaped areas.
8. Implement temporary irrigation (if feasible) to establish native vegetation, including upland grasses and forbs. This will increase seed germination and increase plant survival. Rapid establishment of native vegetation will increase competition and decrease establishment of non-native vegetation and noxious weeds.
9. In the late Fall or early Spring, apply a native seed mix to any open areas that have not already been seeded and any bare areas that may become apparent in subsequent growing seasons. The seed mixes in the Restoration Plans may need to be adjusted depending on soil conditions or the presence of salt.

7.5.3 Weed-specific Control Measures

Weed management recommendations for the species observed on the Restoration Site (refer to Table 1) and those that may emerge in the years to come are summarized in Table 2 below.

Table 2 – Noxious and Common Weeds Controls Measures

LIST B		
Species	**Occurrence**	**Control Methods**
Canada thistle (*Cirsium arvense*)	None currently observed but are typically found in mesic (moist soil)/riparian areas immediately adjacent to wetlands (i.e., the fringes/banks of Vermillion Creek and Little Joe Wetland)	Mechanical: Hand pulling individuals and mowing/weed whacking patches to stress and prevent flowering. Cut every 10 to 21 days during the growing season to prevent flowering and seeding. If already flowering, sever the root below the soil surface, pull and/or cut and dispose of flowers to prevent flowers from dropping seed. Disposal may consist of bagging or transport off-site to a landfill or burning. Mechanical controls must be combined with chemical controls. Chemical: Spot treat individuals or patches with BLM approved herbicides that match with the PUP that are best for the site application. Possible herbicides, include Opensight, especially in the fall so that chemicals are pulled into the root system.
Knapweed species (*Centaurea spp.*)	Individuals observed in the WMA and will likely invade the WMS.	Mechanical: Tilling with a plow or disc will likely cause further invasion. Mow in the bud to early flower growth stage and repeat as necessary for plant suppression. Mowing mature plants with seed is not recommended as it will spread seeds. Biological: Several effective insect species are available to reduce many types of knapweed species, including the: knapweed flower weevils (*Larinus minutus* and *Bangastemus fausti*), gall-forming flies (*Urophora affinis* and *Urophora quadrifasciata)* Chemical: Treat individuals and any patches found with BLM approved herbicides that match with the PUP that are best for the site application. Possible herbicides, include Opensight in spring and fall. Cultural: Burning alone will likely cause resprouting and increase seed germination and must be used in combination with other controls.

musk thistle (*Carduus nutans*)	Scattered individuals found in uplands within the WMS.	Mechanical: Hand pulling individuals and mowing/weed whacking patches to stress and prevent flowering. Cut every 10 to 21 days during the growing season to prevent flowering and seeding. If already flowering, sever the root below the soil surface, pull and/or cut and dispose of flowers to prevent flowers from dropping seed. Disposal may consist of bagging or transport off-site to a landfill or burning. Mechanical controls must be combined with chemical controls. Chemical: Spot treat individuals or patches with BLM approved herbicides that match with the PUP that are best for the site application. Possible herbicides, include Opensight, especially in the fall so that chemicals are pulled into the root system. Biological: Several effective insect species are available to reduce knapweed, including the: crown weevil, (*Trichosirocalus horridus)*
yellow toadflax (*Linaria vulgaris*)	Scattered individuals found in uplands within the WMA.	Yellow toadflax reproduces primarily by adventitious buds on lateral roots. Mechanical: Mowing, chopping, or cutting plants can suppress toadflax but these practices are not recommended since new shoots can resprout rapidly from adventitious root buds in response. Repeated cultivation with a disk or a sweep-type cultivator can be effective if done for 2 or more consecutive years, however, discing will disturb soils in favor of other weeds. Chemical: Most effective control. Use BLM approved herbicides that match with the PUP that are best for the site application. Possible herbicides, include Tordon22k during the flowering or post-flowering stage in the fall. Biological: Several insect species are available and permitted for release but long-term success is largely unknown. Root eating Insects include: a moth (*Eteobalea intermediella)* and a weevil *(Rhinusa linariae)* that eat both types of toadflaxes.

Leafy spurge (*Euphorbia esula)*	No observed, but likely present in WMA.	Mechanical: Mow every 3 weeks during growth season in combination with an autumn herbicide application. Chemical: Most effective. Use BLM approved herbicides that match with the PUP that are best for the site application. Possible herbicides, include Tordon22k in the fall when the chemical is more readily transported to the root system after flowering. Biological: Several effective insect species are available to reduce knapweed, including the: flea beetles (*Aphthona flava, lacertosa or nigriscutis).*
Perennial pepperweed (*Lepidium latifolium*)	Scattered individuals and small patches found in riparian areas within the WMA and WMS.	Pepperweed reproduces by seeds but mostly from a creeping (rhizomatous) roots and is tolerant to alkaline and saline soils. Prevention: Early detection and proactive management utilizing a single method is critical to controlling this weed. Control when infestations are small is the best option. Mechanical: Mow at flower bud stage and apply herbicide to resprouts; and/or hand pull or grub small patches, removing as much of the root as possible, then bag and dispose of debris. Disking will spread the weed allowing it to emerge via the roots. Combine mechanical controls with chemical controls. Chemical: Spray at flower bud stage with BLM approved herbicides that match with the PUP that are best for the site application. Possible herbicides include Opensight during the early flowering or bud stage from May to July. Use backpack or handheld sprayers or use wick method for individual plant treatment (IPT). Broadcast spraying by aerial or ground methods may be used on larger stands, if allowed. Biological: Biological control agents are not available.

Russian olive (*Elaeagnus angustifolia*)	Scattered individuals found in riparian areas within the WMS.	Russian olive grows and spreads from seed, stump sprouts, stem cuttings, and root pieces, especially after parent trees have been cut. Control methods are similar to that of Tamarisk. See below. Mechanical: Hand pull any seedlings and sprouts. Grub saplings (< 3.5 inches diam.) with hoe or weed tool. Extract large trees (> 3.5 inch diam.) with an excavator or backhoe. Anticipate the need to control resprouts. Combine mechanical methods with chemical controls. Chemical: For individuals or light infestations use basal bark treatment (for stems < 5 inches diam). For stems > 5 inches diam., cut to stunt or girdle and inject or spray with BLM approved herbicides that match with the PUP that are best for the site application in the Summer to Fall while the plant is actively growing and fully leafed depending on specific chemical instructions. For dense, monotypic infestations that do not have desirable vegetation, use a foliar application with backpack sprayer; truck- or ATV-mounted; or aerial broadcast sprayer. Biological: Trained goats can be used to selectively graze seedlings and young trees in a short-term grazing approach. This method is not feasible in this situation.

Tamarisk (*Tamarix parviflora*)	Scattered individuals and emerging patches were found in riparian areas within the WMS. Abundant, large and widespread monotypic stands found in WMA upstream, downstream and adjacent to the WMS .	Tamarisk or saltcedar reproduces by seeds as well as vegetatively. Saltcedar sprouts from the root crown and rhizomes, and adventitious roots sprout from submerged or buried stems. Treatment requires both mechanical and chemical controls using 5 principal methods: Mechanical and Chemical: 1) applying herbicide to foliage of intact plants; 2) cutting above ground stems via mechanical means (brush hogs, mowers, and mulchers) followed by foliar application of herbicide to any resprouts; 3) cutting stems close to the ground followed by application of Triclopyr (Garlon™) to the cut stems; 4) spraying basal bark with triclopyr; and 5) digging or pulling plants. The pros and cons of these control methods are outlined below Table 3 – Common Tamarisk Control Methods. Stems must be cut within 5 cm of the soil surface. Herbicides must be applied to all cut stumps/stems within 10 minutes of cutting. Retreatment of the management area with chemicals is required to control any resprouting. Cut tamarisk stems (biomass) must be managed utilizing one or more handling techniques: 1) offsite disposal; 2) piling on site; 3) burning on site; and/or 4) mulching on site. The pros and cons of these various options are outlined below in Table 4 – Tamarisk Biomass Management Options. Biological: A promising option to stress, but not outright kill Tamarisk is the: tamarisk leaf beetle (*Diorhabda elongata*). Cultural: Revegetation of tamarisk treatment areas is essential, including the treatment of any new weeds (such as Kochia or Russian thistle) that may emerge once tamarisk is removed. Drill, broadcast or hydroseed treated areas with native seed, ideally in the late Fall or early Spring after standing biomass or mulch has been removed or reduced. Preferred Tamarisk control methods must be selected in coordination with the BLM as much of infested area is on their land.

LIST C		
Species	**Occurrence**	**Control Methods**
Cheatgrass (*Bromus tectorum*)	Present in small patches throughout uplands in WMA and WMS.	Cheatgrass is a winter annual that matures before native grasses in early spring. It can prevent establishment of native grasses and increase wildfire risk. Mechanical: Mow or weed-whack repeatedly in spring to prevent it from going to seed. Chemical: Use selective pre- and post-emergent herbicide treatment. Use BLM approved herbicides that match with the PUP that are best for the site application. Possible herbicides include Roundup. Cultural: Prescribed burn of cheatgrass if not timed correctly can burn out natives. If burns are not hot enough to kill the soil seed bank of cheatgrass, this method can be ineffective. Drill, broadcast and rake treated areas with native seed, ideally in the late Fall or early Spring after the herbicide half-life is exhausted.

Common Weeds		
Species	**Occurrence**	**Control Methods**
Russian thistle (*Salsola tragus)* *and* Kochia *(Kochia scoparia)*	Present as individuals, small and large patches throughout uplands in WMA and WMS.	Mechanical: It is essential to mow young plants to prevent seed production. Mowing mature plants will only eliminate accumulated organic debris and not affect seed production. Avoid further discing or loosening soil that makes ideal conditions for germination. Chemical: Aim chemical treatments at controlling immature plants when they are 2 to 6-inch stage to prevent them from producing seed. The selection of an appropriate herbicide depends on the site or the crop.

Russian thistle (*Salsola tragus)* *and* Kochia *(Kochia scoparia)*	Present as individuals, small and large patches throughout uplands in WMA and WMS.	Preemergent Herbicides. Preemergent herbicides are applied to the soil before the weed seed germinates and usually incorporates into the soil with irrigation or rainfall. The most effective preemergent herbicides include: atrazine (Aatrex), bromacil (Hyvar), chlorsulfuron (Telar), hexazinone (Velpar), imazapyr (Arsenal), napropamide (Devrinol), simazine (Princep), and sulfometuron (Oust). Herbicide-resistant biotypes of Russian thistle have evolved in only a couple of years following treatment with chlorsulfuron (Telar) or sulfometuron (Oust). Avoid repeated use of a single herbicide or herbicides that have the same mode of action to prevent the evolution of herbicide-resistant populations. Post-emergent Herbicides: Post-emergent herbicides are applied to plants, but timing is critical. For best results, these herbicides must be applied while the weed is in its early growth stages, preferably the early seedling stage before it becomes hardened and starts producing its spiny branches. Do not use post-emergent herbicides to try to control the mature seed (either on the plant or on the ground) as they are not effective for this purpose. The later, spiny stage of Russian thistle is not readily controlled by any post-emergent herbicide. Post-emergent herbicides that are effective when properly applied include: dicamba (2,4-D, Banvel, or Vanquish), glufosinate (Finale, Liberty, or Rely), glyphosate (Roundup), and paraquat (Gramoxone). Biological: Existing biological control agents for Russian thistle have not proven successful. There is recent interest in the introduction of a blister mite, *Aceria salsolae*, a native to the Mediterranean Basin that is known to attack and stunt only Russian thistle by killing the growing tips. Several other potential biological control agents, such as a seed-feeding and stem-boring caterpillar and two different weevils are also under investigation. Cultural: Burning is sometimes used to destroy accumulated Russian thistle plants. This may eliminate the accumulated organic debris and some seed, however, much of the seed will already have been disseminated.

		Planting competitive, more desirable native species can be an effective method of preventing Russian thistle establishment. Drill, broadcast and rake treated areas with native seed, ideally in the late Fall or early Spring.
Pigweed (Amaranthus retroflexus) Horseweed *(Conyza canadensis)* Red goosefoot *(Chenopodium rubrum)* Barnyardgrass (*Echinochloa crus-galli)* Povertyweed *(Iva axillaris)* Prickly lettuce *(Lactuca serriola)* Curly dock *(Rumex crispus)*	Present as individuals, small and large patches throughout uplands in WMA and WMS.	Mechanical: Broadleaf weeds such as these should be mowed or pulled before the set seed. Chemical: Apply a BLM approved broadleaf herbicides that match with the PUP that are best for the site application in late fall and early spring when plants are actively growing that does not damage desirable native perennial grasses, shrubs or trees

Notes:

1. When using herbicides, always read and follow the product label to ensure proper use and application.
2. If near water or wetlands, only use herbicides and formulations approved for use near water.

Table 3 – Common Tamarisk Control Methods

Control Method	Pros	Cons
Biological	• Inexpensive • To date indicate low to negligible environmental impact • Appear to be relatively self-sustaining method • Good for areas of low accessibility	• Requires a moderately dense stand to support sustainable control agent populations • Requires several years of defoliation before mortality of tamarisk occurs, if at all • Has not established well in all areas, although much observed success in the UCRB • Costly removal of dead overstory required prior to revegetation
Manual grubbing / rogueing (pulling seedlings)	• Negligible impact to soil, water, wildlife, and other vegetation • Effective control on young seedlings • Revegetation is not impeded	• Extremely labor intensive and costly • Not advisable for anything but smallest or youngest infestations • Only possible with small (<1/4" diameter stem) plants • May stimulate other invasives by soil churning and disturbance of seed bank
Herbicidal Spot Treatment	• Highly effective control • Limits chemical impact on non-target plants	• Chemical may still persist in soil, water, and organic matter if over-applied, limiting revegetation efforts[6]. • Labor intensive and costly • Licensed applicators with special equipment required • Costly removal of dead overstory required prior to revegetation
Cut-stump, basal bark, girdling herbicidal treatment	• Highly effective control • Limits chemical impact on non-target plants	• Labor intensive, high cost per individual tree treated • Chemical may still persist in soil, water, and organic matter if over-applied, limiting revegetation efforts. • Costly removal of dead overstory required prior to revegetation
Extraction (removal of above-ground biomass and root crown with trackhoe/excavator)	• High rate of tree mortality (80-95%) • Clears ditches and other steep banks other mechanical equipment can't reach • Performed with reduced equipment movement across the landscape	• Expensive • Requires more time and heavy equipment mobilization • Soil is highly disturbed by tamarisk extraction requiring landform reshaping • Costly secondary weed control to treat resprouting tamarisk • Requires site access by heavy equipment
Burning	• May be effective control when combined with chemical treatment • Effective, low-cost biomass removal or reduction in denser stands • Easy access to resprouts	• Used without herbicide, burning can stimulate tamarisk growth (Figure 13) • Can alter soil characteristics (particularly surface salinity); reduce fertility • Air pollution constraints; may harm wildlife and habitat • Site may be prone to erosion and secondary weed invasions, especially without revegetation. • Removal of remaining overstory and roots prior to revegetation
Mowing, disking, roller-chopping, etc.	• Highly effective when combined with chemical treatment • Revegetation is not impeded due to this control method	• Requires site access by large equipment • Expensive due to specialized equipment costs • Heavy equipment may disturb soil and desired vegetation • Site is prone to secondary weed invasions, especially without revegetation.
Broadcast herbicide treatment	• Highly effective control (90-100%) • Large areas can be treated in a small amount of time • Preferable and most effective on large, contiguous, monotypic stands with little or no native understory	• May have higher potential environmental impact to soil, water, wildlife, and other vegetation. • Chemical persistence by certain herbicides (e.g., imazapyr) in soil, water, and organic matter may make revegetation difficult. • Costly removal of dead overstory and roots required prior to revegetation.

Table 4 – Tamarisk Biomass Management Options

Handling of biomass	Pros	Cons
Off site disposal	• Most aesthetic • Reduction of fire risk • Clears areas for active revegetation	• Generally highest cost • Lost benefit of biomass (see 'mulching' and 'piling' below)
Piling on site	• Creates Wildlife habitat • Most cost effective	• Unsightly • May be fire risk • Re-rooting or re-sprouting possible
Burning on site	• Reduces age-class of tamarisk, which may increase efficacy of herbicides and biological control • Low-cost means of rapidly reducing standing biomass	• Can adversely alter soil chemistry, making establishment of desirable species difficult • Stringent fire safety controls required • Site access not reliably safe for tires (puncture risk)
Mulching on site	• Moisture conservation • Moderation of temperature / wind extremes • Salinity remediation and reduced capillary rise of salts • Enhancement of microsite environment for seedlings • Provides weed suppression (particularly for annual / ruderal species) • Elevates C/N ratios that induce nitrogen stress over time, facilitating positive successional trajectory.	• Cost of equipment • Covers bare soil, hinders reseeding • Reduces site access for some equipment • Heavier equipment needed for planting

7.6 Management Timing

The following generally outlines weed management timing (Item #8 from the GWMP).

Mechanical controls should be timed to cut weeds before they flower and set seed. This is usually during the early flowering or bud stage in the spring.

Chemical controls should be timed to coincide with the period when carbohydrate root reserves are lowest during the early flowering or bud stage and when weeds are going dormant to pull chemicals from above ground leaves and stems into the root systems.

Biological controls (acquisition and release of available and approved insects) should be timed as directed by the Colorado Department of Agriculture Request-A-Bug program depending on the species of insect.

Cultural controls such as burning, when applicable may be conducted in the spring or fall when weather conditions are safest. Fall and spring weather provide the best conditions for burning when soil is moist, dry material are available and when there are cooler temperatures. Burning should only take place when and if the conditions are right. This can be accomplished by burning using the 60/40 rule, which recommends burning when the temperature is below 60 F, and relative humidity is above 40 percent when wind speeds are between 5-15 mph measured at 6 feet above the surface of the ground.

Additional weed-specific management strategies may need to be added to this WMA as an addendum and implemented on an ongoing basis if/when any new weed species are identified.

REFERENCES:

Boulder County Prescribed Burns. Accessed at: https://bouldercounty.gov/open-space/management/prescribed-burns/

Colorado Noxious Weed Act. 2017. Colorado Revised Statutes § 35-5.5-101. Moffat County Weed Management Plan. 2017. Accessed at: https://www.colorado.gov/pacific/sites/default/files/MC_NoxWeedMgmtPlan%26Attach_merged_03152017.pdf

Colorado State Forest Services, La Junta Field Office – Tamarisk Management. Accessed at: https://csfs.colostate.edu/la-junta/lj-tamarisk-management/#:~:text=Treating%20Tamarisk&text=After%20cutting%20all%20stems%20of,as%20determined%20by%20the%20landowner

Tamarisk Coalition. Rivers Edge West. Accessed at: https://riversedgewest.org/documents/best-management-practices-revegetation-after-tamarisk-removal

University of California, Davis Statewide IPM Program. Accessed at: https://ipm.ucanr.edu/PMG/PESTNOTES/pn7486.html

USDA, Field Guide for Managing Russian Olive in the Southwest (TP-R3-16-24). September 2014.

USDA, Field Guide for Managing Perennial Pepperweed in the Southwest (TP-R3-16-23). September 2014.

USDA, Field Guide for Managing Leafy Spurge in the Southwest (TP-R3-16-12). September 2014.

USDA, Field Guide for Managing Dalmatian and Yellow Toadflaxes in the Southwest (TP-R3-16-02). September 2014.

USDA, Field Guide for Managing Saltcedar in the Southwest (TP-R3-16-06). September 2014.

USDA, Field Guide for Managing Annual and Biennial Invasive Thistles in the Southwest (TP-R3-16-08). June 2017.

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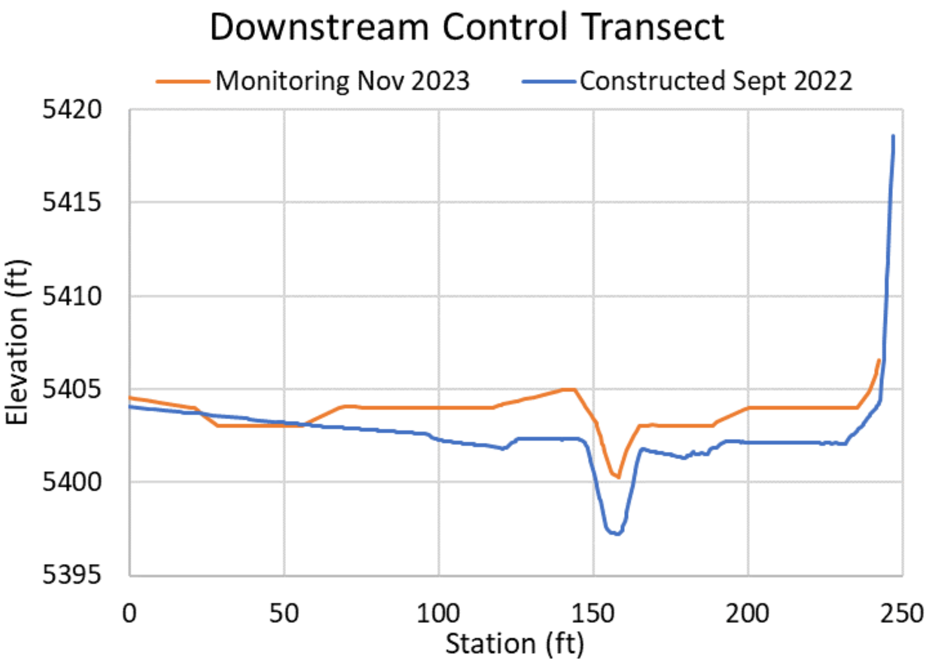
APPENDIX C

Monitoring Cross-Section and Longitudinal Profile Data


Downstream Control Transect
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Station (ft)
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5410
5405
5400
5395
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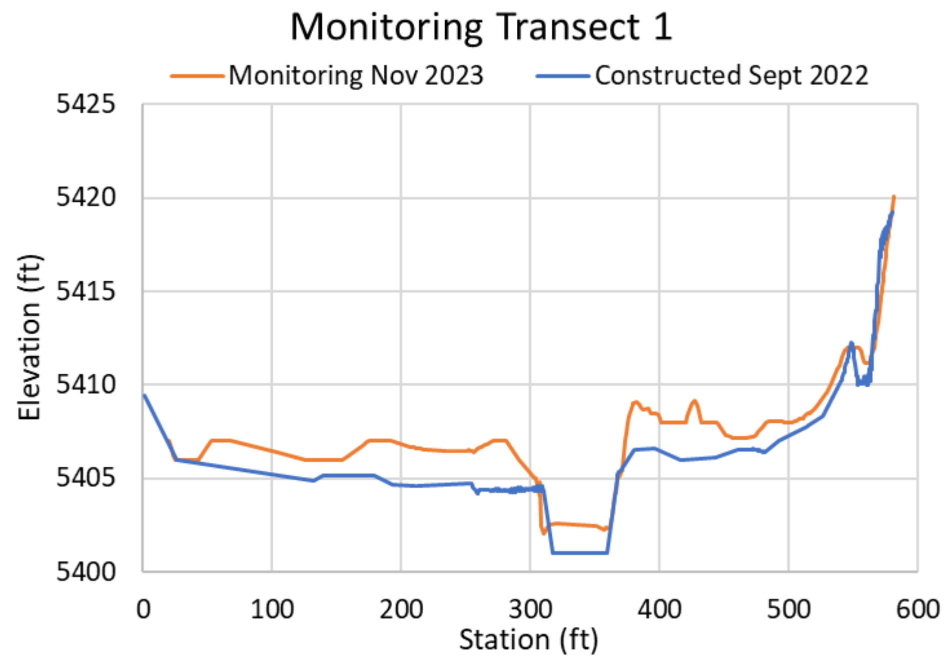
50
100
150
200
250


Monitoring Transect 1
Monitoring Nov 2023
Constructed Sept 2022
Elevation (ft)
Station (ft)
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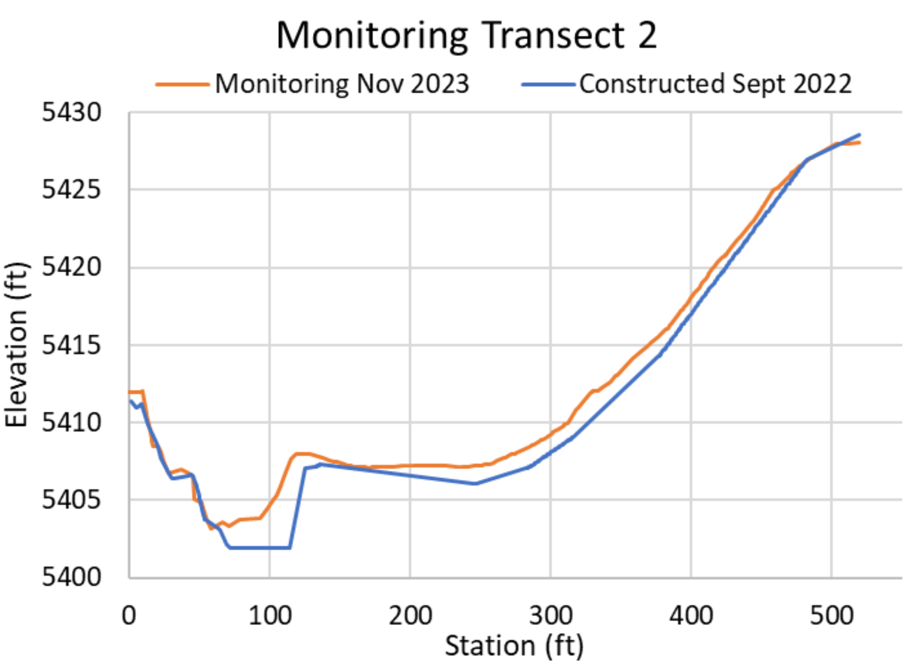
5420
5415
5410
5405
5400
0
100
200
300
400
500
600


Monitoring Transect 2
Monitoring Nov 2023
Constructed Sept 2022
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Station (ft)
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5410
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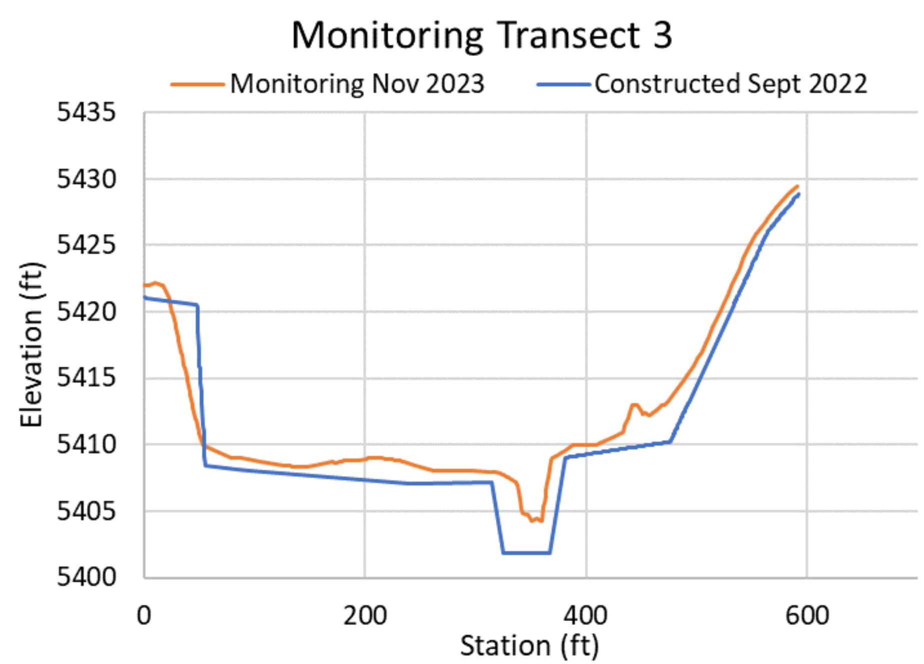
300
400
500


Monitoring Transect 3
Monitoring Nov 2023
Constructed Sept 2022
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Station (ft)
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5410
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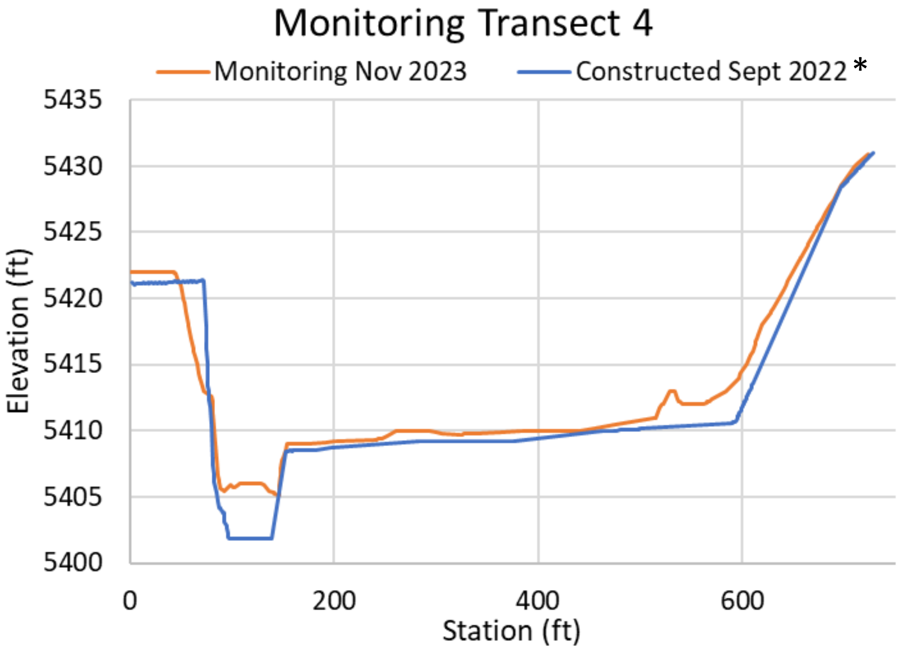
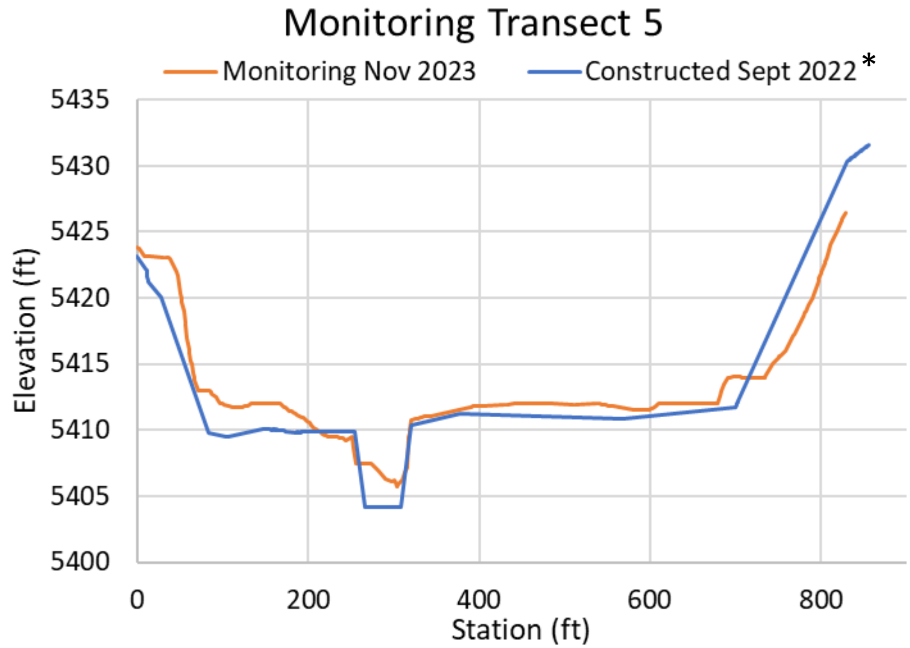
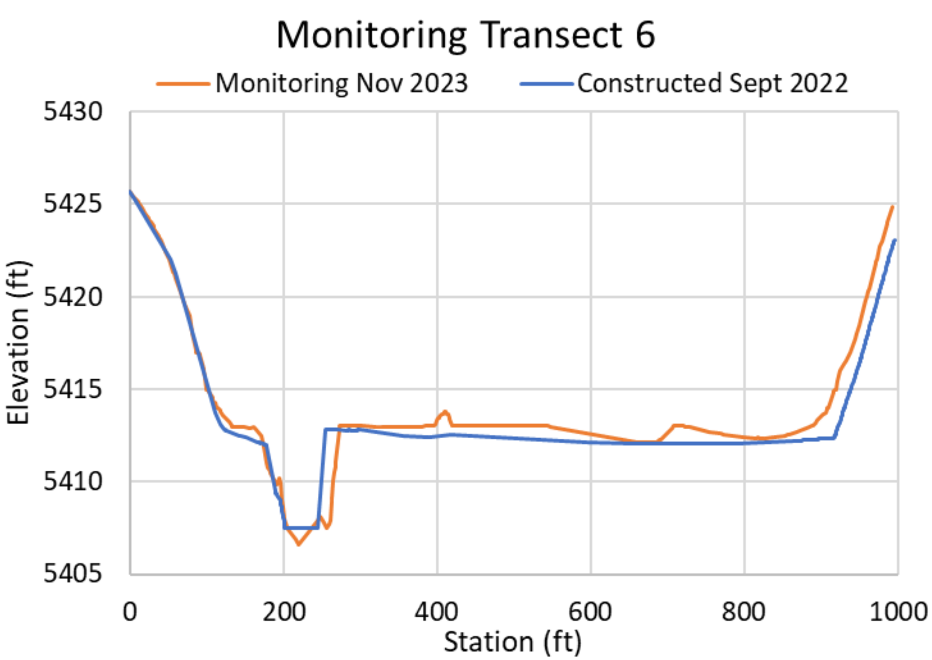
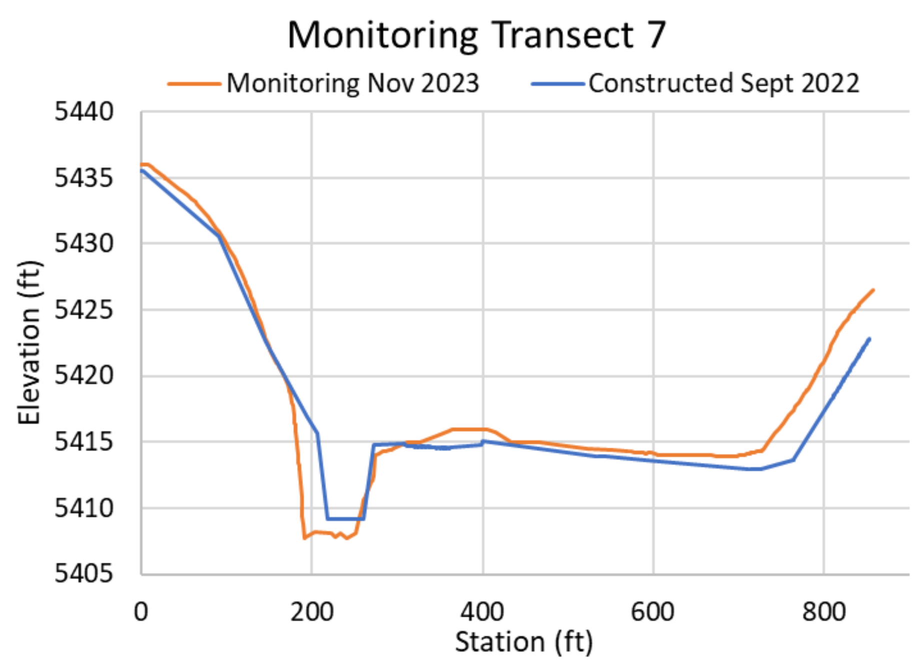
5400
0
200
400
600

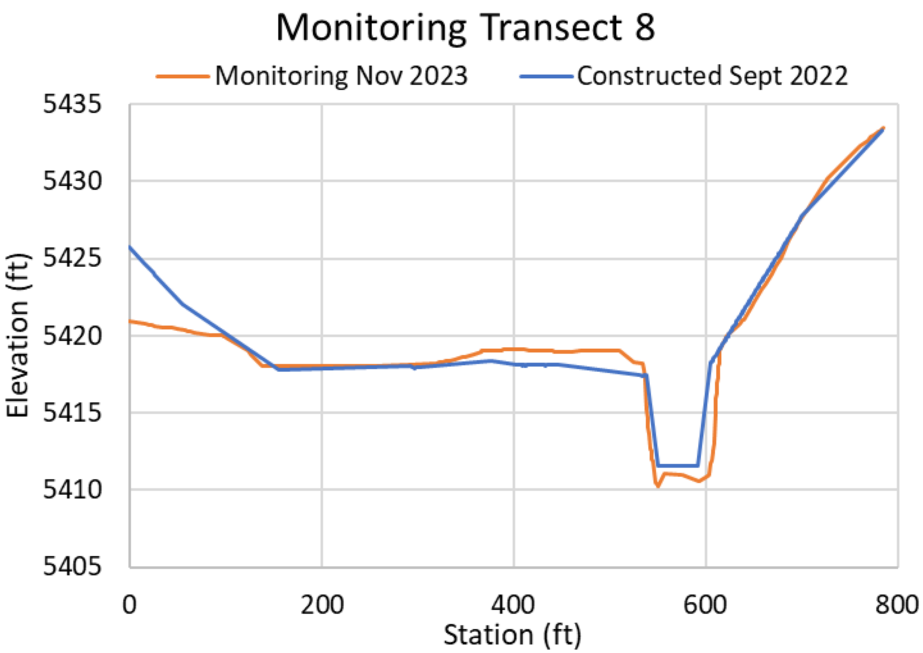


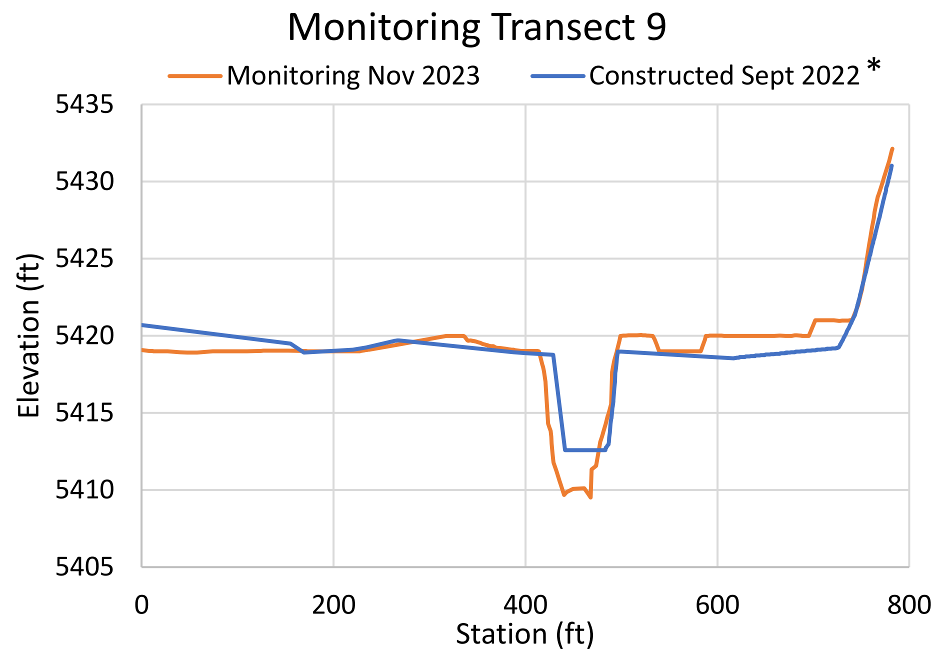


*Nearest constructed cross section projected to monitoring transect

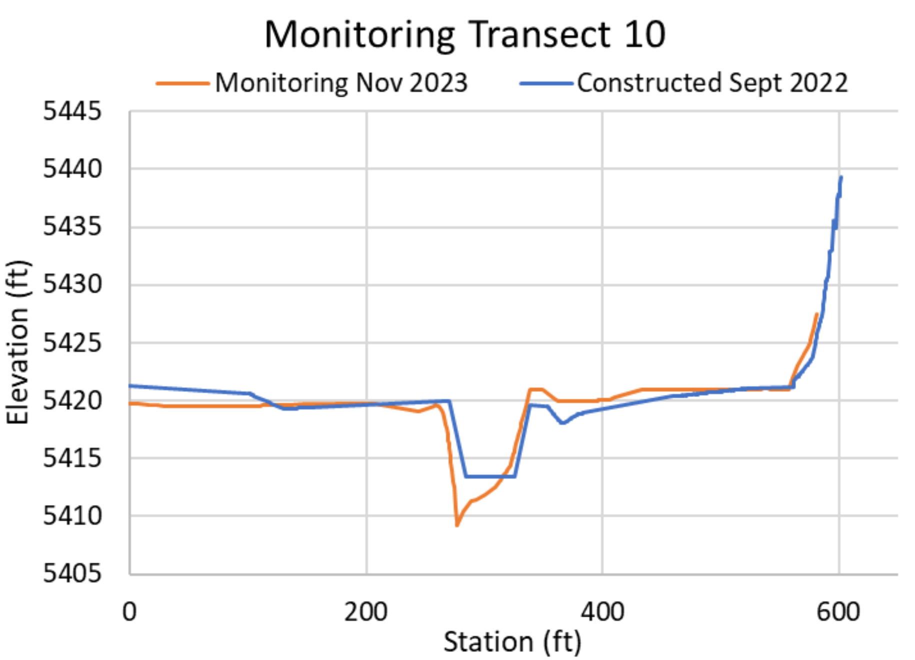


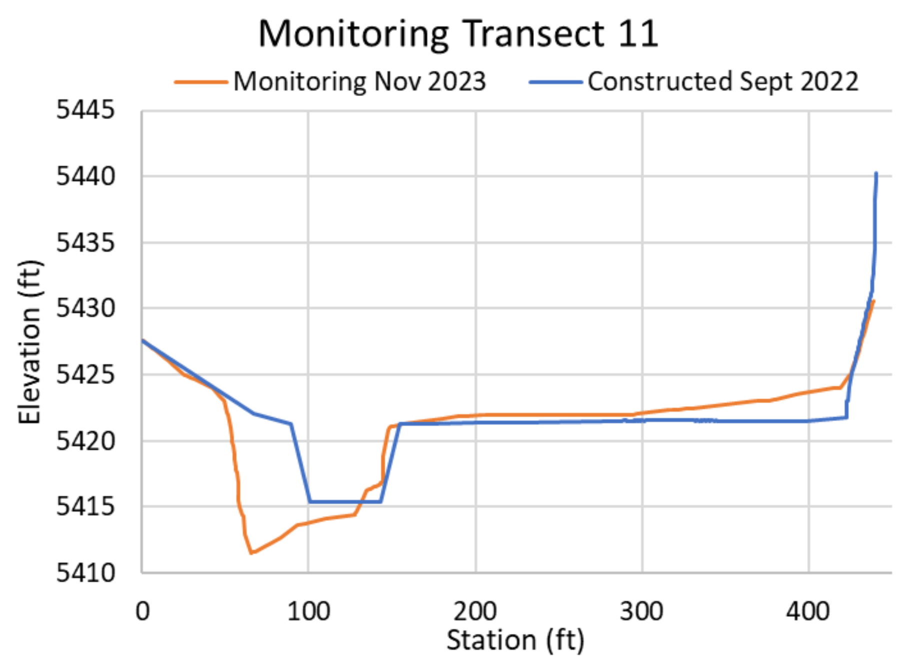


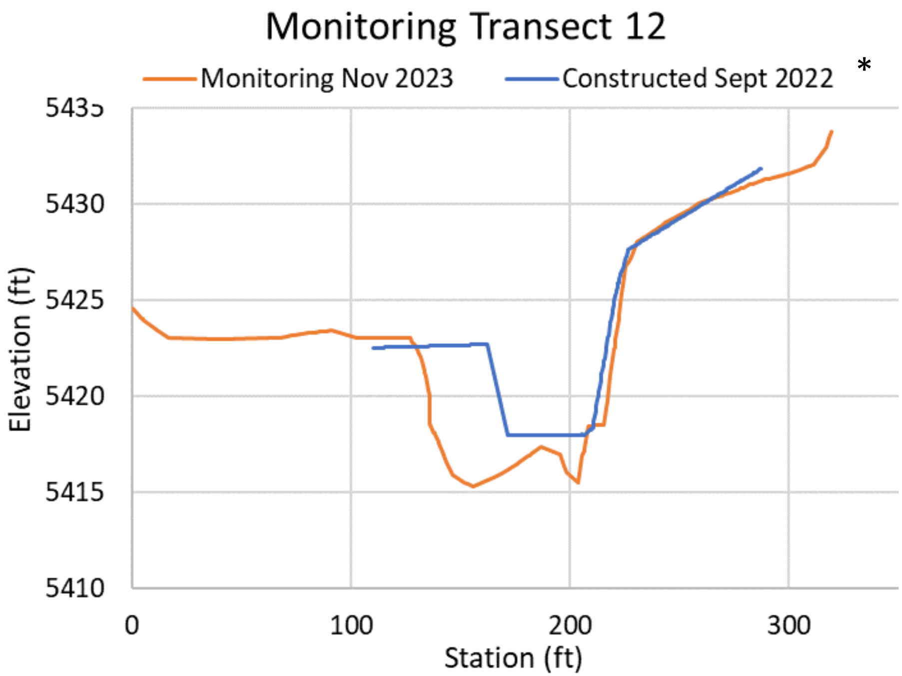


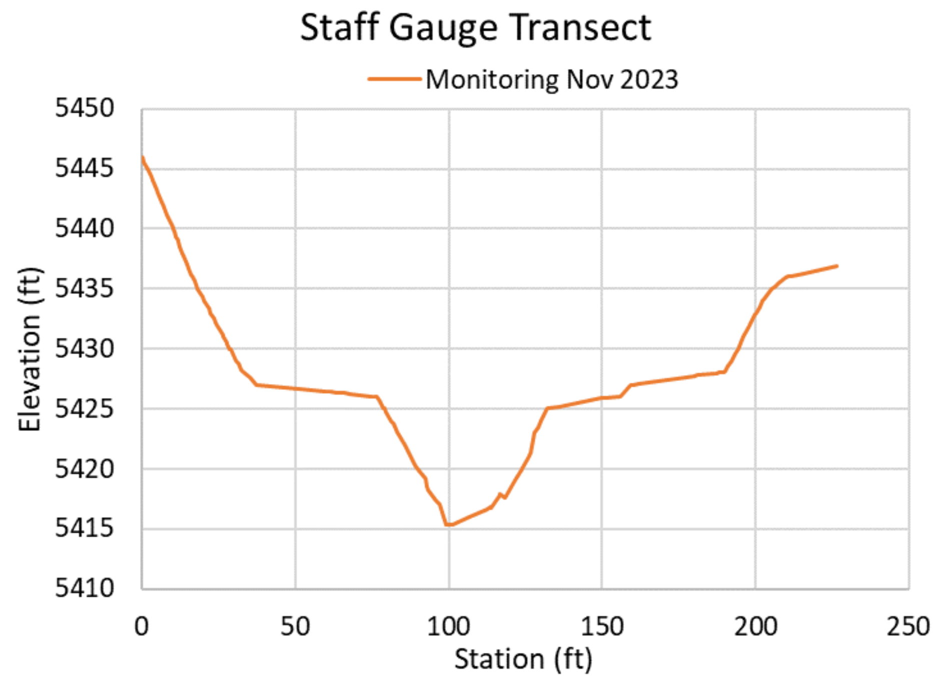


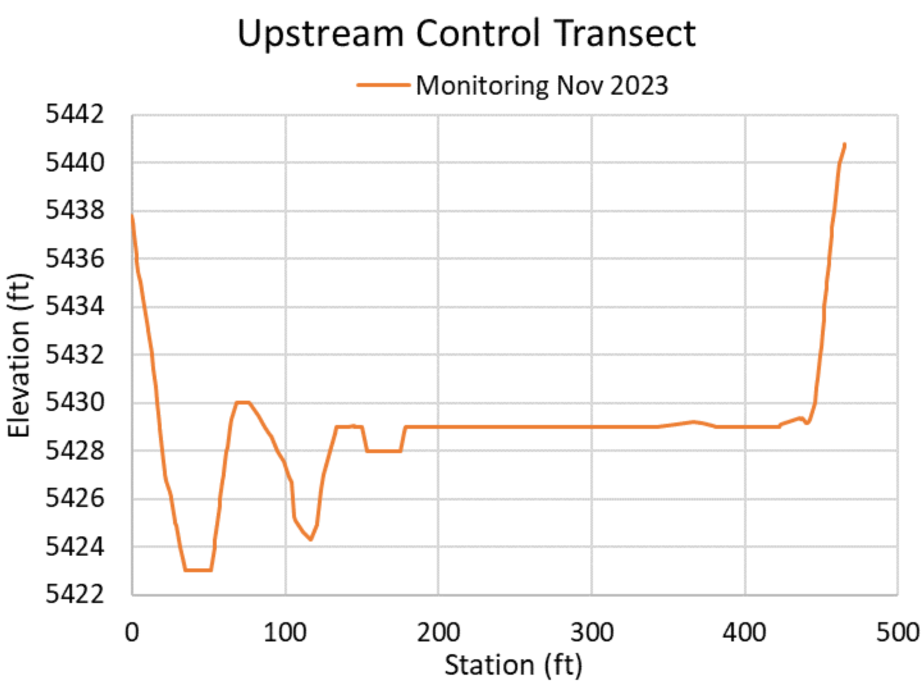
*Nearest constructed cross section projected to monitoring transect





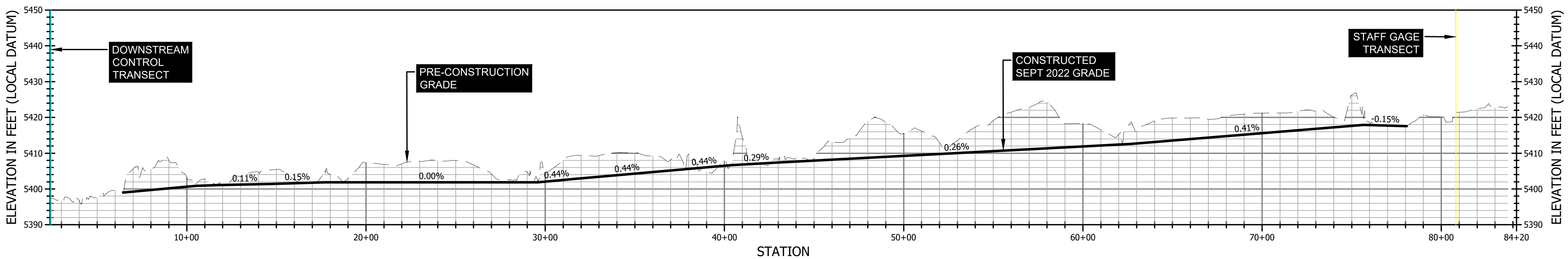




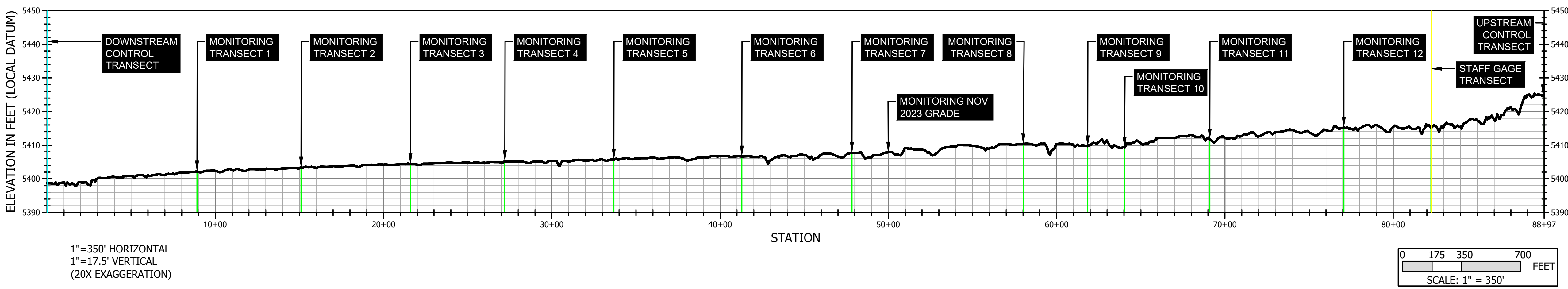


*Nearest constructed cross section projected to monitoring transect

CONSTRUCTED SEPT 2022 THALWEG ALIGNMENT



MONITORING NOV 2023 THALWEG ALIGNMENT



1"=350' HORIZONTAL
1"=17.5' VERTICAL
(20X EXAGGERATION)

VERMILLION CREEK AT DIAMOND PEAK RANCH WETLAND RESTORATION PROJECT

MOFFAT COUNTY, COLORADO

Stillwater Sciences

ecos ecosystem services LLC

PROJECT NUMBER: 880.00
SCALE: AS NOTED
DATE: 11/27/23

DESIGN: JB/TS/RB
DRAWN: TS/EP/KE
CHECKED: TS/RB
APPROVED:

LONGITUDINAL MONITORING PROFILES

SHEET 1

APPENDIX D

USACE Monitoring Report Forms

MITIGATION MONITORING REPORT FORM

Section A: General Project Information		
1. Project Name: Vermillion Creek	**2. DA File Number:** 1:20-CV-03166-SKC	**3. Project Type:** Consent Decree
4. Agent Name and Work Phone Ecosystem Services, LLC Jon Dauzvardis, P.W.S. (303) 579-6167 Stillwater Sciences Julie Ash, P.E. 720-618-5032	**5. Agent Mailing Address:** 1455 Washburn Street Erie, CO 80516 4845 Pearl East Circle, Ste. 101 Boulder, CO 80301	**6. Agent e-mail Address:** jon@ecologicalbenefits.com jash@stillwatersci.com

Section B: Notice of Commencement / Completion of Physical Work	
1. Commencement: 5/1/22	**2. Construction Completion:** 10/31/23
3. Requesting Release: No	**4. Name of Contractor(s) & Phone Numbers:** X Field Services (earthwork) / 970-629-2233 Angelo Raftopoulos (revegetation / 970-756-8600

Section C: Monitoring Status		
1. Final monitoring completed and verification requested: No	**2. Date of Monitoring Report:** 12/31/23	**3. Monitoring Report No:** 1 of 5
4. Management and maintenance activities completed: Refer to 2023 Annual Technical Memorandum / Monitoring Report		
5. Adaptive management activities completed: Refer to 2023 Annual Technical Memorandum / Monitoring Report		

Section C: Monitoring Status (Cont'd)			
6. Performance Standards			
Year:	**Performance Standard:**	**Goal:**	**Results:**
2023	Wetland Acreage	8.47 acres of sustainable Jurisdictional wetland habitat have been restored per the definitions in 33 CFR § 332.2.	Preliminary Estimate: Vermillion Creek = 6.33 acres (min) 9.23 acres (max) Little Joe Wetland = 2.37 acres Total = 8.71 acres (min) 11.61 acres (max) Refer to the 2023 Technical Memorandum for further discussion.
2023	Stream Length and Sinuosity	7070 lineal feet 1.3 sinuosity	Estimate based on Nov 2023 Survey Data: 8903 lineal feet 1.8 sinuosity
2023	FACWet Composite Score	81 (B-)	FACWet Regional Reference = 78 (C+) FACWet Rapid Assessent (2023) = 72 (C-) Refer to 2023 Rapid FACWet Assessment Results.
2023	FACWet Subvariable V1: Habitat Connectivity	Consistent with pre-disturbance condition.	Vermillion Creek and Little Joe remain connected to upstream and downstream reaches. Potential wetland and riparian habitat are on track to meet or exceed the target acreages. Restored vegetation is too immature to reach a result on Neighboring Wetland and Riparian Habitat loss and Barriers to Migration and Dispersal. Refer to 2023 Rapid FACWet Subvariable Assessment Results
2023	FACWet Subvariable V2: Contributing Area	25-foot buffer surrounding 100% of the aquatic resources dominated by native or naturalized vegetation with 70% cover (min).	Buffer area seeding and mulching was performed in stages and fully complete in 10/2023. Seeded buffer area vegetation is immature. Common weed cover following ground disturbance is as expected, but increased the overall cover and soil stability in the buffer. Refer to 2023 Rapid FACWet Subvariable Assessment Results
2023	FACWet Subvariable V3: Water Source	Water source capable of supporting wetland hydrology (14 consecutive days of saturation or water table within 12" of the soil surface).	No measurements were taken in 2023. Groundwater wells and a Stream Staff Gauge were installed in 10/2023 and will be measured in 2024. Refer to the 2023 Technical Memorandum for further discussion. Preliminary wetland delineation of vegetation and hydrology is to take place in 2024 (Phase 2 Monitoring) after vegetation has had a chance to establish. Refer to 2023 Rapid FACWet Subvariable Assessment Results
2023	FACWet Subvariable V4: Water Distribution	Overbank flooding and water can access high-flow channel(s) in the active floodplain at least once in two years unless drier than normal conditions are demonstrated.	Resurvey of the 12 monitoring and 2 control cross-sections, survey of a longitudinal profile, survey of the groundwater well locations, and survey of the crest-stage gage datum and cross-section was completed in November 2023. Aerial imagery and topography were collected at the same time utilizing a drone and then correlated with cross-section and longitudinal survey data. Monitoring survey data will be used to interpret and estimate the lateral extents of water distribution during 2024. Refer to the 2023 Technical Memorandum for further discussion. Direct observation and photographic documentation from established photo points at each established monitoring

			cross-section were collected in 8/2023. See photos below and photo point map. The presence of hydrology indicators will be evaluated during 2024 (Phase 2 Monitoring) to document wetland hydrology. Refer to 2023 Rapid FACWet Subvariable Assessment Results
2023	FACWet Subvariable V5: Water Outflow	Ground and surface water will have unimpeded access to adjacent down valley habitats.	Ground and surface water flowing into Vermillion Creek from the upper watershed, Little Joe and alluvial interflow within the site have unimpeded access to downvalley habitats. Refer to the 2023 Technical Memorandum for further discussion. Photos of Vermillion Creek flows leaving the site are provided below and indicated on the photo point map. Refer to 2023 Rapid FACWet Subvariable Assessment Results
2023	FACWet Subvariable V6: Geomorphology	Overall mitigation site retains or increases SEM creek stage (i.e., positive SEM trajectory) and does not cause site, upstream, or downstream excessive erosion or aggradation: a. No consistent trend of excessive net erosion and aggradation across entire active flow path. b. Overall channel form should not indicate a consistent trajectory indicating a transition from a multi-thread to a single thread channel form. c. as viewed along representative cross-sections has at least two benches or breaks in slope, including the riparian area, above the channel bottom, not including the thalweg. d. By year 5, each of these benches, plus the slopes between the benches, as well as the channel bottom area contain physical	Resurvey of the 12 monitoring and 2 control cross-sections, survey of a longitudinal profile, survey of the groundwater well locations, and survey of the crest-stage gage datum and cross-section was completed in November 2023. Aerial imagery and topography were collected at the same time utilizing a drone and then correlated with cross-section and longitudinal survey data. Monitoring survey data was compared against constructed design elevations to interpret the natural channel development. Refer to the 2023 Technical Memorandum for further discussion. Direct observation and photographic documentation from established photo points of geomorphological conditions along Vermillion Creek at each established monitoring cross-section were collected in 8/2023. See photos below and photo point map. Refer to 2023 Rapid FACWet Subvariable Assessment Results. A SEM assessment was conducted as part of the post-2022 flood assessment to determine if Vermillion Creek is moving along the expected SEM trajectory. The results show that overall, the channel has indeed moved from SEM stage 2, through stage 3 and 4 in most areas, and is currently at stage 5, or between stage 5 and 6, in most of the project reach. See 2023 Technical Memorandum for more detail.

		patch types or features such as boulders or cobbles, animal burrows, partially buried debris, slump blocks, furrows or runnels that contribute to abundant micro-topographic relief characteristic of reference conditions.	
2023	FACWet Subvariable V7: Chemical Environment	Wetlands are exhibiting USDA NRCS hydric soil characteristics as determined by Corps Regional Supplements to the Corps Delineation Manual by year 5.	Direct examination of soil profiles for hydric soil indicators was not performed in 2023. Detailed wetland delineation of vegetation, hydrology and hydric soils is to take place in 2025 (Phase 3 Monitoring) after wetland soil has had a chance to develop. Refer to 2023 Rapid FACWet Subvariable Assessment Results
2023	FACWet Subvariable V8: Vegetation Structure and Complexity	At least 54 planted or volunteer cottonwood (Populus spp.) on BLM land will survive to year 5 and be at least 12.5 feet in height and 1.5 inches diameter at breast height (DBH). Dominant native or naturalized, wetland species (OBL/FACW) as documented in Regional Reference Areas shall meet the following absolute cover percentages by year 5: • Trees (volunteer or planted) = 10% cover of native cottonwood • Shrubs = 32% cover of willow, • Herbs = 72% cover Mean foliar cover of listed noxious weeds including trees and shrubs, grasses, and herbs shall not exceed the following cover percentages by year 5 within the 25-buffer: List A = 0% List B = 10% List B (Moffat County) = 0%	No cottonwood were planted in 2023 pending direct observation of natural recruitment. Natural recruitment is occurring in the lower reaches of the Vermillion Creek (downstream of the low water crossing), but seedlings are too small to census. Cottonwood pole harvesting and transplanting is planned for early spring 2024. A voluntary (not required during Phase 1 Monitoring), preliminary quantitative vegetation sampling of native and naturalized plant cover was conducted in 2023 at 12 sampling transects (6 using the transect/plot method and 6 using the transect/point intercept method) to assess natural recruitment, wetland, riparian and upland seeding and willow planting. Quantitative measurements and results across all transects found the following: Overall Absolute Percent Cover of Dominant Wetland Species (OBL, FACW or FAC) (Buffer and Inset Floodplain) = 15.4 % Overall Absolute Percent Cover of Trees, Shrubs and Herbs by Strata: • Upland Shrubs and Grasses = 5.5% • Riparian Trees = 0.0 % • Wetland Shrubs = 6.3% • Wetland Herbs = 9.1 % • Common Weeds = 10.2% Overall Absolute Percent Cover of Noxious Weeds: • Noxious Weeds (List A & B) = 0.2% • Noxious Weeds (List C) = 4.8 Quantitative data (vegetation hits along transects and sample plots) did not completely represent visual observations: • Overall vegetation cover is immature and needs more time to establish Natural recruitment of willow is significant. • Willow cutting survival is over 80% • Natural recruitment of cottonwood seedlings is significant, especially in the lower reaches where existing cottonwood cotton are located.

			• Natural recruitment (invasion) of tamarisk is significant, especially in the lower reaches where existing, mature tamarisk are/were pervasive prior to the project. A Weed Management Plan (WMP) has been drafted and is under collaborative review with BLM to deal with weeds. Refer to the 2023 Technical Memorandum for further discussion. Refer to 2023 Rapid FACWet Subvariable Assessment Results

7. **Short statement on whether the performance standards are being met:**
   Wetland acreages, stream length and sinuosity, and preliminary FACWet Scores are on a trajectory to meet performance standards and should improve with the maturity of vegetation communities.

8. **Conclusions and adaptive management activities proposed (addressing unresolved issues and failures to meet performance standards:**
   Please refer to 2023 Technical Memorandum for detailed discussion of adaptive management activities that occurred in 2023 and planned for 2024.

TRANSECT 1

Section D: Photo Log	
1. Photo Point #: T1	
2. Photo File #: 1281	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 158 Cardinal: SE	
5. Coordinates (decimal degree): Lat: 40.775301° Long: -108.857293°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain looking upstream.	

Section D: Photo Log	
1. Photo Point #: T1	
2. Photo File #: 1281	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 336 Cardinal: NW	
5. Coordinates (decimal degree): Lat: 40.775301° Long: -108.857293	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain looking downstream.	

Section D: Photo Log	
1. Photo Point #: T1	
2. Photo File #: 1281	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 236 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.775301° Long: -108.857293	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking southwest.	

Section D: Photo Log	
1. Photo Point #: T1	
2. Photo File #: 1281	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 56 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.775301° Long: -108.857293	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking northeast.	

TRANSECT 2

Section D: Photo Log

1. Photo Point #: T2

2. Photo File #: 1282

3. Date: 8/29/2023

4. Compass Direction Taken:
Degrees: 180
Cardinal: S

5. Coordinates (decimal degree):
Lat: 40.773922°
Long: -108.857562

6. Photographer Name:
J. Dauzvardis

7. Description: View of inset floodplain and 25-foot buffer looking upstream.

Section D: Photo Log

1. Photo Point #: T2

2. Photo File #: 1282

3. Date: 8/29/2023

4. Compass Direction Taken:
Degrees: 0
Cardinal: N

5. Coordinates (decimal degree):
Lat: 40.773922°
Long: -108.857562

6. Photographer Name:
J. Dauzvardis

7. Description: View of inset floodplain and 25-foot buffer looking downstream.

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<tr><th colspan="2">Section D: Photo Log</th></tr>
<tr><td>1. Photo Point #: T2
2. Photo File #: 1282
3. Date: 8/29/2023
4. Compass Direction Taken:
Degrees: 270
Cardinal: W
5. Coordinates (decimal degree):
Lat: 40.773922°
Long: -108.857562
6. Photographer Name:
J. Dauzvardis</td><td></td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking west.</td></tr>
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<table>
<tr><th colspan="2">Section D: Photo Log</th></tr>
<tr><td>1. Photo Point #: T2
2. Photo File #: 1282
3. Date: 8/29/2023
4. Compass Direction Taken:
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Cardinal: E
5. Coordinates (decimal degree):
Lat: 40.773922°
Long: -108.857562°
6. Photographer Name:
J. Dauzvardis</td><td></td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking east.</td></tr>
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TRANSECT 3

Section D: Photo Log	
1. Photo Point #: T3	
2. Photo File #: 1283	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 177 Cardinal: S	
5. Coordinates (decimal degree): Lat: 40.772697° Long: -108.856576°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking upstream.	

Section D: Photo Log	
8. Photo Point #: T3	
9. Photo File #: 1283	
10. Date: 8/29/2023	
11. Compass Direction Taken: Degrees: 357 Cardinal: N	
12. Coordinates (decimal degree): Lat: 40.772697° Long: -108.856576°	
13. Photographer Name: J. Dauzvardis	
14. Description: View of inset floodplain and 25-foot buffer looking downstream.	

Section D: Photo Log

1. Photo Point #: T3	
2. Photo File #: 1283	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 267 Cardinal: W	
5. Coordinates (decimal degree): Lat: 40.772697° Long: -108.856576°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking west.	

Section D: Photo Log

1. Photo Point #: T3	
2. Photo File #: 1283	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 87 Cardinal: E	
5. Coordinates (decimal degree): Lat: 40.772697° Long: -108.856576°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking east.	

TRANSECT 4

Section D: Photo Log

1. **Photo Point #:** T4	
2. **Photo File #:** 1284	
3. **Date:** 8/29/2023	
4. **Compass Direction Taken:** Degrees: 142 Cardinal: SE	
5. **Coordinates (decimal degree):** Lat: 40.771892° Long: -108.857640°	
6. **Photographer Name:** J. Dauzvardis	
7. **Description:** View of inset floodplain and 25-foot buffer looking upstream.	

Section D: Photo Log

1. **Photo Point #:** T4	
2. **Photo File #:** 1284	
3. **Date:** 8/29/2023	
4. **Compass Direction Taken:** Degrees: 322 Cardinal: NW	
5. **Coordinates (decimal degree):** Lat: 40.771892° Long: -108.857640°	
6. **Photographer Name:** J. Dauzvardis	
7. **Description:** View of inset floodplain and 25-foot buffer looking downstream.	

Section D: Photo Log

1. Photo Point #: T4	
2. Photo File #: 1284	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 232 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.771892° Long: -108.857640°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking southwest.	

Section D: Photo Log

1. Photo Point #: T4	
2. Photo File #: 1284	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 52 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.771892° Long: -108.857640°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking northeast.	

TRANSECT 5

Section D: Photo Log

1. **Photo Point #:** T5
2. **Photo File #:** 1285
3. **Date:** 8/29/2023
4. **Compass Direction Taken:** Degrees: 173 Cardinal: S
5. **Coordinates (decimal degree):** Lat: 40.771033° Long: -108.856422°
6. **Photographer Name:** J. Dauzvardis

7. **Description:** View of inset floodplain and 25-foot buffer looking upstream.

Section D: Photo Log

1. **Photo Point #:** T5-N
2. **Photo File #:** 1285
3. **Date:** 8/29/2023
4. **Compass Direction Taken:** Degrees: 353 Cardinal: N
5. **Coordinates (decimal degree):** Lat: 40.771033° Long: -108.856422°
6. **Photographer Name:** J. Dauzvardis

7. **Description:** View of inset floodplain and 25-foot buffer looking downstream.

Section D: Photo Log

1. **Photo Point #:** T5
2. **Photo File #:** 1285
3. **Date:** 8/29/2023
4. **Compass Direction Taken:** Degrees: 263 Cardinal: SW
5. **Coordinates (decimal degree):** Lat: 40.771033° Long: -108.856422°
6. **Photographer Name:** J. Dauzvardis

7. **Description:** View of inset floodplain and 25-foot buffer looking southwest.

Section D: Photo Log

1. **Photo Point #:** T5
2. **Photo File #:** 1285
3. **Date:** 8/29/2023
4. **Compass Direction Taken:** Degrees: 83 Cardinal: NE
5. **Coordinates (decimal degree):** Lat: 40.771033° Long: -108.856422°
6. **Photographer Name:** J. Dauzvardis

7. **Description:** View of inset floodplain and 25-foot buffer looking northeast.

TRANSECT 6

Section D: Photo Log	
1. Photo Point #: T6	
2. Photo File #: 1286	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 45 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.770022° Long: -108.855231°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking upstream.	

Section D: Photo Log	
1. Photo Point #: T5	
2. Photo File #: 1286	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 225 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.770022° Long: -108.855231°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking downstream.	

Section D: Photo Log	
1. **Photo Point #:** T6	
2. **Photo File #:** 1286	
3. **Date:** 8/29/2023	
4. **Compass Direction Taken:** Degrees: 135 Cardinal: SE	
5. **Coordinates (decimal degree):** Lat: 40.770022° Long: -108.855231°	
6. **Photographer Name:** J. Dauzvardis	
7. **Description:** View of inset floodplain and 25-foot buffer looking southeast.	

Section D: Photo Log	
1. **Photo Point #:** T6	
2. **Photo File #:** 1286	
3. **Date:** 8/29/2023	
4. **Compass Direction Taken:** Degrees: 315 Cardinal: NW	
5. **Coordinates (decimal degree):** Lat: 40.770022° Long: -108.855231°	
6. **Photographer Name:** J. Dauzvardis	
7. **Description:** View of inset floodplain and 25-foot buffer looking northwest.	

TRANSECT 7

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T7</td><td rowspan="6"></td></tr>
<tr><td>2. Photo File #: 1287</td></tr>
<tr><td>3. Date: 8/29/2023</td></tr>
<tr><td>4. Compass Direction Taken:
Degrees: 24
Cardinal: NE</td></tr>
<tr><td>5. Coordinates (decimal degree):
Lat: 40.770487°
Long: -108.853376°</td></tr>
<tr><td>6. Photographer Name:
J. Dauzvardis</td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking upstream.</td></tr>
</table>

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T7</td><td rowspan="6"></td></tr>
<tr><td>2. Photo File #: 1287</td></tr>
<tr><td>3. Date: 8/29/2023</td></tr>
<tr><td>4. Compass Direction Taken:
Degrees: 204
Cardinal: SW</td></tr>
<tr><td>5. Coordinates (decimal degree):
Lat: 40.770487°
Long: -108.853376°</td></tr>
<tr><td>6. Photographer Name:
J. Dauzvardis</td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking downstream.</td></tr>
</table>

Section D: Photo Log

1. Photo Point #: T7	
2. Photo File #: 1287	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 114 Cardinal: SE	
5. Coordinates (decimal degree): Lat: 40.770487° Long: -108.853376°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking southeast.	

Section D: Photo Log

1. Photo Point #: T7	
2. Photo File #: 1287	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 294 Cardinal: NW	
5. Coordinates (decimal degree): Lat: 40.770487° Long: -108.853376°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking northwest.	

TRANSECT 8

Section D: Photo Log

1. Photo Point #: T8	
2. Photo File #: 1288	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 84 Cardinal: E	
5. Coordinates (decimal degree): Lat: 40.771981° Long: -108.852023°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking upstream.	

Section D: Photo Log

1. Photo Point #: T8	
2. Photo File #: 1288	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 264 Cardinal: W	
5. Coordinates (decimal degree): Lat: 40.771981° Long: -108.852023°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking downstream.	

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T8</td><td rowspan="6"></td></tr>
<tr><td>2. Photo File #: 1288</td></tr>
<tr><td>3. Date: 8/29/2023</td></tr>
<tr><td>4. Compass Direction Taken:
Degrees: 174
Cardinal: S</td></tr>
<tr><td>5. Coordinates (decimal degree):
Lat: 40.771981°
Long: -108.852023°</td></tr>
<tr><td>6. Photographer Name:
J. Dauzvardis</td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking south.</td></tr>
</table>

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T8</td><td rowspan="6"></td></tr>
<tr><td>2. Photo File #: 1288</td></tr>
<tr><td>3. Date: 8/29/2023</td></tr>
<tr><td>4. Compass Direction Taken:
Degrees: 354
Cardinal: N</td></tr>
<tr><td>5. Coordinates (decimal degree):
Lat: 40.771981°
Long: -108.852023°</td></tr>
<tr><td>6. Photographer Name:
J. Dauzvardis</td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking north.</td></tr>
</table>

TRANSECT 9A (VERMILLION CREEK)

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T9A
2. Photo File #: 1289
3. Date: 8/29/2023
4. Compass Direction Taken: Degrees: 124 Cardinal: SE
5. Coordinates (decimal degree): Lat: 40.771757° Long: -108.850847°
6. Photographer Name: J. Dauzvardis</td><td></td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking upstream.</td></tr>
</table>

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T9A
2. Photo File #: 1289
3. Date: 8/29/2023
4. Compass Direction Taken: Degrees: 304 Cardinal: NW
5. Coordinates (decimal degree): Lat: 40.771757° Long: -108.850847°
6. Photographer Name: J. Dauzvardis</td><td></td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking downstream.</td></tr>
</table>

Section D: Photo Log	
1. Photo Point #: T9A	
2. Photo File #: 1289	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 200 Cardinal: N	
5. Coordinates (decimal degree): Lat: 40.771757° Long: -108.850847°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking north.	

Section D: Photo Log	
1. Photo Point #: T9A	
2. Photo File #: 1289	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 20 Cardinal: S	
5. Coordinates (decimal degree): Lat: 40.771757° Long: -108.850847°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking south.	

TRANSECT 9B (LITTLE JOE)

Section D: Photo Log	
1. Photo Point #: T9B	
2. Photo File #: 1290	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 160 Cardinal: SE	
5. Coordinates (decimal degree): Lat: 40.772093° Long: -108.850955°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of Little Joe wetland looking upstream.	

Section D: Photo Log	
1. Photo Point #: T9B	
2. Photo File #: 1290	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 340 Cardinal: NW	
5. Coordinates (decimal degree): Lat: 40.772093° Long: -108.850955°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of Little Joe wetland looking downstream.	

Section D: Photo Log

1. Photo Point #: T9B	
2. Photo File #: 1290	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 250 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.772093° Long: -108.850955°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of Little Joe wetland looking southwest.	

Section D: Photo Log

1. Photo Point #: T9B	
2. Photo File #: 1290	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 70 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.772093° Long: -108.850955°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of Little Joe wetland looking northeast.	

TRANSECT 10A (VERMILLION CREEK)

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T10A</td><td rowspan="6"></td></tr>
<tr><td>2. Photo File #: 1291</td></tr>
<tr><td>3. Date: 8/29/2023</td></tr>
<tr><td>4. Compass Direction Taken:
Degrees: 146
Cardinal: SE</td></tr>
<tr><td>5. Coordinates (decimal degree):
Lat: 40.771267°
Long: -108.850426°</td></tr>
<tr><td>6. Photographer Name:
J. Dauzvardis</td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking upstream.</td></tr>
</table>

<table>
<tr><td colspan="2">Section D: Photo Log</td></tr>
<tr><td>1. Photo Point #: T10A</td><td rowspan="6"></td></tr>
<tr><td>2. Photo File #: 1291</td></tr>
<tr><td>3. Date: 8/29/2023</td></tr>
<tr><td>4. Compass Direction Taken:
Degrees: 326
Cardinal: NW</td></tr>
<tr><td>5. Coordinates (decimal degree):
Lat: 40.771267°
Long: -108.850426°</td></tr>
<tr><td>6. Photographer Name:
J. Dauzvardis</td></tr>
<tr><td colspan="2">7. Description: View of inset floodplain and 25-foot buffer looking downstream.</td></tr>
</table>

Section D: Photo Log	
1. Photo Point #: T10A	
2. Photo File #: 1291	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 234 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.771267° Long: -108.850426°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking southwest.	

Section D: Photo Log	
1. Photo Point #: T10A	
2. Photo File #: 1291	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 54 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.771267° Long: -108.850426°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking northeast.	

TRANSECT 10B (LITTLE JOE)

Section D: Photo Log

1. Photo Point #: T10B	
2. Photo File #: 1292	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 136 Cardinal: SE	
5. Coordinates (decimal degree): Lat: 40.771506° Long: -108.849959°	
6. Photographer Name: J. Dauzvardis	

7. Description: View of Little Joe wetland looking upstream.

Section D: Photo Log

1. Photo Point #: T10B	
2. Photo File #: 1292	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 316 Cardinal: NW	
5. Coordinates (decimal degree): Lat: 40.771506° Long: -108.849959°	
6. Photographer Name: J. Dauzvardis	

7. Description: View of Little Joe wetland looking downstream.

Section D: Photo Log	
1. Photo Point #: T10B	
2. Photo File #: 1292	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 236 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.771506° Long: -108.849959°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of Little Joe wetland looking southwest.	

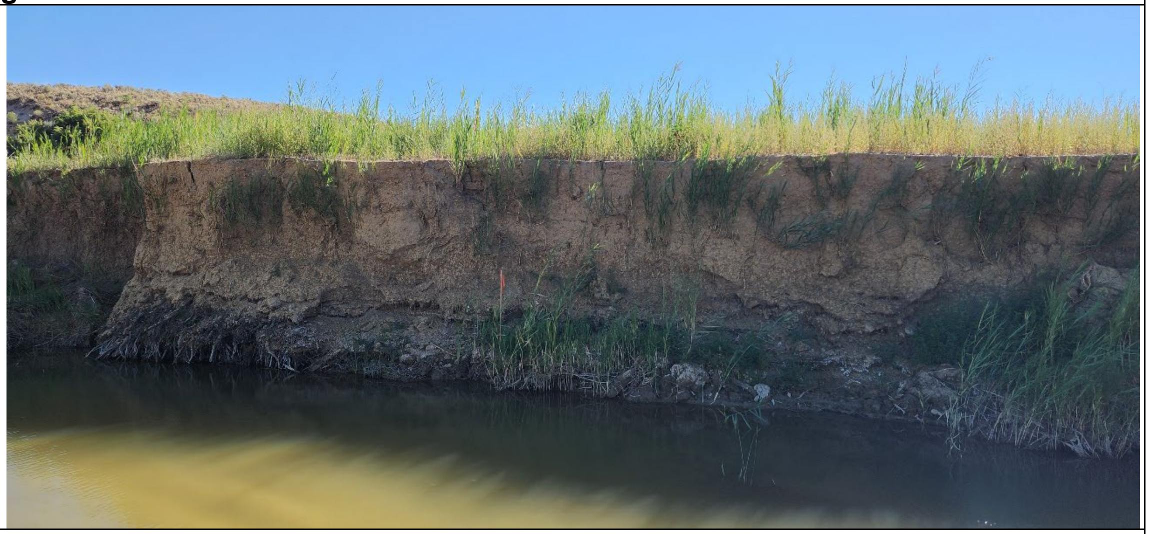
Section D: Photo Log	
1. Photo Point #: T10B	
2. Photo File #: 1292	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 28 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.771506° Long: -108.849959°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of Little Joe wetland looking northeast.	

TRANSECT 11

Section D: Photo Log	
1. Photo Point #: T11	
2. Photo File #: 1293	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 122 Cardinal: SE	
5. Coordinates (decimal degree): Lat: 40.770414° Long: -108.849176°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking upstream.	

Section D: Photo Log	
1. Photo Point #: T11	
2. Photo File #: 1293	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 302 Cardinal: NW	
5. Coordinates (decimal degree): Lat: 40.770414° Long: -108.849176°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking downstream.	

Section D: Photo Log

1. Photo Point #: T11	
2. Photo File #: 1293	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 212 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.770414° Long: -108.849176°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking southwest.	

Section D: Photo Log

1. Photo Point #: T11	
2. Photo File #: 1293	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 32 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.770414° Long: -108.849176°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking northeast.	

TRANSECT 12

Section D: Photo Log	
1. Photo Point #: T12	
2. Photo File #: 1294	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 152 Cardinal: S	
5. Coordinates (decimal degree): Lat: 40.769695° Long: -108.847353°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking upstream.	

Section D: Photo Log	
1. Photo Point #: T12	
2. Photo File #: 1294	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 332 Cardinal: N	
5. Coordinates (decimal degree): Lat: 40.769695° Long: -108.847353°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking downstream.	

Section D: Photo Log

1. Photo Point #: T12	
2. Photo File #: 1294	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 242 Cardinal: SW	
5. Coordinates (decimal degree): Lat: 40.769695° Long: -108.847353°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking southwest.	

Section D: Photo Log

1. Photo Point #: T12	
2. Photo File #: 1294	
3. Date: 8/29/2023	
4. Compass Direction Taken: Degrees: 62 Cardinal: NE	
5. Coordinates (decimal degree): Lat: 40.769695° Long: -108.847353°	
6. Photographer Name: J. Dauzvardis	
7. Description: View of inset floodplain and 25-foot buffer looking northeast.	

<table>
<tr><th>Section E: Photo Point Map/Figure</th><th>Map # (if applicable)</th></tr>
<tr><td colspan="2">Refer to attached Appendix H, Monitoring Transect Location Map showing the location of the monitoring transects and the location of the monitoring photo points and photos included herein.

Photo points on Appendix H were consistently located in the center of the inset floodplain on each transect and photos were consistently taken upstream, downstream (perpendicular to the transect) and left and right (parallel with the transect).</td></tr>
</table>

APPENDIX E

2023 Vermillion Creek Functional Assessment

Submitted, November 2023

Brad Johnson PhD, PWS

2023 Vermillion Creek Functional Assessment

August 29, 2023 survey

JOHNSON ENVIRONMENTAL CONSULTING

The Confluence of Science & Application

Overview

Compensatory mitigation for Vermillion Creek impacts was constructed in two distinct areas and in two phases. The creek was reconstructed during the summer of 2022. The bulk of construction of the Little Joe mitigation area ("Little Joe") was completed in or around June of 2023, with finishing occurring throughout the summer and after this assessment was complete.

This report describes the findings of a site assessment conducted on August 29, 2023. The Functional Assessment of Colorado Wetlands method (FACWet; described on following page) was used to guide and convey study findings for the main Vermillion Creek mitigation area.

Figure 1 provides an overview of the major features of the mitigation areas. Vermillion Creek was divided into two assessment reaches for the FACWet. Little Joe was not evaluated using FACWet, because the regional references were focused exclusively on Vermillion Creek, as were the functionally-based performance standards included in the consent decree. Little Joe was evaluated with regard to its apparent ability to attain and/or support wetland conditions.

An initial FACWet was done on the impact channel and regional reference reaches. This current assessment does not re-evaluate those areas but instead focuses exclusively on the newly constructed channel.

Figure 1. 2023 aerial photograph of the Vermillion Creek and Little Joe Mitigation areas, along with relevant features.

Purpose and Approach

- This study used the Functional Assessment of Colorado Wetlands (FACWet) to evaluate and rate the condition of aquatic resources at the Vermillion Creek mitigation site.
- **Table 1** reproduced from the FACWet user manual shows the Attributes, Variables and Subvariables considered during a FACWet evaluation.
- FACWet uses letter grades based on the academic grading scale (**Table 2;** reproduced from the FACWet user manual). In FACWet, evaluation of variable condition consists of a score/grade which represents the summary opinion of the evaluator and the rationale supporting that opinion (**Fig. 2** reproduced from the FACWet manual).
- This report cannot be a primer on FACWet, however, some basic characteristics of the approach are as follow:
    - FACWet is a forensic, weight-of-evidence approach to aquatic resource condition assessment.
    - It is a formalization of an investigative approach to wetland functional assessment.
    - It is an information framework used to structure data sources and observations in a way that provides context and insight into holistic habitat functioning.
    - It is a systematic way to describe and support interpretations of system functioning.

Table 2. Functional Grades, scores and definitional criteria.

Score Range	Letter Grade	Narrative Condition Category	Interpretation
1.0 – 0.9	A	Reference Standard	Pristine or nearly so. Supports highest level of sustainable functioning.
<0.9 – 0.8	B	Highly Functioning	Stressors detectably alter the variable's form in minor ways. The variable still retains its essential qualities and supports a high level of ecological function.
<0.8 – 0.7	C	Functioning	Obvious alteration and degradation of the variable, but it still supports basic, natural, passive wetland functioning.
<0.7 – 0.6	D	Functionally Impaired	Major ecologically harmful alterations to the variable. Active management commonly required to support maintenance of wetland characteristics.
<0.6	F	Non-Functioning	Massive deleterious alteration of the variable. The level of alteration generally results in an inability of the variable to support wetland conditions or it otherwise makes the area biologically-unsuitable.

Table 1. Summary of FACWet attributes, State Variables and Sub-variables. The final column provides the total weight assigned to the variable when calculating the overall site score, or composite FCI.

Attribute	Variable Number	State Variable Name	Sub-Variable Name	Total Weight of Variable in Composite FCI
Buffer & Landscape Context	V1	*Habitat Connectivity*	*SV 1.1 – Neighboring Wetland and Riparian Habitat Loss*	*0.04*
			SV 1.2 – Barriers to Migration and Dispersal	
	V2	*Contributing Area*	*SV 2.1 – Buffer Condition*	*0.11*
			SV 2.2 – Buffer Extent	
			SV 2.3 – Buffer Width	
			SV 2.4 – Surrounding Land Use	
Hydrology	V3	*Water Source*	*No sub-variables*	*0.13*
	V4	*Water Distribution*		*0.17*
	V5	*Water Outflow*		*0.17*
Abiotic & Biotic Habitat	V6	*Geomorphology*	*No sub-variables*	*0.15*
	V7	*Chemical Environment*	*SV 7.1 – Nutrient Enrichment*	*0.07*
			SV 7.2 – Sedimentation/turbidity	
			SV 7.3 – Toxic Contamination	
			SV 7.4 – Temperature	
			SV 7.5 – Soil Chemistry and Redox	
	V8	*Vegetation Structure and Complexity*	*SV 8.1 – Tree Stratum*	*0.15*
			SV 8.2 – Shrub Stratum	
			SV 8.3 – Herb Stratum	
			SV 8.4 – Aquatic Stratum	

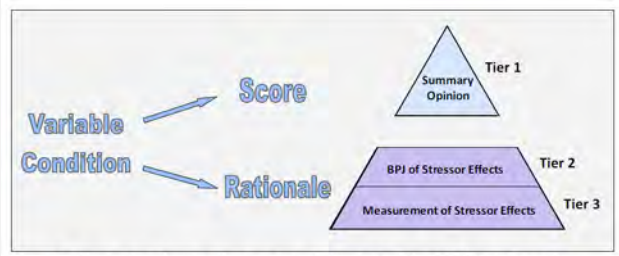


Fig. 2. Illustration showing the conceptual structure of the FACWet information framework. Variable condition is comprised of a score and the supporting rationale. The variable score, which relates to an academic letter grade, represents the evaluator's summary opinion on variable. In routine assessments the variable score is supported by a rationale based on stressor inventory and interpretation. When necessary, more intensive methods can be used to form the rationale justifying the variable score.

FACWet of Vermillion Creek Mitigation, Abstract of Findings

Overview
This assessment occurred during the first growing season following construction and the October 2022 flood that basically recreated the system within the excavated channel alignment. The system is currently reassembling itself. This process will probably start fairly slowly and accelerate through time. The foundational geomorphic template has been set by the 2022 flood, sizing the inset floodplain to the capacity of a large event and creating a naturalistic pattern of variable height bars and benches down the length of the mitigation reach. Within this template, further geomorphic development will likely have to await vegetation establishment. There were no apparent impediments to vegetation establishment observed, so the conclusion is that the mitigation is on an appropriate trajectory.

FACWet Variables
Figure 3 provides a comparison of post-build/post-flood variable grades with the average the regional reference reaches grades. That average is the mean of the grades of the four regional references, the on-site reference and the estimated pre-impact condition of Vermillion Creek.

The landscape-scale variables, Habitat Connectivity and Contributing Area, were held constant from the baseline assessment. Water Source was also left unchanged from the baseline assessment, since the Vermillion Creek flow regime has not been altered, to my knowledge.

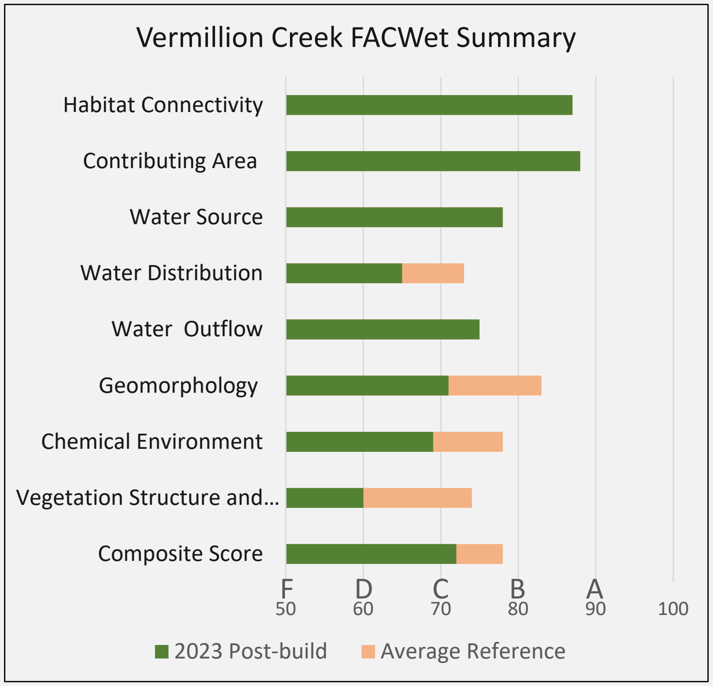
Within the mitigation reach, Water Distribution, Geomorphology, Chemical Environment and Vegetation Structure and Complexity are all in impaired condition compared to the regional references owing to the early stage of restoration development. The composite score of the mitigation at the time of this assessment was a C- (72) as compared to the C+ (78) regional reference[1]. Most of the FACWet variable grades, for both the mitigation and regional references, are lower than their composite grade. The composite grade is elevated because the region's excellent landscape setting props up habitat functioning.

[1] the target grade for mitigation is a B-; that is, a bit better than the typical regional condition.

The current keystone stressor in the system is the sparsity of vegetation. This stressor is key because vegetation seems to be fundamentally important to geomorphic development in this system. Geomorphology in turn controls the distribution of water within the system. Finally, the uncharacteristic water distribution results in oversaturation of soils across the bottom of the inset floodplain.

This logic suggests that as vegetation establishes and that stressor is alleviated, the improvements will flow through the system in the same way the in which the impacts did and grades will rise correspondingly.

Fig. 3. A bar graph of FACWet variable scores comparing post-build to regional reference condition.



Approach to Restoration

The design and as-built configuration the Vermillion Creek mitigation area are documented elsewhere. This report provides a description of initial restoration outcomes and a discussion of the apparent developmental trajectory based on a one-day field survey.

The Vermillion Creek restoration approach was based on excavating a fairly simple inset floodplain and allowing natural processes to rebuild the system in response to actual watershed conditions.

This general strategy to restoration is common in wetland restoration, but less so in traditional stream restoration. The strategy chosen for Vermillion Creek seems to reflect the need to create a substantial amount of wetland while simultaneously restoring the interdependent stream (i.e., in-channel) habitat.

In October of 2022, according to Stillwater Sciences (SWS) an intense storm occurred creating what was modelled as a 25-year flow event in Vermillion Creek. This event carried out an impressive amount of work on the excavated floodplain, expanding and reconfiguring essentially the entire restoration area.

Approach to Assessment

The restoration reach was reconnoitered by vehicle and then walked end-to-end twice ("there and back"). This was an observational assessment that documented and illustrated conditions using accurately geo-tagged photographs.

The restoration is early in its development. At the time of the assessment, little in the way of habitat differentiation had occurred. Because of the uniformity of condition and functioning, the mitigation was functionally assessed as a single unit. There was, however, a switch in geomorphic context about mid-way down the restoration reach. The upper reach was predominately erosional in the October 2022 event, while the lower one was aggradational**.** A constructed low-water crossing occurs near to where the switch in sediment dynamic occurs, and it assumably plays some role as grade control, but I did not observe evidence that it was a primary control on sediment dynamics during the 2022 event **(Fig. 4**)**.** Two FACWet assessment reaches were defined, using the low-water crossing serving as the reach break. While the low water crossing may not have been the primary cause of the switch in sediment dynamics, it is a substantial feature near the transitional zone (**Fig. 1**)**.**

Summary Description of Mitigation

The details and rationale behind these conclusions are described in the FACWet assessment on the following pages.

The October 2022 flow event advanced macro-geomorphic development of the restoration many years A multistage floodplain configuration is common throughout the restoration, suggesting an ability to support diverse riverine wetland and riparian habitats **(Fig. 5**)**.** The inset floodplain is also substantially larger than that which was actively excavated (approximately 9 acres), providing a larger than planned footprint of potential wetland and riparian habitat.

Fig. 4. View southeast of the low water crossing that divides the two assessment reaches.

Fig. 5. View southwest showing the geomorphic template of the restoration.

Mitigation functioning at this phase appears to parallel that of an arroyo **(Fig. 6).** Classically, arroyos are fine-grained systems, inset into uplands, that are periodically subjected to high energy flow events that essentially restart habitat succession. Vermillion Creek is somewhat atypical in having perennial rather than episodic flow, however. In arroyo habitat succession, if large events are infrequent, vegetation may move into the bottom and begin to exert control on low flows, splitting sheet flow into concentrated braids flowing between protected islands. When islands become stabilized with vegetation, channels with well defined bed and bank can form, being carved by the concentrated flows. The system may continue to develop along these lines until the next major event.

The initial development of the Vermillion Creek restoration appears to be on a similar trajectory. The mitigation construction created a feature similar in character to an arroyo after an extreme event; that is, a shallowly inset, sandy gully. Minor vegetation establishment ensued before a large, natural flood event occurred in October 2022. This flood did substantial work toward “naturalizing” the system on the landscape, creating features in response to watershed forces rather than an imposed design. While unavoidable, this circumstance is generally viewed as having had a favorable influence on system development.

If sufficient vegetation can develop before the next large event, the functioning of the Vermillion Creek restoration will likely depart from the arroyo model and transition to the reference stream type **(Fig. 7).** This transition will probably be complete when the vegetation is established enough to persist through all but the most extreme events.

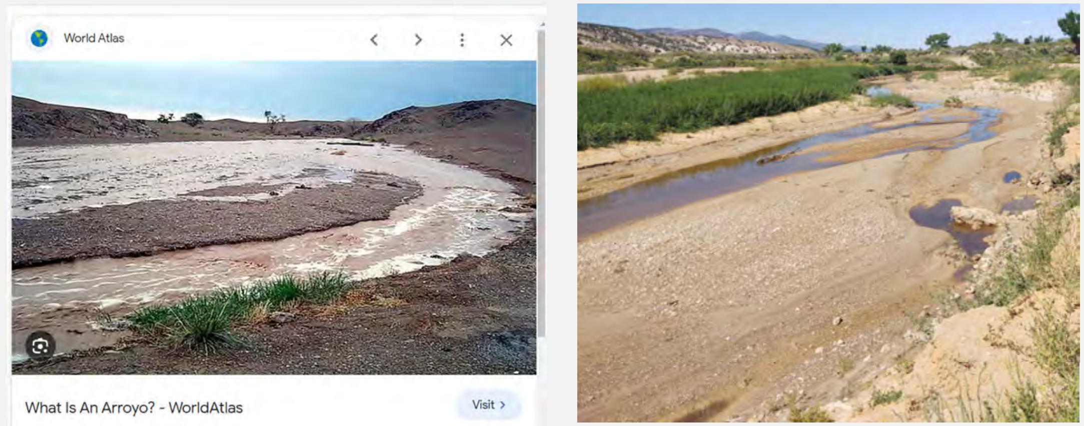


Fig. 6. The left panel is a photographic explanation of the character of an arroyo as found on the *World Atlas* webpage. The right panel is a photograph of the lower reach of the Vermillion Creek mitigation. There is a clear similarity in appearance.

Fig. 7. The on-site reference reach in the impact channel, showing a likely developmental outcome of the mitigation. Photograph reproduced from the Baseline FACWet assessment report (JEC 2021).

Discussion of FACWet Variable Condition

Each variable of FACWet will be discussed individually, followed by a summary of overall mitigation condition and performance assessment. Letter grades (A – F) summarily describing variable condition are provided parenthetically in the variable explanations.

FACWet of Vermillion Creek Mitigation

Buffer and Landscape Context Variables
The Buffer and Landscape Context Attribute has two variables: Habitat Connectivity and Contributing Area. The FACWet condition grades determined during the baseline assessment were used, unchanged, for this assessment. This was done because the site is in a very early state of development. For example, it is not useful to evaluate variables such as Neighboring Wetland and Riparian Habitat Loss at this point, because the stable character of aquatic habitats in and around the mitigation is unclear. Moreover, the condition of the buffer flanking the creek would be artificially depressed in the assessment because haul roads and other construction features were still present during the assessment, but they were scheduled for reclamation shortly after this assessment was conducted. Finally, holding the Buffer and Landscape Context condition scores constant focuses the assessment on the functioning of the target aquatic habitats rather than their surroundings.

Hydrology Variables
In FACWet, wetland hydrology is evaluated by considering the quality of the water source, the pattern of distribution within the wetland and the wetland's ability to support down gradient habitats in a characteristic manner. The water source, for the mitigation is the flow of Vermillion Creek. The flow regime of Vermillion Creek has not been altered subsequent to the baseline assessment, to my knowledge. Therefore, the Water Source variable grade is unchanged from the base line assessment (C+).

Water Distribution is impaired throughout much of the mitigation area, in that water is generally too evenly distributed across the bottom (D). With a lack of incised channels, water commonly flows in a sheet-like fashion, with its surface only interrupted by low, constantly shifting sediment bars **(Figs. 8 and 9).** This pattern is unlike the target reference. As explained previously, the lack of channel formation appears to be a product of the restoration's early developmental stage rather than a deficit in design or implementation. It seems likely that channels will form, and water distribution will become more characteristic of regional references.

Only minor impairment to Water Outflow occurs other than the limitations set by the condition of the Water Source (C).

Fig. 8. One the extreme examples of impaired water distribution, found in the upper reach.

Fig. 9. View northwest near the bottom of the site. Water outflow is no wholly characteristic but still able to support down-valley habitats.

Geomorphology
This is the key response variable at this point in the restoration. The October 2022 flood was the overwhelmingly controlling event in the restoration's development, dramatically changing the cross-sectional and longitudinal profile of the creek and its adjacent, nascent wetlands.

There are two aspects of geomorphology considered in this assessment; the cross-sectional surface form of the mitigation, and its longitudinal configuration. The longitudinal configuration has been largely driven by sediment transport processes in force in the 2022 flow event. Although differences in sediment transport characteristics served as the primary basis for differentiating the two assessment reaches, the quality of geomorphology within each floodplain was generally similar.

The cross-sectional form of the inset floodplain appeared quite good with surface heights commonly being variable. This condition should encourage the development of diverse habitats. The benches and bars have also formed at approximately regular intervals providing longitudinal heterogeneity in addition to the cross-sectional diversity (**Fig**. **10**).

The primary deficit of the riverine habitat at this early stage is the lack of a channel system, but this is understood to be an intentional aspect of restoration design (**Fig. 11**). Future channel formation seems probable, but the mechanism of formation likely requires a threshold level of vegetation development.

The lack of vegetation can be characterized as a stressor causing geomorphic impairment; that is, the channels characteristic of reference habitats cannot form in the unconsolidated sediments. Instead, water tends to flow in either as shallow sheet across the bottom (**Figs. 8 and 11**) or in an ever shifting, braided network (**Figs. 6 and 9**). This uncharacteristic flow pattern is reflected in a decrease in the Water Distribution condition score.

Once vegetation is sufficiently established to bind the sandy soils, channels should begin passively forming as suggested by the on-site reference reach identified in the (former) impact channel (**Fig. 7**).

Fig. 10. Drone imagery illustrating the pattern of bar formation that formed after the 2022 flood. The freshly graded Little Joe mitigation site can be seen on the right side of the photograph. The blue line delineates the approximate extent of the inset floodplain in 2023.

Fig. 11. Two examples of the good degree of variation in cross-sectional elevation, creating the foundation for development of diverse habitats. The geomorphic component that is missing is the channel system, which likely can only form in concert with vegetation development.

FACWet of Vermillion Creek Mitigation

Considering now the longitudinal profile and sediment dynamics, the October 2022 event mobilized massive amounts of sediment. In terms of outcomes, the upper reach was generally erosional, commonly down-cutting about four feet and substantially widening (**Fig. 11 and 12**). In the upper reach, the mitigation floodplain is now deeply inset into the historical floodplain. In contrast, the lower reach generally aggraded, with up to about four feet of sediment accumulating (**Figs. 9 and 13**).

The exact sequence of events that occurred during the October 2022 flood is unclear, but likely a head cut began somewhere in the upper reach. The head cut ran up to the top of the mitigation reach and then for about another 600 ft. above the site. The head cut above the mitigation site is about 25 to 50 ft. wide, and it appears to have down cut about four feet **(Fig. 14).** The down-cut channel appears to have intersected a bedrock sill just above the mitigation site, which probably defined the new base grade **(Fig. 15**). At the downstream end of the upper reach, the rock, low-water crossing likely played a role in grade control **(Fig. 1).** With those grade controls, the upper mitigation reach may have attained a new stable bed elevation and longitudinal profile. The top of the head cut, above the mitigation area, was addressed with rock grade controls (**Fig. 16**).

This study only assessed the head cut with regard to its potential affects on the mitigation. As of the time of this assessment, the head cut did not appear to be negatively impacting the mitigation, however, the affect of down cutting on adjacent wetlands should be monitored (**Fig. 17 and 18**). A loss of adjacent wetland habitat would impact the FACWet Buffer and Landscape Context variables**.** At the time of this assessment wetland vegetation exhibited no obvious signs of stress.

In the case of the Vermillion Creek mitigation, in the upper reach, the depth that the floodplain is inset does not impair the functioning of restored habitat within. It is unlikely that the creek will ever reattach to the historical floodplain placing it in the category of "relict". The inset floodplain will probably continue widening, creating more and more wetland and riparian habitat at the new, lower base level, thereby continuing the geomorphic succession illustrated in **Fig. 19**.

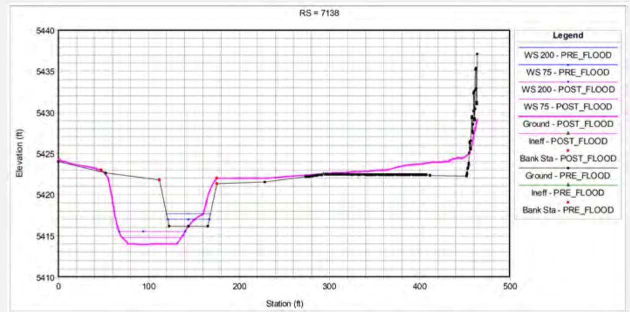


Fig. 12. Post-build and Post-flood cross-sections illustrating an **erosional** reach. The post-flood cross-section was created expediently based on drone data which introduces some error in surface representation, but accuracy is sufficient for illustrative purposes.

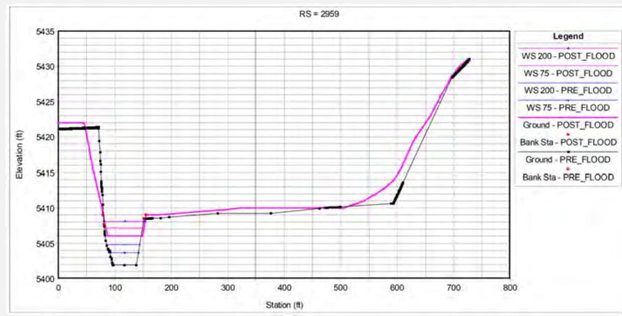


Fig. 13. Post-build and Post-flood cross-sections illustrating a **depositional** reach. The post-flood cross-section was created expediently based on drone data which introduces some error in surface representation, but accuracy is sufficient for illustrative purposes.

Fig. 14. Overview of the middle section of the head cut above the mitigation area. The fence hanging over the span provides a sense of scale.

Fig. 15. An apparent bed rock sill in the head cut reach above the mitigation, is likely holding grade.

FACWet of Vermillion Creek Mitigation

In the upper reach, steep scarps, up to about eight feet in height, connect the active floodplain to the relict one (**Fig. 20**). Although unstable, this source of sediment may be important support for the lower reach and the on-going process of floodplain reconnection. High, steep terrace scarps are also in character with this stream type as shown in the regional reference assessment (JEC 2021) and by paleo features (**Fig. 17 - 19**).

Downstream of the low water crossing (**Fig. 1**), terrace heights begin decreasing as the amount aggraded sediment increases **(Figs. 6, 9 and 13**). In the lowest reaches, the creek appears connected to its historical floodplain, or nearly so **(Figs. 9 and 13**). While not a goal of mitigation, passive reconnection of the creek to its historical floodplain would be a substantial ecological benefit. The risk in this geomorphic aggradation is one of head cutting from the bottom of the mitigation site, up through the newly deposited sediment, thereby dewatering the freshly established mitigation wetlands. No evidence of imminent or incipient head cutting in the lower reach was observed in this assessment, however.

In summary, the October 2022 flow event recreated the geomorphology of the Vermillion Creek mitigation along its excavated channel alignment. Because it was overwhelmingly formed by natural processes, the gross geomorphology of the mitigation appears natural and characteristic of regional references (JEC 2021). The deficit in geomorphological condition is the lack of a channel system, and formation of that likely awaits vegetation development. Because the mitigation habitat is missing a foundational element of characteristic geomorphology, it is considered "functionally impaired", and the Geomorphology variable is given a D condition rating. This grade is expected to rise as the site matures.

Fig. 20. High, erodible floodplain scarps are common in the upper mitigation reach. They are in character with Vermillion Creek regional reference reaches

Fig. 16. Rock grade control installed at the top of the head cut.

Fig. 17. View from inside the head cut. Based on the regional reference survey, bank heights in this area prior to October 2022 were four to five feet.

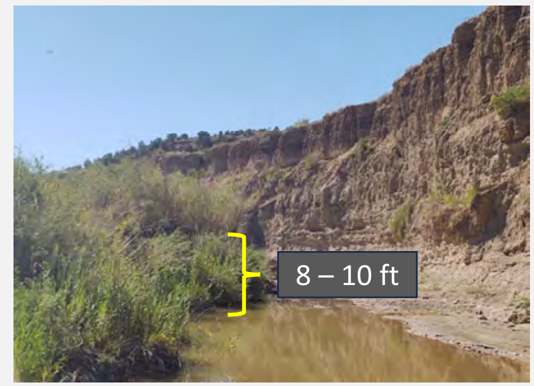
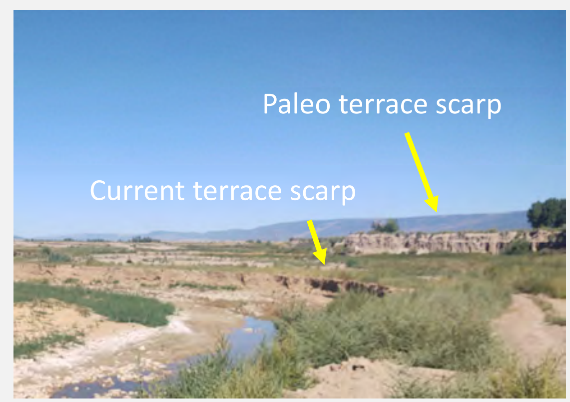


Fig. 18. A view down on to the surface of the bench shown in **Fig. 17**. The steep scarp in both pictures provides reference.

Fig. 19. View northwest showing the terrace scarp of the mitigation, in reference to a paleo terrace scarp associated with a long-abandoned floodplain.



Chemical Environment
Five chemical environment subvariables are evaluated in FACWet. Four of those sub-variables are related to water quality, with the fifth describing soil chemistry. The four water quality variable scores from the baseline assessment were unchanged in this assessment, since there is no evidence to suggest that water quality changed.

The soil chemical environment across the whole inset floodplain appears to be close to reference, except in the channel-less bottom. The flooded bottoms have hydric soils but are somewhat over-saturated secondary to the over distribution of water across the bottom **(Fig. 21)**. The Chemical Environment variable score is a D+, with the impaired temperature regime caused by the wide, shallow flow characteristics and lack of shading driving the grade into the functionally impaired category **(Fig. 21)**. This grade is expected to rise as the mitigation matures.

Vegetation
Vegetation at the time of this assessment was primarily volunteer herbaceous species and newly establishing willow slips **(Fig. 22)**. The early growth of willow slips was often impressive. The herbaceous flora appeared overwhelmingly comprised of ruderal and weedy species. This is expected at early states of development. Additional seeding and willow and cottonwood planting were scheduled after the completion of this assessment.

Given these conditions the Vegetation Structure and Complexity variable was rated D-. This grade is expected to rise as mitigation matures.

Fig. 21. A spectrum of redox regimes are present in reaches such as in the photograph below and left. Reaches such as that pictured to the right have a redox regime with overly even and reduced conditions.

Fig. 22. Vegetation establishment is at a rudimentary stage. The majority of vegetation coverage appears to be comprised of ruderal species.

Overview
According to the Concept Design Technical Narrative (ECO/SWS 2021) the goal of the Little Joe mitigation area is to establish 2.5 acres of palustrine emergent and scrub-shrub wetland. Little Joe does not have other functional performance standards and regional references are focused on Vermillion Creek, and not directly applicable to Little Joe. The Little Joe mitigation site is being evaluated according to the degree to which it is, or appears on a trajectory toward, supporting wetland conditions according to the three Corps parameters: wetland hydrology, hydrophytic vegetation and hydric soils. The extent of potential wetland habitat in Little Joe was not determined but will be during a future wetland delineation.

The bulk of mitigation construction was completed in the summer of 2023; however, additional finishing work and planting/seeding was scheduled to take place after the completion of this assessment. Also, I understand there are plans to adaptively modify the configuration of the site as its functioning becomes better understood.

Hydrology
Little Joe is a natural water way that has its entire flow artificially controlled. The mitigation site is configured in as roughly triangular, shallow basin, transected by earthen berms that create five cells **(Fig. 23 - 24**). The gross configuration is strikingly similar to the one used in the Marshall Mitigation Bank, outside of Boulder Colorado (**Fig. 25**). Little Joe flows into the northeast corner of the site (**Fig. 26**). Each cell is hydrologically linked by a gated culvert piercing the cell's lower berm **(Fig. 27).** The foundation of the Little Joe hydrologic system is a leveed channel that runs along the north edge of the site **(Figs. 23, 28 – 29).** This peripheral water supply ditch releases water into the cells. The water level in each cell can be adjusted by manipulating the culvert gates. According to Angelo Raftopoulos the site had been flooded prior to this site assessment. It was still wet and held patches of shallow ponded water decreasing from the upper to lower cells.

With appropriate source water management, the mitigation area has demonstrated the ability to support wetland hydrology.

Soils
Soil profiles were not evaluated in this assessment, because the site was so recently graded and little time had elapsed for the soils to develop hydric indicators. Because there was obvious saturation and clear ability to maintain saturation, the soils are presumed to be incipiently hydric. A future wetland delineation will confirm this presumption.

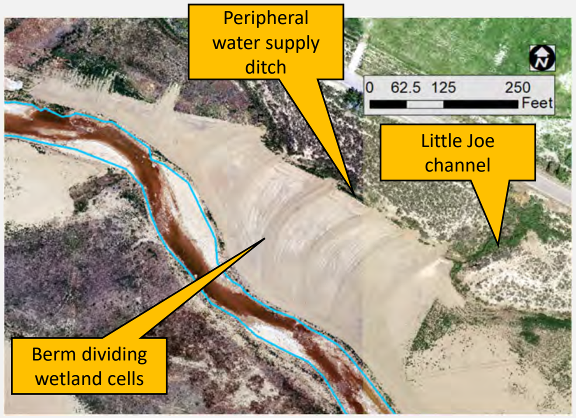


Fig. 23. 2023 aerial image of Little Joe taken with a drone. The site is the roughly conical feature at the center of the photograph. The site was still under construction, and freshly graded, but site configuration and major features can be discerned.

Fig. 24. Two photographs showing the berms partitioning wetland cells.

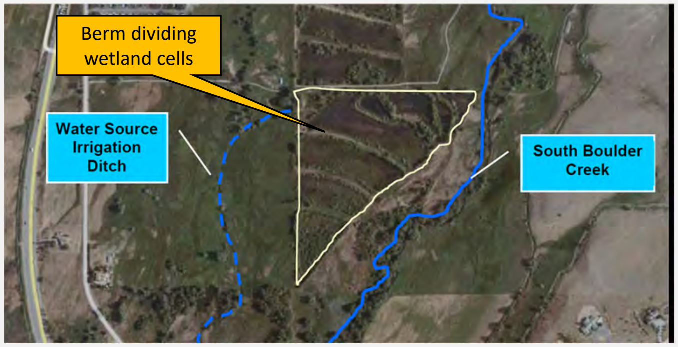


Fig. 25. Figure 17 from the FACWet manual (edited) showing the Marshall Wetland Mitigation Bank outside of Boulder, Colorado. The similarity between it and Little Joe is striking.

Vegetation
The site was essentially freshly graded and, therefore, was almost entirely bare ground (**Figs. 30**). The site appears capable of supporting hydrophytic vegetation in the future.

Conclusion
The Little Joe mitigation site has demonstrated the ability to support wetland hydrology. Based on the hydrologic regime it is presumed to support hydric soil processes. Finally, the site appears capable of supporting hydrophytic vegetation, but very little vegetation had established at the time of this survey.

Fig. 26. Little Joe enters the wetland basin at the northeast corner.

Fig. 27. The berms creating the wetland cells are pierced with a plastic pipe, fitted with a flow control gate that can be pulled up to increase flow volume.

Fig. 28. View northwest looking down the peripheral supply channel, to the right in the picture. Another supply pipe goes left into the upper wetland cell.

Fig. 29. View east-southeast of the peripheral supply channel from a dividing berm.

Fig. 30. View northwest showing the predominantly bare soil conditions.

References Cited

- ECOS/Stillwater Sciences. (2021) Concept Design Technical Narrative: Vermillion Creek Restoration at Diamond Peak Ranch . February 19, 2021 .
- Johnson, J.B., M. Beardsley and J. Doran. 2013. Functional Assessment of Colorado Wetlands (Version 3.0).
- JEC. 2021. Vermillion Creek Functional Assessment, June 2021.

Appendix A – Vermillion Creek FACWet Detail

	State Variable Name	Sub-Variable Name	2023 Condition	Average of Regional References and Pre-impact Condition	Total Weight of Variable in Composite FCI
Buffer & Landscape Context	*Habitat Connectivity*	*SV 1.1 – Neighboring Wetland and Riparian Habitat Loss*	*86*	*86*	*0.04*
		SV 1.2 – Barriers to Migration and Dispersal	*88*	*88*	
		Variable 1 Score	*87*	*87*	
	Contributing Area	*SV 2.1 – Buffer Condition*	*89*	*89*	*0.11*
		SV 2.2 – Buffer Extent	*97*	*97*	
		SV 2.3 – Buffer Width	*93*	*93*	
		SV 2.4 – Surrounding Land Use	*88*	*88*	
		Variable 2 Score	*88*	*88*	
Hydrology	*Water Source*	**Variable 3 Score**	*78*	*78*	*0.13*
	Water Distribution	**Variable 4 Score**	*65*	*73*	*0.17*
	Water Outflow	**Variable 5 Score**	*75*	*73*	*0.17*
Abiotic & Biotic	*Geomorphology*	**Variable 6 Score**	*71*	*83*	*0.15*
	Chemical Environment	*SV 7.1 – Nutrient Enrichment*	*74*	*74*	*0.07*
		SV 7.2 – Sedimentation/turbidity	*79*	*79*	
		SV 7.3 – Toxic Contamination	*92*	*92*	
		SV 7.4 – Temperature	*68*	*76*	
		SV 7.5 – Soil Chemistry and Redox	*76*	*82*	
		Variable 7 Score	*69*	*78*	
	Vegetation Structure and Complexity	*SV 8.1 – Tree Stratum Expected = 10%*	*55*	*65*	*0.16*
		SV 8.2 – Shrub Stratum Expected = 36%	*59*	*81*	
		SV 8.3 – Herb Stratum Expected = 72%	*62*	*72*	
		Variable 8 Score	*60*	*74*	
		Composite FCI	**72**	**78**	
		Grade	**C-**	**C+**	

Table 3. FACWet variable and sub-variable scores for the Vermillion Creek mitigation area, as well as an average of the regional and on-site references defined during the baseline assessment.

These FACWet scores are the basis for variable summary provided in **Fig. 3.** Explanation of the scoring rationale is provided in the relevant sections of this report text.

APPENDIX F

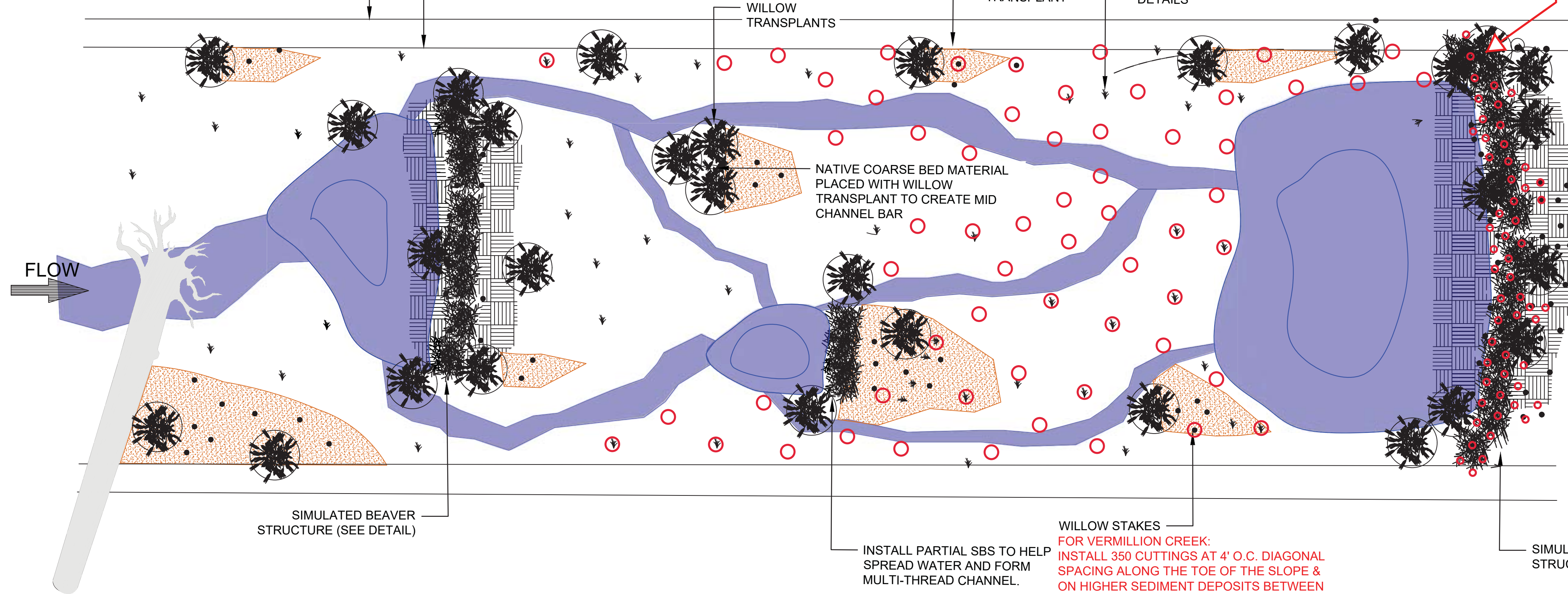
Willow Planting Layout Detail

NOTE: WILLOW (TRANSPLANTED CLUMPS & CUTTINGS) IN THE QUANTITY SPECIFIED ARE INTENDED TO COVER 40% OF THE ENTIRE WETLAND AREA, AND THEREFORE ONLY 40% OF THE AREA BETWEEN EACH SBS STRUCTURE. PLANTABLE AREAS BETWEEN EACH SBS WILL VARY DEPENDING ON FLOW & SEDIMENT DEPOSITION PATTERNS.

TYPICAL CHANNEL PLAN VIEW

NOT TO SCALE

FOR VERMILLION CREEK SBS:
INSTALL 70 WILLOW CUTTINGS PER SBS. (PLANT IN 2+ ROWS AT 1.0' O.C. DIAGONAL SPACING ALONG THE ENTIRE LENGTH OF THE SBS)
FOR LITTLE JOE SBS:
INSTALL 35 WILLOW CUTTINGS PER SBS. (PLANT IN 2+ ROWS AT 1.0' O.C. DIAGONAL SPACING ALONG THE ENTIRE LENGTH OF THE SBS)
USE ANY EXTRA CUTTINGS RANDOMLY NEAR EACH SBS AT 1' O.C. WHERE THERE IS SATURATED SOIL.



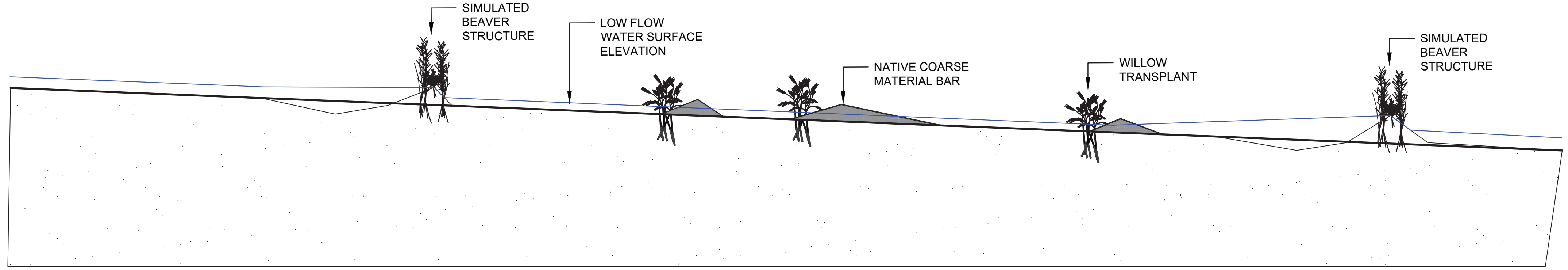
FOR VERMILLION CREEK:
INSTALL 350 CUTTINGS AT 4' O.C. DIAGONAL SPACING ALONG THE TOE OF THE SLOPE & ON HIGHER SEDIMENT DEPOSITS BETWEEN EACH SBS STRUCTURE (NOT IN ACTIVE CHANNELS OR STANDING WATER).

FOR LITTLE JOE:
INSTALL 80 CUTTINGS AT 4' O.C. DIAGONAL SPACING UPSTREAM EACH SBS STRUCTURE WHERE SOIL IS SATURATED.

IN LOCATIONS DIRECTED BY DESIGNER, WOOD AND PLANT MATERIALS FOR PARTIAL SBS TO BE STRATEGICALLY INSTALLED FOR GREATER PERSISTENCE TO ENCOURAGE LOCALLY LENGTHENED FLOW PATH FOR DIVERSITY.

TYPICAL CHANNEL PROFILE VIEW

NOT TO SCALE



TYPICAL CHANNEL CROSS SECTION DIMENSIONS

DIMENSION	PROPOSED RANGE OF DIMENSION
BOTTOM WIDTH (FT.)	30 - 42
TOP WIDTH (FT.)	50 - 80
CUT SIDE SLOPE (H:V)	2:1
DEPTH OF CUT (FT.)	3.2 - 7.5

TYPICAL CHANNEL NOTES:
1. NATIVE COARSE BED MATERIAL WILL BE SALVAGED AND STOCKPILED DURING MASS GRADING OF RESTORED CHANNEL. IT WILL THEN BE PLACED ALONG THE CHANNEL BOTTOM AS DIRECTED BY DESIGNER AFTER MASS GRADING IS COMPLETED.
2. EXISTING LARGE WOOD WILL BE SALVAGED AND REUSED IN THE CHANNEL AT THE DIRECTION OF THE DESIGNER.
3. ROUGHNESS ELEMENTS SUCH AS LARGE WOOD, TRANSPLANTS, SBS, AND NATIVE COARSE BED MATERIAL WILL BE INSTALLED INTO FINISHED CHANNEL AT THE DIRECTION OF THE DESIGNER.


EXAMPLE PHOTO 1: EXISTING CHANNEL WITHIN THE PROJECT REACH THAT SHOWS MULTI-THREAD CHANNEL WITH COARSE BARS AND VEGETATION THOUGHOUT CHANNEL BOTTOM


EXAMPLE PHOTO 2: NATIVE COARSE MATERIAL MID-CHANNEL BAR

VERMILLION CREEK AT DIAMOND PEAK RANCH WETLAND RESTORATION PROJECT

MOFFAT COUNTY, COLORADO

Stillwater Sciences

ecos ecosystem services LLC

PROJECT NUMBER: 880.00
SCALE: AS NOTED
DATE: 4/27/2023

DESIGN: JB/TS/RB
DRAWN: TS/EP/KE
CHECKED: TS/RB
APPROVED:

TYPICAL MAIN CHANNEL DETAIL

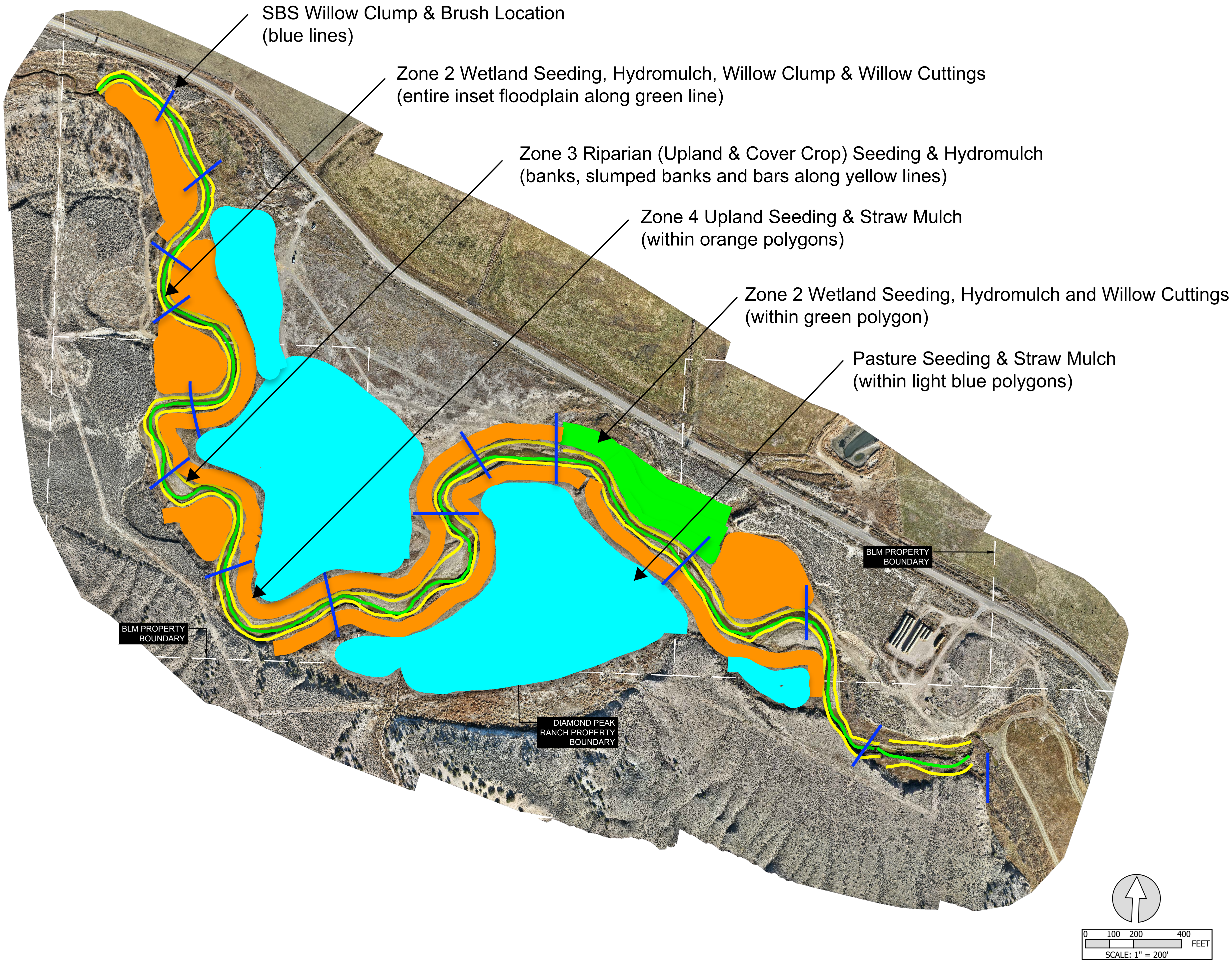
SHEET 27

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

C:\STILLWATER SCIENCES\880.00 VERMILLION CREEK – DOCUMENTS\CAD\PLANSET\REFERENCE\VERMILLION_TYP_CHAN_DETAIL.DWG LAST SAVED: 9/17/2021 PLOT DATE: 6/17/2022 PLOT STYLE: STILLWATER-GRAYSCALE-255

APPENDIX G

As-Built Seeding and Planting Map



VERMILLION CREEK AT DIAMOND PEAK RANCH WETLAND RESTORATION PROJECT

MOFFAT COUNTY, COLORADO

Stillwater Sciences

ecos ecosystem services LLC

AS-BUILT SEEDING & PLANTING PLAN

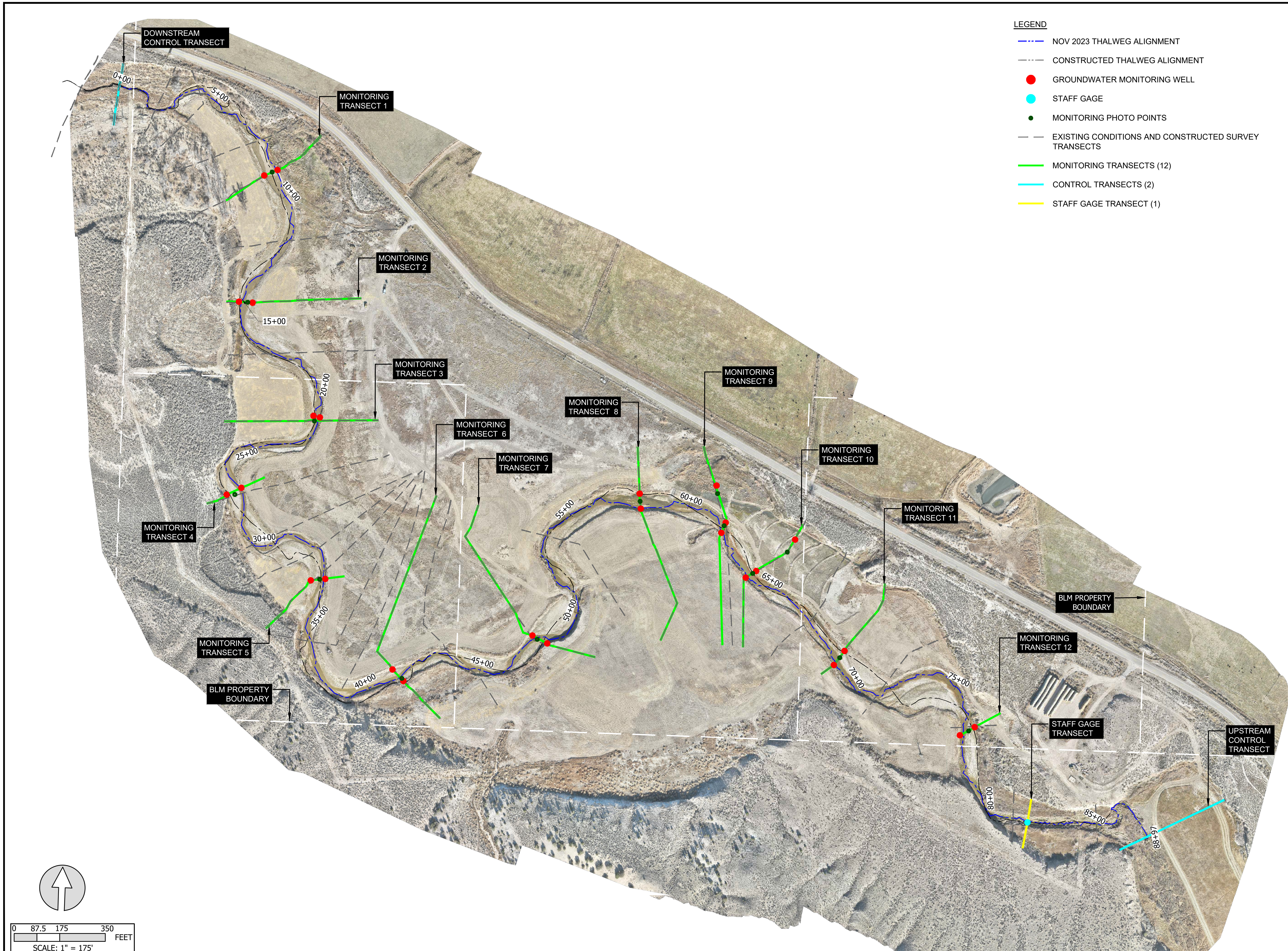
PROJECT NUMBER: 880.00
SCALE: AS NOTED
DATE: 11/27/23

DESIGN:
DRAWN:
CHECKED:
APPROVED:

SHEET

APPENDIX H

Monitoring Transect Location Map



VERMILLION CREEK AT DIAMOND PEAK RANCH WETLAND RESTORATION PROJECT

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Stillwater Sciences

ecos ecosystem services LLC

PROJECT NUMBER: 880.00

SCALE: AS NOTED

DATE: 11/27/23

DESIGN:

DRAWN:

CHECKED:

APPROVED:

MONITORING TRANSECT LOCATION MAP

SHEET 1