COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Water Plan

Water Project Summary

Name of Applicant	Headwaters Alliance
Name of Water Project	Project-01889 Lower Willow Creek Stream and Floodplain Restoration
Grant Request Amount	**$838,342.00**
Primary Category	$838,342.00
Watershed Restoration & Recreation	
Total Applicant Match	**$969,721.00**
Applicant Cash Match	$860,753.00
Applicant In-Kind Match	$108,968.00
Total Other Sources of Funding	**$994,321.00**
Lower Willow Creek Restoration Company	$101,800.00
Trout Unlimited Abandoned Mine Lands Program	$30,000.00
Lower Willow Creek Restoration Company	$23,468.00
City of Creede	$10,000.00
American Forest	$30,000.00
National Fish and Wildlife Foundation Restore Grant	$350,528.00
Headwaters Alliance	$24,600.00
Mineral County Fairgrounds Association	$5,000.00
US Homeland Security	$218,275.00
Colorado Water Conservation Board	$115,150.00
Navajo Development	$85,500.00
Total Project Cost	**$2,802,384.00**

Applicant & Grantee Information

Name of Grantee: Headwaters Alliance
Mailing Address: PO Box 518 Creede CO 81130
FEIN: 814,405,786

Organization Contact: Heather Greenwolf
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Grant Management Contact: Heather Greenwolf

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Grant Management Contact - Alternate: Randy McClure
Position/Title: President, Headwaters Alliance Board of Directors
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Engineering Contact: Aaron Sutherlin
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Description of Grantee/Applicant

Sole community-driven watershed organization in Mineral County, CO attending to legacy mining impacts in Willow Creek, the vital water quality and quantity issues at the mountain headwater of the Rio Grande, and providing high-quality stewardship education and information to our community - young and old, local and visitors in service to a climate resilient future.

Type of Eligible Entity

- ☐ Public (Government)
- ☐ Public (District)
- ☐ Public (Municipality)
- ☐ Ditch Company
- ☐ Private Incorporated
- ☐ Private Individual, Partnership, or Sole Proprietor
- ■ Non-governmental Organization
- ☐ Covered Entity
- ☐ Other

Category of Water Project

- ☐ Agricultural Projects
  Developing communications materials that specifically work with and educate the agricultural community on headwater restoration, identifying the state of the science of this type of work to assist agricultural users among others.
- ☐ Conservation & Land Use Planning
  Activities and projects that implement long-term strategies for conservation, land use, and drought planning.
- ☐ Engagement & Innovation Activities
  Activities and projects that support water education, outreach, and innovation efforts. Please fill out the Supplemental Application on the website.
- ■ Watershed Restoration & Recreation
  Projects that promote watershed health, environmental health, and recreation.
- ☐ Water Storage & Supply
  Projects that facilitate the development of additional storage, artificial aquifer recharge, and dredging existing reservoirs to restore the reservoirs' full decreed capacity and Multi-beneficial projects and those projects identified in basin implementation plans to address the water supply and demand gap.

Location of Water Project

Latitude	37.838672

Longitude	-106.922166
Lat Long Flag	Stream location: Coordinates based on general location on stream
Water Source	Willow Creek, Creede, Co. A tributary of Rio Grande.
Basins	Rio Grande
Counties	Mineral
Districts	20-Rio Grande

Water Project Overview

Major Water Use Type	Environmental
Subcategory	Construction
Scheduled Start Date - Design	11/1/2020
Scheduled Start Date - Construction	7/18/2022

Description

The Lower Willow Creek Stream and Floodplain Restoration Project will implement a single restoration design for the ecological reach called Lower Willow Creek, a tributary of the Rio Grande Watershed. This funding request will support Phase 1 and 2 (defined elsewhere) construction for stream restoration, designed by Matrix Design Group, that arose out of the multi-partner/funder - including CWCB, Comprehensive Willow Creek Watershed Planning Project.

While the full project attends to the full 9000ft of the reach, from the terminus of the concrete flume through Creede to the Rio Grande (see maps in the Appendix), this project seeks funding to support construction and revegetation of the upper 6,600 feet of the creek, spanning 4 properties and 137 acres in 2 Phases. Project outcomes include reconnecting floodplain, re-establishing native riparian vegetation, restoring stream geomorphology suitable for increased aquatic species habitat, including 13 acres of wetland restoration. While the project sits squarely within the Environment and Recreation category, it will also meet many of the goals found in Conservation and Land Use Planning, and will maximize water education and outreach criteria.

Measurable Results

	New Storage Created (acre-feet)
	New Annual Water Supplies Developed or Conserved (acre-feet), Consumptive or Nonconsumptive
	Existing Storage Preserved or Enhanced (acre-feet)
	New Storage Created (acre-feet)
6,600	Length of Stream Restored or Protected (linear feet)
	Efficiency Savings (dollars/year)
	Efficiency Savings (acre-feet/year)
137	Area of Restored or Preserved Habitat (acres)
	Quantity of Water Shared through Alternative Transfer Mechanisms or water sharing agreement (acre-feet)
	Number of Coloradans Impacted by Incorporating Water-Saving Actions into Land Use Planning
17,500	Number of Coloradans Impacted by Engagement Activity

Water Project Justification

The Lower Willow Creek Stream and Floodplain Restoration Project meets or exceeds multiple goals and objectives identified in the Colorado Water Plan, Technical Update, and newly revised 2020 Rio Grande Basin Implementation Plan, as well as alignment with Colorado Parks and Wildlife goals, as noted below:

Key environmental objectives that align with Colorado Water Plan goals include:

* Riparian restoration including revegetation and stream stabilization (CWP, 2015, p. 7-4).
* Flood mitigation and preparedness through a reconnected, functioning floodplain (CWP, 2015, p. 7-16).
* Enhancing water quality through wetland filtration, vegetation, and slowed flood waters (CWP, 2015, p. 7-31).
* Improving the economic value of recreation along the Willow Creek Corridor, most notably fishing, through revegetation, habitat creation, and stream stabilization (CWP, 2015, p. 6-157).

Collaborative practices that align with Colorado Water Plan goals include:
* Headwaters Alliance engaged in numerous outreach efforts addressing multiple needs with public and private stakeholders including a community review of the 60% engineering design, recreation and economic development concept maps, community meetings, and individual meetings with landowners of the project area (Colorado Water Plan, 2015, p. 9-43).
* HWA's Comprehensive Willow Creek Watershed Planning Project prioritizes engagement with a diverse set of local and regional stakeholders which aligns with the CWP goal of establishing a master plan and watershed coalition (CWP, 2015, p. 7-3).
* A variety of education efforts have focused on informing residents, visitors, and stakeholders about ecosystem function, floods, climate change, and water quality (CWP, 2015, p. 9-53).
* This project falls within the Comprehensive Willow Creek Watershed Planning Project which acknowledges the connection between forest health, water quantity and quality, socio-environmental wellbeing, and overall watershed health. As a result, the project is in accordance with the CWP goal of demonstrating sustainability (CWP, 2015, p. 9-44) and developing a stream management plan (CWP, 2015, p. 6-168).

Key activities that align with CWCB 2019 Colorado Water Plan Analysis Technical Update include:
* Stream bank stabilization, intensive revegetation and soil improvement efforts will enable the floodplain project to mitigate the effects of warmer and drier temperatures in summer months and improve habitat for cold-water fish species, notably trout as well as ensure the stability of the floodplain ecosystem (CWP Analysis and Technical Update, 2019, p. 124 and p. 134).
* The Willow Creek Inventory, by HWA, catalogues all past reports and materials related to Willow Creek and identifies and prioritizes risks and mitigation measures. It was created as part of the CWCB Comprehensive Willow Creek Watershed Planning project to facilitate the dissemination and use of Best Current Data across and between organizations and projects. The risks identified mirror the Colorado Water Plan Analysis and Technical Update, emphasizing the importance of planning for an uncertain future and consideration of climate change (CWP Analysis and Technical Update, 2019, p. xviii). Additionally, The Willow Creek Inventory identifies and acknowledges the specific climate-related risks to the Rio Grande Basin, including changes in mid- and late-summer streamflow, earlier peak runoff timing, and risk to cold water fish in summer months (CWP Analysis and Technical Update, 2019, p. 124-125).

Revised DRAFT, Rio Grande Basin Implementation Plan, Volume 2, 2022:
* The Willow Creek Stream and Floodplain Restoration Project is included in the newly revised Rio Grande Basin Implementation Plan, 2022 (RG-BIP, Draft, Volume 2, 2022).
* More specifically, this project addresses three out of the five of the new RG-BIP goals RG-BIP, Draft, Volume 2, 2022, pg 53):
* Healthy watersheds that provide critical ecosystem services, are resilient to disturbances, and benefit from ongoing efforts to protect water sources, improve water quality, enhance aquatic, riparian, wetland, and upland habitat, and maintain connected ecosystems.
* Vibrant and resilient agriculture, recreation, municipal, and industrial economies that support thriving communities.
* Engaged and informed citizens who understand the scope and urgency of local, state, and regional water issues and participate in robust and diverse educational opportunities.

Key actions that align with Colorado Parks and Wildlife goals include:
* The project location sits at the convergence of numerous flora and fauna communities. Restoring habitat on the floodplain will directly improve habitat conditions and connect adjacent habitat areas. Restoration activities include building soil, planting willows and native grasses, planting trees, creating and improving wetlands, and leveraging irrigation to ensure long-term survival. These activities are expected to improve habitat for mule deer, elk, moose, bighorn sheep, and many bird species (e.g. waterfowl, Bald Eagle, Golden Eagle, Brewer Sparrow, Cassin Finch, Northern Goshawk, Rufous Hummingbird), which directly addresses CPW's goal to "conserve wildlife and habitat to ensure healthy sustainable populations and ecosystems" (CPW, 2015).
* According to Colorado Parks and Wildlife, the project area is within one of the Waterfowl Conservation Priority Areas (CPW, 2011). Riparian and wetland features directly provide habitat for waterfowl.
* The project area falls within the severe winter range for elk and mule deer as well as the winter range for moose. Severe winter range is defined by CPW as "part of the overall range where 90% of the individuals are located when the annual snowpack is at its maximum and/or temperatures are at a minimum in the two worst winters out of ten," (CPW, 2020). The winter range is defined as, "part of the overall range where 90% of the individuals are located during the average five winters out of ten from the first heavy snowfall to spring green-up, or during a site specific period of winter," (CPW, 2020). The northern half of the project area (~137 acres) falls within the winter range for bighorn sheep. See attached map.

Related Studies

* 60% Design Plans Lo Willow Creek Floodplain, by Matrix Design Group. See Appendix.
* LWC Draft Technical Memo_60%_revised_8.16.2021 by Matrix Design Group. See Appendix.
* Memo – Design Review for Lower Willow Creek Floodplain Restoration, Chris Sturm, CWCB Watershed Protection Director.
* CHAMP Phase III, Mineral County, Colorado, Hydrologic Analyses Report (2019).
* Hydrologic Analysis of Rio Grande. (2020). Wood Environment and Infrastructure Solutions, Inc.
* Rio Grande Floodway Map, Wood Environment and Infrastructure Solutions, Inc. CWCB. 2021
* Letter of Map Revision for Willow Creek, submitted by Wood Environment and Infrastructure Solutions, Inc., 2021.
* Willow Creek Inventory, by Headwaters Alliance, including access to the Willow Creek Library (https://headwatersalliance.com/willowcreek-watershed-plan-inventory/)
* Colorado Water Plan, 2015
* CWCB 2019 Colorado Water Plan Analysis Technical Update
* Rio Grande Basin Implementation Plan, Volume 2, 2022

Taxpayer Bill of Rights

It is our best understanding, that no conflict with TABOR issues related to our organization or projects.

Budget and Schedule

This Statement of Work shall be accompanied by a combined Budget and Schedule that reflects the Tasks identified in the Statement of Work and shall be submitted to CWCB in excel format.

Reporting Requirements

Progress Reports: The applicant shall provide the CWCB a progress report every 6 months, beginning from the date of issuance of a purchase order, or the execution of a contract. The progress report shall describe the status of the tasks identified in the statement of work, including a description of any major issues that have occurred and any corrective action taken to address these issues.

Final Report: At completion of the project, the applicant shall provide the CWCB a Final Report on the applicant's letterhead that: (1) Summarizes the project and how the project was completed. (2) Describes any obstacles encountered, and how these obstacles were overcome. (3) Confirms that all matching commitments have been fulfilled. (4) Includes photographs, summaries of meetings and engineering reports/designs. The CWCB will pay out the last 10% of the budget when the Final Report is completed to the satisfaction of CWCB staff. Once the Final Report has been accepted, and final payment has been issued, the purchase order or grant will be closed without any further payment.

Payment

Payment will be made based on actual expenditures and must include invoices for all work completed. The request for payment must include a description of the work accomplished by task, an estimate of the percent completion for individual tasks and the entire Project in relation to the percentage of budget spent, identification of any major issues, and proposed or implemented corrective actions. Costs incurred prior to the effective date of this contract are not reimbursable. The last 10% of the entire grant will be paid out when the final deliverable has been received. All products, data and information developed as a result of this contract must be provided to as part of the project documentation.

Performance Measures

Performance measures for this contract shall include the following: (a) Performance standards and evaluation: Grantee will produce detailed deliverables for each task as specified. Grantee shall maintain receipts for all project expenses and documentation of the minimum in-kind contributions (if applicable) per the budget in the Budget & Schedule Exhibit B. Per Water Plan Grant Guidelines, the CWCB will pay out the last 10% of the budget when the Final Report is completed to the satisfaction of CWCB staff. Once the Final Report has been accepted, and final payment has been issued, the purchase order or grant will be closed without any further payment. (b) Accountability: Per Water Plan Grant Guidelines full documentation of project progress must be submitted with each invoice for reimbursement. Grantee must confirm that all grant conditions have been complied with on each invoice. In addition, per Water Plan Grant Guidelines, Progress Reports must be submitted at least once every 6 months. A Final Report must be submitted and approved before final project payment. (c) Monitoring Requirements: Grantee is responsible for ongoing monitoring of project progress per Exhibit A. Progress shall be detailed in each invoice and in each Progress Report, as detailed above. Additional inspections or field consultations will be arranged as may be necessary. (d) Noncompliance Resolution: Payment will be withheld if grantee is not current on all grant conditions. Flagrant disregard for grant conditions will result in a stop work order and cancellation of the Grant Agreement.

Last Updated: May 2021

Colorado Water Conservation Board
Water Plan Grant – Statement of Work – Exhibit A

Statement Of Work	
Date:	**December 1, 2021**
Name of Grantee:	**Headwaters Alliance, Creede, CO**
Name of Water Project:	**Lower Willow Creek Stream and Floodplain Restoration**
Funding Source:	**CWCB, NFWF, Homeland Security, Trout Unlimited, City of Creede, American Forest and others.**

Water Project Overview

This project, *The Lower Willow Creek Stream and Floodplain Restoration Project*, embodies the complex history of anthropogenic impacts – both past and present while reaching to address the myriad of currently pressing environmental issues such as changing climate, flood, fire and drought and more. At the simplest level, we are seeking funding to implement Phase 1 & 2 construction for stream restoration per the well-considered and vetted design by Aaron Sutherlin, PE, Matrix Design Group.

We have a vision for the lower Willow Creek floodplain - and it hits at the heart of all the beautifully poetic and absolutely vital goals related to everything WATER! Let's take a quick tour of where we started, where we are going, and most importantly - why it matters.

The starting point (in a nutshell): Sitting within the heart of the Historic Creede Mining District and flowing through the center of the City of Creede, Willow Creek was used and abused during 95 years of active mining - this included moving the creek multiple times, using the creek as dumping ground and passage for waste materials, and more. When mining ended in 1987, Willow Creek became the focal point for a new range of activities including community-led reclamation work from legacy mining impacts, to ongoing attention at the Nelson Tunnel Commodore Waste Rock Superfund due to the 300 gallons per minute (GPM) of acid mine drainage that continually enters the Creek, and more recently as a busy corridor for recreationalists of all types.

A bit of transitional history: 1997 brought together a truly phenomenal group of residents at the request of City and County government to provide counsel on how to best respond to the many legacy mining impacts within the watershed. This group became the ad hoc volunteer organization known as the Willow Creek Reclamation Committee (WCRC). In the words of long-time WCRC president, Zeke Ward: "We told CDPHE that we wanted them to give us the opportunity to implement local solutions for Willow Creek. We told them, 'We won't do it the same as you would, we will start from the top of the watershed and work our way down, but we will do it for less money and in good time." And with that, 25 years of community-led reclamation work was begun that HWA continues to carry on to this day.

Like the WCRC, Headwaters Alliance also adopted an integrated view of projects within the Willow Creek watershed, particularly in the aftermath of the high-water 2019 Spring runoff event that caused significant damage to the then-newly restored lower Willow Creek floodplain. In fact, it was the combination of flood risk to sensitive surrounding infrastructure on the lower floodplain (i.e. Emperius Tailings Pile, City of Creede's sewer line and ponds, and water right diversions), the frustration by floodplain landowners at the lack of integrated response for high-water events, and ongoing partner project with CWCB's Flood Protection Program to submit a Letter of Map Revision to FEMA for Willow Creek that catalyzed our next step.

Thus HWA, with the stellar partnership of Trout Unlimited, initiated the *Comprehensive Willow Creek Watershed Planning Project* (*The Plan*). A multi-partner, multi-funder project (City of Creede, Mineral County, Rio Grande Water Conservation District, Rio Grande Basin Roundtable, National Fish and Wildlife, American Forest and others), with CWCB as our largest funder. We are proud to state that we will have completed all objectives ahead of schedule and within the project period, ending March 2022. Central to *The Plan* is the concept of <u>comprehensive</u>, as a deep dedication to both the understanding and the practice that everything is connected in one way or another; that it is our responsibility to make as many connections visible and accessible as possible, to share this information with all possible stakeholders, and to practice what we preach. *The Lower Willow Creek Stream and Floodplain Restoration Project* embodies the practical and principled objectives that represent comprehensive and collaborative action.

Statement of work: A central objective of *The Plan* was acquiring a design for Stream and Floodplain Restoration of the lower Willow Creek Floodplain. We released a RFP with clearly articulated criteria to reflect the multiple needs of the varied land owners, while squarely prioritizing the ecological function of the site - as a connected floodplain, important riparian zone for habitat and the potential for passive water quality improvement, as well as a beloved community recreational site and connective corridor between outlying neighborhoods and the City of Creede. Six excellent submissions were evaluated by community and expert reviewers; Matrix Design Group was selected. Over the course of the past year, Matrix has worked diligently to provide a design that met all the articulated criteria and that listened and responded to the rigorous community review process unique to a small town. Indeed the design we are seeking to construct reflects the outcomes of this process perfectly.

At this time we are seeking funds to support implementation of the Matrix Design Group design for stream and floodplain restoration in three phases as follows:

- <u>Phase 1</u>: Station 93+43 to Station 54+00. By landmarks, and moving upstream to downstream, the flume terminus to immediately below the Wason head gate diversion. Restoration of this section will utilize Matrix's design, in detail, as is. We are currently moving the 60% draft Design (attached as part of proposal) to a Final, engineer stamped version for this entire reach given the necessary flume modifications. The Matrix design meets all original criteria, providing energy dissipation at the flume, a stable single-thread channel within the flood-prone zone area adequate to handling a 100-yr high water event, and thereby protecting sensitive infrastructure.

- <u>Phase 2</u>: Station 54+00 to Station 27+00. By landmarks – from just below the engineering feature at Wason head gate diversion to a proposed meander bend lower downstream. This section of the Creek demonstrates the benefits of high-water events on floodplains. In the two-years since the 2019 high-water event, soil and seed dispersion resulted in lush grasses and stunningly verdant willow recruitment across the braided width of the flood-prone area. This area is naturally topographically constrained, bringing the creek back into a single channel as it passes under "JB's Bridge". After a series of thoughtful discussions with various stakeholders and site visits by both Matrix and lead project partner Jason Willis, PE, Trout Unlimited, it was decided to adopt a "watch and wait" approach with this reach, as it currently represents ideal floodplain conditions which require no remedy. With that said, there is an experimental quality to transitioning from the engineered single stream in Phase 1 to the natural conditions of the Phase 2 reach. As such, we will establish a framework for observation and monitoring, with the goals of (1) qualifying and quantifying what is and is not working related to vegetation islands in naturally restoring areas; (2) better understanding the potential improvements to water quality due to native vegetation recruitment; (3) the interaction between designed and natural spaces; (4) enacting rich stewardship programming via onsite environmental education, volunteer opportunities, and more.

- Phase 3: Station 27+00 to Station 0+00. By landmarks – from Station 27+00 to the confluence with the Rio Grande. We will be assiduously working to finalize a Phase 3 as part of this project. This will require the full arsenal of state, regional and local collaborators to arrive at a design that balances the private landowner's preferences and rights, the complex interaction between recent structural changes on the Rio Grande directly surrounding the confluence with Willow Creek - particularly as related to the newly revised Rio Grande Floodway mapping, and water-smart design. This is a challenging and worthwhile endeavor that will require patience, environmental education, collaboration, negotiation savvy and stalwart persistence.

Why it matters: Stream and floodplain restoration of lower Willow Creek will achieve many worthy top-tier goals as articulated throughout this document. These reasons alone – flood mitigation, increased habitat, riparian restoration – make this project important and worthwhile. Add on the potential for making incremental improvements to water quality in Willow Creek before it enters the Rio Grande – the lifeblood river of the Desert Southwest, and we have more than a responsibility, but an obligation to do better wherever we can given a changing climate and limited water resources.

Indeed, we have a vision for the lower Willow Creek floodplain. We envision this site as becoming a conserved, public park and a living, outdoor classroom; providing ongoing education regarding the length of time for land and water to heal from abusive environmental practices and the exquisite and complex manner in which land and water do heal; a science lab for students, residents, visitors and volunteers alike to have direct hands-on experiences planting willows, removing trash, observing and monitoring changes in plant and animal populations and more; an opportunity to attempt at water quality improvements to benefit aquatic species. We are already exploring partnerships for deeper site-specific research with University of Colorado School of Public Health, Western Colorado University, Adams State University and Creede Schools to experiment with various soil building techniques including the potential for carbon sequestration, to better articulate environmental-human health interactions, to advocate for all actions that protect that vital water quantity and quality at the mountain headwaters of the Rio Grande.

Additionally, we are in evolving discussion with both Wason Ranch and Rio Grande Headwaters Land Trust about the possibility of Wason donating their portion of the floodplain for public use, permanently conserving another 140 acres on the Rio Grande.

HWA founder, Guinevere Nelson, wrote, " Our work will inspire stewardship in the hearts of every citizen and visitor such that the ecological integrity of the area is protected from profligate action, with the understanding that environmental and economic sustainability and resiliency can be mutually compatible." This is our vision, and we believe implementing construction on the lower Willow Creek floodplain will empower this work.

<u>Project Objectives</u>

Project objectives are direct:

1. Construct Phase 1 Stream and Floodplain Restoration of Willow Creek per the Matrix design once all necessary permits in place, using leadership of a highly qualified Contractor and the stellar project partner team of HWA, Trout Unlimited (TU), Matrix with stakeholder engagement by City of Creede, floodplain property owners, community others and other regional and state entities. The end objective for Phase 1 will be a tangible 3,943 linear feet of new and restored stream channel and stable floodplain.
2. Initiate a long-term intensive vegetation plan for Phase 2 of the lower Willow Creek floodplain that will result significantly increase vegetation density across a 12 acre wetland area and 2,000LF of stream channel.
3. Develop and implement a thoughtful observation and monitoring plan for the entire reach of the lower Willow Creek floodplain to facilitate high-quality science, quantifying successes and challenges, and ensuring collaborative access by other researchers, students and community members.
4. Finalize the design for Phase 3 of the lower Willow Creek floodplain via an open, collaborative process to meet ecological criteria, to minimize risks from high-flow events both on Willow Creek and at the confluence of Rio Grande, and protect human health and infrastructure from damages, with the intent of beginning construction in 2023.
5. Provide effective community engagement and education programming in relation to all facets of this project to inspire stewardship and best environmental, water conscious practices in residents, volunteers and participants.

Tasks
Task 1 –Design Finalization, Permitting, and Materials Acquisition

Description of Task:
Task 1 includes the myriad of post-design/pre-construction activities that will enable a smooth, efficient, well-oiled construction process. This will include moving design from 60% to Final status for Phase 1; identifying and obtaining all necessary permits/fees for Phase 1 and Phase 2; resourcefully acquiring local building materials including rocks and root wads, trees, and willows within the informal economy of low-resource frontier communities; finalizing Phase 3 concepts and design with landowners to meet ecological criteria that will allow for construction in 2023; and other related pre-construction tasks.

It should be noted that the majority of project management time required to complete Task 1 is included in Task 4 - Project Management. The costs outlined in Task 1 either reflect match contributions and/or fees/unit costs to accomplish specific sub-tasks .

Method/Procedure:

1. Headwaters Alliance (HWA) will work with Phase 1 property owners, City of Creede and Lower Willow Creek Restoration Company (LWCRCo) and Matrix Design Group (Matrix) to bring Phase 1 to Final Stamped drawings, defined as Station 54+00 to Station 93+43.
2. HWA, with support by Trout Unlimited (TU), will obtain all necessary permits from US Army Corps of Engineers, CDPHE and County for Phase 1 and Phase 2 construction, including NWP 27, Groundwater, Traffic Control and other documents to satisfy the existing Voluntary Cleanup Plan on the LWCRCo parcel. At this time, we do not anticipate requiring any permits for Phase 2. Permit fees to procure these permits are the budgetary line items listed under this Task.
3. HWA will utilize local relationships and knowledge, as well as the larger regional network of established organizations to resourcefully secure building materials. More directly stated, we are scouring for large rocks and hope to utilize only local trees for this project. Ample opportunities exist locally for trees given various forest health projects.
4. HWA will continue to work with all Phase 3 property owners, defined as Station 0+00 to Station 27+00, including Mountain Views RV Resort and Wason Ranch to finalize design.

Deliverable:

1. Partner approved, Final, engineer stamped design for Phase 1, Station 54+00 to Station 93+43.
2. All necessary permits in place to support Phase 1 & 2 construction activities.
3. Finalize the design for Phase 3 of the lower Willow Creek floodplain to meet ecological criteria, to minimize risks from high-flow events both on Willow Creek and at the confluence of Rio Grande, and protect human health and infrastructure from damages.
4. Obtain as many local materials for construction as possible in an effort to reduce overall cost, to maximize use of local resources and businesses, and reduce carbon footprint involved in long-distance acquisition.

Tasks
Task 2 – Construction – Phase 1, Station 93+43 to Station 54+00

Description of Task:
The work begins! Task 2 will focus on flume modifications and stream channel/floodplain construction activities beginning at Station 93+43 and working downstream to Station 54+00. This 3,943 linear feet (LF) of channel work will fall under what project partners consider Phase one of three that will eventually confluence with the Rio Grande at the downstream terminus. For the purpose of this grant, project partners will be concentrating on construction of Phase 1 as to provide a more-tangible outcome and measurable result. All station locations and channel features can be referenced in the attached Matrix Design Group design and associated Engineer's Estimate.

Within this Task, construction activities will have two primary focal points, (1) straightening the current outlet of the flume to facilitate energy dissipation during climate-driven high flows, and (2) establishment of a functioning stream channel and connected floodplain that will facilitate native vegetation growth for long-term stability. The rationale behind the design associated this this Task is to protect key surrounding infrastructure (i.e. Emperius Tailings Pile, City of Creede sewer lines and ponds, water rights) before allowing for implementation of a more natural channel approach in subsequent Phase 2 and 3 actions.

Along the 3,943 LF of stream channel, construction activities will include Best Management Practices (BMPs) for stream stabilization such as: bank protection through installation of toe wood, soil lifts, brush layers, and riprap, rock cross vanes, floodplain sills, drop structures, rough grading and excavation, and riparian/upland plantings. Where applicable, large willow clumps will be imported or sourced locally to provide immediate stability along the reach. The 60% design, Technical Memo and associated Engineer's Estimate are found in the Appendix and should be referenced throughout this Task and subsequent sections for specific unit costs, locations, and quantities.

Method/Procedure:
It should be noted that project management time required to complete Task 2 is broken down under Task 4 - Project Management. The only costs proposed for Task 2 are associated with on-the-ground construction costs.

1. HWA and TU will work with the Engineer of record (EOR), Matrix Design Group, during Task 2 to ensure design elements are implemented correctly and according to permits procured under Task 1. It is estimated that the construction timeline for Task 2 will take place over the course of four months with work finishing up by early to mid-November. A bulk of the project management funding being requested in Task 4 will be applied towards this Task via the procurement and oversight aspects.
2. To accomplish construction activities, directives will be given to the selected contractor to begin construction activities at the current outlet of the flume (Station 93+43) and work downstream to Station 54+00. Surveying, staking, and flagging will take place along this section prior to excavation.
3. By cutting off the end of the flume slightly upstream of its current terminus, the current bend and failure point of the 2019 flood, will be eliminated. Work for Task 2 will begin by installing a grouted drop structure to maintain connectivity to the concrete flume outlet, while also providing energy dissipation. An end sill will also be installed slightly downstream of this feature to provide bank stability across the flood prone area.

4. Moving downstream of the new flume outlet, the contractor will begin excavation of the new channel alignment while simultaneously rough grading this material into the former Lower Willow Creek stream channel.
    - It should be noted that Lower Willow Creek will be dewatered and managed throughout the new channel construction to allow for rainfall events.
5. At approximate stations 91+00 and 89+00, two large cross vanes and floodplain sills will be installed to span freshly graded floodplain soils, while also providing grade control and an added level of stability before native vegetation has time to establish.
6. Moving downstream to station 88+00 and through end of the project reach at 54+00, the contractor will install a mixture of 10 cross vanes, 675 LF of toe wood/soil lift bank protection, 1,585 LF of soil lift/riprap bank protection, one headgate structure, and rough grade approximately 6,530 CY of imported and local floodplain material.
7. While this Task will incorporate several hundred feet of new channel construction and flume modifications, it will also stabilize several thousand feet of existing channel that was cut during the 2019 flood. Along these segments project partners and selected contractor will focus on "softer" bank protections where possible in between where flood response emergency actions took place following the 2019 flood. By tying this upcoming construction work with 2019 emergency actions, partners will protect the $50k investment already completed with partial funding from CDPHE and LWCRCo.
8. Project partners will complete 3,943 LF of stream restoration over the course of four months of construction and will tie into downstream Phase 2 stream actions described later in Task 3. The connection point between the two Phases will be downstream of essential diversion points where a more natural system can exist.

Deliverable:

1. Complete 3,943 LF of stream and floodplain restoration on Lower Willow Creek that translates to improved riparian and upland habitat. This work also will contain attributes of a multi-stakeholder project including collaboration between private landowners, city officials, non-profit organizations, State/Federal agencies, and private entities.
    - Not only has HWA shown significant stakeholder engagement through the planning phases of this project, a continued community transparency will be maintained through the construction phase and subsequent planning for Phase 3.
2. Specific deliverables contained within the 3,943 LF of stream and floodplain restoration associated with CWCB funds will be installation of two cross vanes with floodplain sills, 10 cross vanes, 675 LF of soil lift/toe wood bank protection, 1,585 LF of soil lift/riprap bank protection, one headgate structure, and rough grading of approximately 6,530 CY of imported local floodplain material.
3. Another deliverable will be a more stable system at the beginning of the reach. The flume in its current alignment with respect to the valley requires a substantial turn where failure and avulsion has occurred in the past. By cutting off the bend in the flume and constructing the downstream channel portion, partners are reducing risk and significant erosion that could result from future flooding, post-fire flooding, or other episodic climate events.
4. Incorporation of two Agricultural ditches as part of a greater environmental and recreation project. Collaboration between two separate ditch holders will result in sustainable connection between proposed Lower Willow Creek stream channel work, and existing ditch rights (Wason and Fairgrounds). The Fairgrounds ditch was disconnected during 2019 flooding so will be re-established as part of this project. Both ditches will be sustainably connected to reduce future O&M.

Tasks
Task 3 – Phase 2 - Intensive Revegetation

Description of Task:
One of the many exciting design revisions to come out of the community review process was the collaborative decision by HWA, TU and Matrix, with support from LWCRCo, MCFA and Chris Sturm, to articulate an active plan for observation and monitoring of the middle third of the WC reach - defined as Phase 2; Station 54+00 to Station 27+00. The plan will allow for this 2,700 LF section to continue to regenerate itself through a natural ecological process that has already begun, as evidenced by natural recruitment of wetland and riparian vegetation across the braided channel network.

This decision was reached after observing the effect that two growing seasons had on this particular segment of Lower Willow Creek. Optimal growing conditions were facilitated by redistribution of riparian grasses and a natural seed-bank following the 2019 high-water event, along with substantial recruitment of willows throughout. While this section has some braiding, it is naturally topographically constrained, being directed back into a single stream channel as it passes under "JB's Bridge", close to Station 41+75, which will not compromise the final design of Phase 3 (Station 0+00 to Station 27+00).

Another part of the rationale with a more-natural approach to this section was that it does not pose any flood risk to surrounding infrastructure other than the potential for being inundated itself during a high-flow event. Unlike the up and downstream reaches that need more engineering controls, the Phase 2 segment was determined to be a reasonable risk for natural channel conditions. The result of two-years of growth emphasizes that natural revegetation is a viable alternative to hard engineering controls, where applicable. Project partners, through collaborative on-site meetings, have also recognized that significant cost savings can take place by more passive treatments along the Phase 2 segment. As such, Phase 2 work will be focused on intensive revegetation with large clump willows, native riparian grasses, sedges and other wetlands species sited on vegetation "islands" that naturally exist between various braided channels.

Ongoing observation and monitoring should offer insight into best solutions for this site and the potential for balancing well-engineered stream systems with natural processes. Additionally, this approach represents collaborative decision making about where precision water-project dollars are best spent.

Method/Procedure:
1. Revegetation Activities
    a. Partnering with American Forest, HWA will plant a minimum of 140 large clump Willows in both 2022 and 2023.
    b. Given the success of the various riparian grasses, notable Red Top which is in short supply due to the regional increase in fires, HWA will harvest seed stock to be planted on site.
    c. Install repeatable vegetation plots where percent cover can be evaluated in riparian and upland vegetation zones along Phase 2.
    d. During construction, project partners will direct the contractor to certain barren areas where locally sourced fertilizer and biochar should be ripped into the soils. These amendments will facilitate native vegetative growth in the nutrient-deprived soils.

2. Community Engagement
    a. Through organized activities, HWA will utilize community members, volunteers, and other local non-profit partners to plant willow cuttings, riparian plants, upland trees, and apply native seed along the 2,700 LF segment of Phase 2. This is a favored activity by many long-term and new volunteers and we look forward to educational opportunity this provides.
3. Monitoring Activities.
    a. Tagging and monitoring 3 different Willow species with ongoing quarterly observation.
    b. Complete vegetation diversity surveys within established vegetation plots, particularly related to soil amendments.
    c. Expanded water quality sampling to determine impact on water quality by increased coverage of native vegetation.

Deliverable:
1. Dense revegetation of up to 12 acres of braided wetlands zone and along 2,700 LF of stream channel.
2. Soil improvements via use of local fertilizer, biochar, willow clumps, and native seed.
3. Establishment of monitoring locations and repeatable data that will ultimately show measurable changes in water quality and environmental health of the area. These data will be essential to future projects where a changing climate and watershed resiliency are paramount.
4. Involved volunteers and residents inspired by the beneficial impacts to the site, water quality, habitat improvement and climate resilience through revegetation efforts.

Tasks
Task 4 – Project Management

Description of Task:
HWA and TU will co-facilitate and divide project management duties throughout the life of this grant. One of the main criteria noted in the grant guidance was whether the applicant establishes the fiscal and technical feasibility of the project. To ensure effective project management and technical oversight occurs during all Tasks, HWA and TU will divide and conquer duties as articulated in this Task. The proposed cost structure has been organized to meet the myriad of complex needs involved in a a project of this scope, and with as many stakeholders. Collaboration takes time.

HWA and TU have a long history of collaborating in the upper Rio Grande watershed and will continue to do so throughout this project. HWA brings several important aspects to the project such as a local knowledge and relationship with key stakeholders, intimate knowledge of the watershed and its properties, efficiency in managing multiple grants, project management, and a drive to bring stakeholders together and get work done on-the-ground. As a partner, TU brings almost a decade of experience when it comes to riverine systems, contractor procurement, design, and construction oversight that will provide balance to help achieve the final deliverables. The unique organizational and individual strengths of HWA and TU offer an ideal example of a national organization genuinely empowering and amplifying the capacity of a small, community-driven local non-profit to implement excellent work.

Method/Procedure:
HWA and TU have divided project management duties into categories that ideally result in a successful project. For example, these include:

- Monthly Meetings and Stakeholder Engagement
- Secure Permits and permit maintenance
- Contractor Bid Process and Procurement
- Material Generation
- Phase 1 Construction Management
- Phase 2 Revegetation Activities
- Volunteer and Stewardship Programming
- Grant Administration, Invoicing, and Reporting

By continually involving the community throughout every phase of this project, and working to secure necessary permits, project partners will ensure a smooth transition to the construction phase that is the focus of both Task 1 measurable outcomes and Task 2 construction. Prior to construction, HWA and TU will work to develop a request for proposal (RFP) based on the finalized design quantities and submit this document for competitive bidding to a prequalified list of heavy equipment contractors. Project partners will review bids and select a contractor through a standardized ranking system. Following selection, a contract will be procured that will ultimately drive the implementation of the final design. The biggest line items with regards to project management will be construction oversight given its anticipated duration. HWA and TU will combine efforts to effectively manage the selected construction contractor in tandem with Matrix design engineer. This will ensure that a project representative is on-site most days to answer questions, and direct the construction contractor when field decisions need to be made. Field decisions are an important part of construction and can have a meaningful impact on the success of the end product. Construction management will undoubtedly be a major asset when Task 2 actions are underway. Given the scope and size of this proposed project, significant time and resources will be necessary to efficiently manage grant duties, track costs, submit invoices, and compile periodic reports. HWA and TU will use their combined experience managing past grants from Federal, State, and local entities to ensure grant obligations are being met.

Deliverable:

1. An informed, engaged and participatory local community
2. Completion of necessary permits to being construction
3. Development of an RFP, completion of a pre-bid meeting, and competitive bidding process
4. Selection of construction contractor and subsequent contract development
5. Efficient construction management and documentation of work progress
6. Completion of grant deliverables, invoice submission, and necessary status report.
7. Successful implementation of 3,943 LF of stream and floodplain restoration in Phase 1.
8. Successful implementation of intensive revegetation with large clump willows, seed-harvesting and re-planting in Phase 2.
9. Observation and monitoring of project outcomes to amplify future environmental education and stewardship programming.

Budget and Schedule
This Statement of Work shall be accompanied by a combined Budget and Schedule that reflects the Tasks identified in the Statement of Work and shall be submitted to CWCB in excel format.

Last Updated: May 2021

Reporting Requirements

Progress Reports: The applicant shall provide the CWCB a progress report every 6 months, beginning from the date of issuance of a purchase order, or the execution of a contract. The progress report shall describe the status of the tasks identified in the statement of work, including a description of any major issues that have occurred and any corrective action taken to address these issues.

Final Report: At completion of the project, the applicant shall provide the CWCB a Final Report on the applicant's letterhead that:

5 Summarizes the project and how the project was completed.
6 Describes any obstacles encountered, and how these obstacles were overcome.
7 Confirms that all matching commitments have been fulfilled.
8 Includes photographs, summaries of meetings and engineering reports/designs.

The CWCB will pay out the last 10% of the budget when the Final Report is completed to the satisfaction of CWCB staff. Once the Final Report has been accepted, and final payment has been issued, the purchase order or grant will be closed without any further payment.

Payment

Payment will be made based on actual expenditures and must include invoices for all work completed. The request for payment must include a description of the work accomplished by task, an estimate of the percent completion for individual tasks and the entire Project in relation to the percentage of budget spent, identification of any major issues, and proposed or implemented corrective actions.

Costs incurred prior to the effective date of this contract are not reimbursable. The last 10% of the entire grant will be paid out when the final deliverable has been received. All products, data and information developed as a result of this contract must be provided to as part of the project documentation.

Performance Measures

Performance measures for this contract shall include the following:
(a) Performance standards and evaluation: Grantee will produce detailed deliverables for each task as specified. Grantee shall maintain receipts for all project expenses and documentation of the minimum in-kind contributions (if applicable) per the budget in Exhibit C. Per Grant Guidelines, the CWCB will pay out the last 10% of the budget when the Final Report is completed to the satisfaction of CWCB staff. Once the Final Report has been accepted, and final payment has been issued, the purchase order or grant will be closed without any further payment.
(b) Accountability: Per Grant Guidelines full documentation of project progress must be submitted with each invoice for reimbursement. Grantee must confirm that all grant conditions have been complied with on each invoice. In addition, per Grant Guidelines, Progress Reports must be submitted at least once every 6 months. A Final Report must be submitted and approved before final project payment.
(c) Monitoring Requirements: Grantee is responsible for ongoing monitoring of project progress per Exhibit A. Progress shall be detailed in each invoice and in each Progress Report, as detailed above. Additional inspections or field consultations will be arranged as may be necessary.
(d) Noncompliance Resolution: Payment will be withheld if grantee is not current on all grant conditions. Flagrant disregard for grant conditions will result in a stop work order and cancellation of the Grant Agreement.

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Water Plan Grant - Exhibit C
Budget and Schedule

Prepared Date: Decmber 1, 2021
Name of Applicant: Headwaters Alliance
Name of Water Project: Lower Willow Creek Stream and Floodplain Restoration Project
Project Start Date: March 2022
Project End Date: March 2024

Task No.	Task Description	Task Start Date	Task End Date	Grant Funding Request	Match Funding	Total
1	**Task 1 -Design Finalization, Permitting, Materials Acquisition and Contractor Selectio**	11.01.2021	12.31.2022	$0	$162,750	$162,750
1.A	60% Design Lower Wilow Creek Floodplain	11.01.2020	11.15.2021	$0	$108,150	$108,150
1.B	Phase 1 Design brought to Final	11.01.2021	02.28.22	$0	$34,000	$34,000
1.C	Permits NWP, Groundwater, etc	01.01.2022	05.31.2022	$0	$5,000	$5,000
1.D	Resourceful Materials Acquisation	11.1.2021	12.31.2022	$0	$7,800	$7,800
1.E	Phase 3 Finalization	10.01.2021	05.31.2022	$0	$7,800	$7,800
2	**Task 2 - Construction - Phase 1. Station 54+00 - Station 93+43, 3,900 linear feet**	07.01.2022	03.15.2023	$752,567	$755,308	$1,507,875
2.A	Site Prep	07.01.2022	12.31.2022	$235,000	$120,000	$355,000
2.B	Construction- Flume	07.01.2022	12.31.2023	$0	$218,275	$218,275
2.C	Construction - Stream Channel	07.01.2022	12.31.2023	$471,115	$289,733	$760,848
2.D	Water Rights Installations	07.01.2022	12.31.2023	$0	$5,000	$5,000
2.E	Revegetation	07.01.2022	12.31.2023	$13,482	$102,300	$115,782
2.F	Engineer Consultation	07.01.2022	12.31.2023	$32,970	$20,000	$52,970
3	**Task 3 - Phase 2 - Intensive Revegetation & Monitoring**	07.01.2022	03.15.2023	$0	$29,263	$29,263
4	**Task 4 - Project Management**	12.01.2021	03.15.2023	$85,775	$47,000	$132,775
			Total	$838,342	$994,321	$1,832,663
						$1,832,663

LOWER WILLOW CREEK FLOODPLAIN RESTORATION

MATRIX PROJECT NO. 20.1183.001

60% Design Opinion of Probable Construction Cost

AACE International Class 3 Cost Estimate

BID ITEM NO.	DESCRIPTION OF BID ITEM	QUANTITY	PAY UNIT	UNIT PRICE	TOTAL COST OF BID ITEM
1	Mobilization	1	LS	$340,000	$340,000
2	Traffic Control	1	LS	$10,000	$10,000
3	Clearing and Grubbing	11.0	AC	$3,000	$33,000
4	Dewatering, Erosion, and Sediment Control	1	LS	$160,000	$160,000
5	Drop Structure at Flume Outlet	1	EA	$185,000	$185,000
6	End Sill	59	LF	$225	$13,275
7	Flume Outfall Modification	1	LS	$20,000	$20,000
8	Soil Characterization	1	LS	$50,000	$50,000
9	Earthwork - Cut/Fill Onsite	55,000	CY	$12	$660,000
10	Import Topsoil	17,790	CY	$55	$978,450
11	Bank Protection - Soil Lifts, Toe Wood, and Willow Brush Layerin	1,793	LF	$104	$186,472
12	Bank Protection - Soil Lifts, Riprap, and Willow Brush Layering	3,658	LF	$198	$724,284
13	Rock Cross Vane - Channel	1,379	LF	$225	$310,275
14	Rock Cross Vane - Floodplain Sill	489	LF	$175	$85,575
15	Erosion Control Fabric/Soil Stabilization	53,370	SY	$11	$587,070
16	Headgate	2	EA	$2,500	$5,000
17	Check Structure	1	EA	$2,500	$2,500
18	Seeding (Riparian/Upland)	11.0	AC	$2,500	$27,500
19	Broader Floodplain Restoration	80.4	AC	$2,500	$201,000
20	Soil Amendment	11.0	AC	$1,200	$13,200
				Total	**$4,592,601**

AACE Class 3 Low Estimate (-20%) $ 3,903,711

AACE Class 3 Upper Estimate (+30%) $ 5,511,121

AACE International Class 3 Cost Estimate Definition – Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineered process and utility equipment lists. Expected accuracy ranges are from –10% to –20% on the low side and +10% to 30% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

Matrix

Authentic. Heritage. Home

November 29, 2021

Chris Sturm
Colorado Water Conservation Board
1313 Sherman Street, Room 718
Denver, CO 80203

RE: CWCB Water Plan Grant application: *Lower Willow Creek Stream and Floodplain Restoration Project*, by Headwaters Alliance

Dear Mr. Sturm,

On behalf of the City of Creede, I would like to enthusiastically express our support for the Lower Willow Creek Stream and Floodplain Restoration Project spearheaded by the Headwaters Alliance (HWA). In light of the high run-off event that occurred in 2019 and the extensive damage that it caused to the floodplain, the City of Creede is very supportive of this effort to re-establish an ecologically and functionally sustainable stream corridor through stream channelization, bank stabilization, revegetation, erosion control and wetland protection. The City recognizes the importance of this work in fostering environmental protection, improving riparian habitat for a variety of animal and plant species, improving surface water quality by decreasing contaminated run-off, increasing resilience to high water events and aesthetically improving the floodplain. This project dovetails nicely with the City's effort to rehabilitate the Willow Creek Flume and is an integral component of the overall effort to address infrastructure and environmental concerns along the lower reaches of Willow Creek.

The City will continue to partner with HWA on this project, with financial contribution, collaborating on final design criteria for changes to the flume and as a Board member of the Lower Willow Creek Restoration Project. The Lower Willow Creek Floodplain sits at the gateway of Creede, and additionally functions as a central connecting corridor for residents and visitors who live outside town. This site offers key environmental education and interpretive history potential for the long-term benefit of maintaining pristine environmental conditions at the headwaters of the Rio Grande.

Should you require any assistance from the City with regard to project implementation, please do not hesitate to contact me.

Sincerely,

Louis Fineberg, Town Manager

2223 N. Main Street • Creede, CO • 719-658-2276 • www.creedetownhall.com

Lower Willow Creek Restoration Co.

LOWER WILLOW CREEK
RESTORATION COMPANY
PO BOX 518
CREEDE, CO 81130

November 29, 2021

Chris Sturm
Colorado Water Conservation Board
1313 Sherman Street, Room 718
Denver, CO 80203

RE CWCB Water Plan Grant application: *Lower Willow Creek Stream and Floodplain Restoration Project*, by Headwaters Alliance

Dear Mr. Sturm,

The Lower Willow Creek Restoration Company (LWCRCo) offers strong endorsement of Headwaters Alliance's *Lower Willow Creek Stream and Floodplain Restoration Project.* As one of several property owners on the Lower Willow Creek floodplain, an active financial contributor to total project costs and a long-time member of the Creede/Willow Creek community, we are committed collaborators in implementing a rigorously vetted design to benefit the community and Willow Creek as a key tributary of the Rio Grande.

We were devastated by the damage caused to the Willow Creek floodplain during the high water 2019 Spring runoff. The resulting *Comprehensive Willow Creek Watershed Planning project*, which included an integrated design for Willow Creek from flume to Rio Grande, has created a framework to encourage property owner collaboration to benefit the variety of unique ownership criteria while prioritizing the overall function of the entire reach. Please note, LWCRCo was an also an active partner, collaborator and funder of the *Comprehensive Willow Creek Watershed Planning project.*

We are particularly pleased that this construction approach will provide for energy dissipation at the flume and provide for a stable stream channel while flowing adjacent to vulnerable infrastructure and then will allow for a more cost-and-resource friendly approach once the creek has moved past these constructed features by supporting Willow Creek in it's naturally restoring form. This cost-savvy approach will also fit with the existing Voluntary Cleanup requirements for the LWCRCo parcel, again utilizing the benefits of high water events to build soil and support aggressive revegetation efforts across the full width of the floodprone zone. Additionally, this staged approach, informed by careful expert observation will significantly increase the wetlands footprint, establish vital habitat for small and large mammals alike, aquatic species and birds – truly there is nothing grander than elk over-wintering on the vigorous riparian grasses along the Creek!

It has been the long-term commitment of the LWCRCo to implement a design that reduces the environmental risk of this legacy mining impacted site. We anticipate that the plan for ongoing observation and monitoring of outcomes by Headwaters Alliance will demonstrate measurable benefits to this site and contribute meaningfully to the body of work on this subject.

We invite you to reach out with any questions regarding LWCRCo support and active involvement in this important collaborative project.

Sincerely,

Paul Glader
Board President, LWCRCo

RiO GRANDE
HEADWATERS LAND TRUST

November 27, 2021

Chris Sturm
Colorado Water Conservation Board
Denver CO, 80203

RE: CWCB proposal Lower Willow Creek Stream and Floodplain Restoration Project

I am delighted to write a letter of support for Headwaters Alliance's (HWA) project Lower Willow Creek Stream and Floodplain Restoration Project for the CWCB's 2022 Water Plan Grant program.

Rio Grande Headwaters Land Trust has had the pleasure of working closely with HWA over the past few years in several capacities. RiGHT shares HWA's vision for establishing a continuous public and conserved floodplain from the City of Creede to the Rio Grande. While this project is still very much in development, RiGHT, HWA, and the private Wason Ranch view the stream restoration of the lower Willow Creek floodplain as a vital next step in realizing the larger potential for permanently conserving the beautiful gateway to Creede at the confluence of Willow Creek and the Rio.

In 2021 RiGHT was able to support HWA through our Community and Stewardship programming in by providing staff to manage tree and willow plantings. We also assisted HWA by establishing a vegetation monitoring system to be used by Creede School. RiGHT is impressed by HWA's continuing commitment to restoring the Willow Creek floodplain. We will continue to support HWA as part of our shared effort to conserve and connect land and water in the Rio Grande basin.

We strongly support HWA's project. Please let us know if you have any questions.

Sincerely,

Allen Law
Executive Director

PO Box 444 Del Norte, CO 81132
(719) 657.0800
info@riograndelandtrust.org

riograndelandtrust.org

CONSERVING
OUR LAND, WATER
AND WAY OF LIFE
IN COLORADO'S
SAN LUIS VALLEY

Sam Leake
Dallas, TX & Creede, CO

November 27, 2021

Chris Sturm
Colorado Water Conservation Board
Denver CO, 80203

RE: CWCB proposal Lower Willow Creek Stream and Floodplain Restoration Project

To Mr. Sturm:

I am a second-generation Wason Ranch resident in Creede, Colorado; spending six months or more in Creede, most years since 1963. My essay, *The Wason Family, 1832-1963*, fostered my familiarity with the long history of Willow Creek. Major Wason raised hay and pastured his horses on his Willow Creek acreage for years before Nic Creede's silver strike in 1892. That strike and boom began the creek's demise to an unstable, polluted floodplain.

As a board member of the Wason Ranch Corporation, my focus was oversight of our four miles of the pristine Rio Grande, working with Dave Rosgen to improve the hydrology, trout habitat, and riparian habitat along our reach. In addition, I partnered with USDA Partners for Fish and Wildlife to install riparian corridor fencing. Consequently, I am imminently aware of the value of the proper stabilization of the creek into a single, multi-property, and unified design. Sedimentation from Willow Creek during runoff events has already compromised portions of the restoration work on the Rio Grande. Shifts in the stream have, at times, diverted the creek from our head-gate and water right that dates to 1875.

My involvement in Willow Creek's restoration predates the current effort; I voiced a strong opinion that the 2012 Kiowa Engineering design would be unsuccessful. It proved so in the 2019 spring runoff. However, Headwaters Alliance's approach to collaborating with property owners and experts alike to define and devise single design are helping us move towards a more optimal solution. There is no doubt that the ongoing education provided by HWA to several of the property owners will be central to the final success. The current phased construction approach is an excellent example of balancing community education with what's best for Willow Creek.

Additionally, I share in the vision of a fully restored and protected to Creede on the lower Willow Creek floodplain. I have asked Wason shareholders to consider a donation of our property's 137 acres at the downstream end of the Willow Creek floodplain to the Headwaters Alliance to be used for low-impact public use. Since the shareholder consensus is "let's wait and see what progress is made on stabilization and restoration of the creek," I think it underscores the importance of this project.

Sincerely,

Sam Leake

Sam Leake
Wason Ranch Corps. Shareholder

Jason Willis, P.E. – CO AML Program Manager
128 East 1st Street, Salida, CO 81201
jwillis@tu.org – (719) 221-0411

December 1, 2021
TO: Mr. Chris Sturm – Colorado Water Conservation Board
1313 Sherman Street, Room 718
Denver, CO 80203

RE: CWCB Water Plan Grant: Lower Willow Creek Stream and Floodplain Restoration Project

Dear Mr. Sturm,

I am writing to express the support of Trout Unlimited (TU) towards Headwaters Alliance (HWA) and their grant application for the Colorado Water Conservation Board's (CWCB) Water Plan Grant Program. The Lower Willow Creek Stream and Floodplain Restoration Project will build upon past comprehensive planning efforts in the watershed, as well as funding investments by CWCB. Not only does TU support this application as a partner conservation organization, but we will also maintain an active partnership role to help carry out the proposed scope of work that will yield tangible, on-the-ground results. Headwaters Alliance (HWA) has been a great partner of TU for several years and the collaborative, genuine manner that our organizations have worked together on past projects should be a good indication of the successful results this project will yield. The outcomes of this project specifically align with TU's goals improvements to our cold-water resources through stream and floodplain restoration.

As one of the leading cold-water conservation organizations, TU strives to protect, restore, reconnect, and sustain our nation's waterways. Since TU was founded in 1959, on-the-ground restoration of streams, watersheds, and fisheries has been our hallmark. TU has been supporting project work across Colorado since the early 2000's. Specifically, TU has completed over 40 reclamation projects across the State since 2012 that focus on water quality improvement, non-point source contamination reduction, and revegetation of degraded landscapes. All these aspects are wrapped into the implementation of the Lower Willow Creek Stream and Floodplain Restoration Project. Not only will this project focus on overall watershed health, but it will also nail down into site-specific enhancements to withstand flood events, improve riverine and riparian habitats, implement engineered structures for the flume outlet, and incorporate sustainable irrigation headgate diversions along the project. This extensive effort will also continue to collaboratively engage a group of diverse stakeholders dedicated to protecting the Willow Creek Watershed.

TU is in support of this proposal because it exhibits progress by building on past grant efforts and deliverables. HWA and project partners have successfully procured a collaborative, living design that will drive tangible construction results being requested from this funding opportunity.

With a strong work ethic, and a dedicated local watershed coordinator, HWA has the capacity necessary to manage and coordinate this type of comprehensive grant. In addition, the support of local private consultants, Federal/State agencies, other non-profits, and Trout Unlimited's program staff will ensure a collaborative approach to a quality finished product. TU supports the HWA's Water Plan Grant application, which aligns with our goals to protect the nation's cold-water resources.

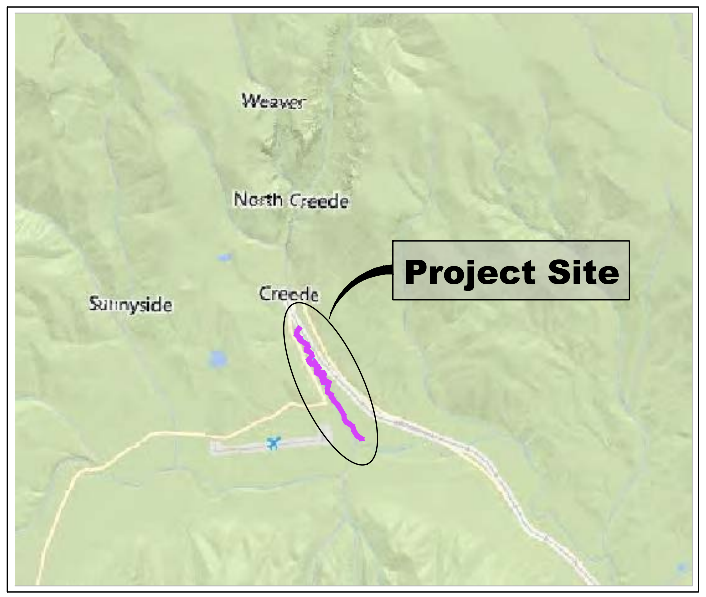
Best Regards,

Jason Willis, P.E.
Trout Unlimited CO AML Program Manager

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
HEADWATERS ALLIANCE & TROUT UNLIMITED

60% DESIGN PLANS
August 2021

MATRIX PROJECT No. 20.1183.001



VICINITY MAP

N.T.S.

VERTICAL DATUM: THE ELEVATIONS ON THIS PROJECT ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.

HORIZONTAL DATUM: THE BASIS OF BEARINGS ARE GRID BEARINGS OF THE STATE PLANE COLORADO SOUTH ZONE. PROJECT COORDINATES ARE NAD83/2011 STATE PLANE COLORADO SOUTH ZONE, GRID COORDINATES.

AERIAL PHOTO: PROVIDED BY MICROSOFT BING AERIAL IMAGERY

BENCHMARK STATEMENT: THE BENCHMARK USED FOR THIS PROJECT IS A NATIONAL GEODETIC SURVEY MONUMENT "D-168", DATED 1934, BEING A FOUND 3-1/4" ALUMINUM CAP IN CONCRETE APPROXIMATELY 4" ABOVE GROUND AND HAVING A PUBLISHED NAVD88 ELEVATION OF 8671.32 U.S. SURVEY FEET.

LOCATION MAP

SCALE: 1" = 4,000'

SHEET INDEX

REFERENCE DRAWINGS

X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\20.1183.001 Lower Willow Creek Floodplain Restoration\Dwg\Design Plans\1183-TS01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 8/12/2021 4:22 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

60% DESIGN PLANS

NOTICE:
THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF AARON SUTHERLIN, PE
IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.

HEADWATERS ALLIANCE CREEDE, CO

TROUT UNLIMITED

PREPARED BY:

Matrix Excellence by Design

SEAL

PRELIMINARY
THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

TITLE SHEET

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS

SCALE
HORIZ. N/A
VERT. N/A

DATE ISSUED: August 2021
SHEET 01 OF 25

DRAWING No. TS01

Know what's **below.** **Call** before you dig.

GENERAL NOTES:

1. THE LOCATIONS OF KNOWN ABOVE GROUND AND UNDERGROUND UTILITIES ARE SHOWN IN THEIR APPROXIMATE LOCATIONS ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. CONTRACTOR TO CALL FOR UTILITY LOCATOR AT LEAST 3 CALENDAR DAYS BEFORE EXCAVATION. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY THEIR FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL ABOVE GROUND AND UNDERGROUND UTILITIES. IN THE EVENT THAT THE CONTRACTOR UTILITY VERIFICATION RESULTS IN EXISTING STRUCTURES OR UTILITIES BEING IN CONFLICT WITH THE PROPOSED WORK OF THIS CONTRACT, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY UTILITIES AND COORDINATE ANY NEEDED MODIFICATIONS TO THE PROPOSED WORK AS DIRECTED BY THE DISTRICT.
2. THE CONTRACTOR SHALL COORDINATE WITH ALL AFFECTED UTILITY OWNERS TO ESTABLISH THE REQUIREMENTS AND METHODS TO ACCOMMODATE THE PROTECTION, TEMPORARY SUPPORT, ADJUSTMENT OR RELOCATION OF UTILITIES PRIOR TO THE START OF CONSTRUCTION.
3. OVERHEAD UTILITIES ARE NOT INDICATED ON PROFILE OR SECTION DRAWINGS.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING AND MAINTAINING IN CONTINUOUS OPERATION, ALL EXISTING STRUCTURES. NOT ALL POTENTIALLY IMPACTED STRUCTURES MAY BE SHOWN ON THE DRAWINGS AND IT IS THE CONTRACTOR'S RESPONSIBILITY TO IDENTIFY AND PROTECT ALL STRUCTURES INCLUDING BUT NOT LIMITED TO STREETS, CURB AND GUTTER, BRIDGE PIERS AND ABUTMENTS, CREEK BANK PROTECTION OF VARIOUS TYPES, CREEK DROP STRUCTURES, SIGNS, PEDESTRIAN WALKS, RETAINING WALLS AND FENCING. IN THE EVENT THAT A STRUCTURE OR UTILITY IS DAMAGED DURING CONSTRUCTION THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE OWNER OF THE FACILITY IN WRITING AND MAKE REPAIRS PER THE APPROPRIATE SPECIFICATIONS.
5. THE CONTRACTOR SHALL CONFIRM THE RECEIPT OF ALL NECESSARY PERMITS AND APPROVALS BEFORE THE START OF CONSTRUCTION.
6. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE STANDARDS OF CDOT UNLESS SPECIFICALLY DETAILED OTHERWISE ON THESE PLANS AND ASSOCIATED SPECIFICATIONS. ANY ELEMENT OF CONSTRUCTION WHICH IS NOT ADDRESSED EITHER BY THESE PLANS AND SPECIFICATIONS OR BY THE STANDARDS OF CDOT SHALL CONFORM TO THE STANDARD SPECIFICATIONS OF MILE HIGH FLOOD DISTRICT AND AGREEMENT DOCUMENTS.
7. THE CONTRACTOR SHALL MAINTAIN AT THE SITE AT ALL TIMES ONE SIGNED COPY OF THE PROJECT DRAWINGS AND SPECIFICATIONS, ONE COPY OF THE STORMWATER MANAGEMENT PLAN AND ONE COPY OF ALL REQUIRED PERMITS.
8. THE CONTRACTOR SHALL CONDUCT THEIR OPERATIONS IN SUCH A WAY THAT THE AREA OF DISTURBANCE IS MINIMIZED. ALL EXISTING TREES, SHRUBS AND VEGETATION SHALL BE PROTECTED UNLESS OTHERWISE NOTED ON THE DRAWINGS. NO TREES SHALL BE REMOVED WITHOUT APPROVAL.
9. FOR ALL SITE GRADING, SMOOTH, PARABOLIC TRANSITIONS SHALL BE MADE BETWEEN CHANGES IN SLOPE.
10. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR PROVIDING STABLE EXCAVATIONS AND TEMPORARY SLOPES AND FOR SATISFYING ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS.
11. CONSTRUCTION OF THE PROPOSED WORK WILL TAKE PLACE WITHIN THE CHANNEL AND WATER CONTROL MEASURES WILL BE REQUIRED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE ACCEPTANCE AND CONTROL OF DRAINAGE WATER FROM AREAS ADJACENT TO WILLOW CREEK AND FOR FLOW WITHIN WILLOW CREEK AND ITS TRIBUTARIES INCLUDING STORMWATER OUTFALLS AND DIVERSION RETURN FLOWS. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ESTABLISHING MEANS AND METHODS OF GROUND AND SURFACE WATER CONTROL APPROPRIATE FOR CONSTRUCTION IN ACCORDANCE WITH THE REQUIREMENTS OF THE PROJECT DRAWINGS AND SPECIFICATIONS AND ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS AND PERMITS.
12. THE CONTRACTOR SHALL PREPARE AND MAINTAIN THE STORMWATER MANAGEMENT PLAN AND OBTAIN THE NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT THROUGH THE COLORADO DEPARTMENT OF PUBLIC HEALTH (CDPHE) AND ALL OTHER APPROPRIATE FEDERAL, STATE AND LOCAL PERMITS.
13. CONTRACTOR SHALL BE RESPONSIBLE FOR AS-BUILT DRAWINGS TO BE MAINTAINED AND SUBMITTED TO HEADWATERS ALLIANCE, IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
14. THE CONTRACTOR SHALL PROVIDE AND MAINTAIN ON-SITE SURVEY CONTROL.
15. CONTRACTOR SHALL FENCE OFF CRITICAL AREAS TO BE PROTECTED AT THE DISCRETION OF HEADWATERS ALLIANCE OR APPROVED REPRESENTATIVE.
16. THE CONTRACTOR SHALL DEVELOP A TRAFFIC CONTROL PLAN FOR PLANNED ACCESS TO THE SITE AND FOR EXITING AND ENTERING PUBLIC ROADS.
17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IDENTIFYING AND MAINTAINING PHYSICAL AND LEGAL ACCESS TO THE PROJECT SITE AND SHALL LIMIT TRANSPORTATION TO AND FROM THE SITE TO THOSE APPROVED BY HEADWATERS ALLIANCE.

ABBREVIATIONS

℄	CENTER LINE	APPROX.	APPROXIMATE
HCL	HORIZONTAL CONTROL LINE	MIN.	MINIMUM
DIA	DIAMETER	MAX.	MAXIMUM
EX/EXIST	EXISTING	HORIZ	HORIZONTAL
EL./ELEV	ELEVATION	VERT.	VERTICAL
FT.	FEET	DIST.	DISTANCE
INV.	INVERT	NTS	NOT TO SCALE
LF	LINEAR FEET	TYP	TYPICAL
LT	LEFT	O.C.	ON CENTER
N,S,E,W	NORTH, SOUTH, EAST, WEST	L.O.C.	LIMITS OF CONSTRUCTION
ℙ	PROPERTY LINE	RR	RAILROAD
ROW	RIGHT-OF-WAY	BCL	BANKFULL CONTROL LINE
RT	RIGHT	TCL	THALWEG CONTROL LINE
SF	SQUARE FEET	LPSTP	LONGITUDINAL PEAKED STONE TOE PROTECTION
STA.	STATION		
PR.	PROPOSED		

STANDARD SYMBOLS

CENTER LINE

EXISTING CONTOURS

PROPOSED CONTOURS

L.O.C.

CONSTRUCTION ACCESS

ROW

RAILROAD ROW

PROTECT EXISTING VEGETATION

LEGEND

DT03.1 — DETAIL REFERENCE LABEL

DRAWING NUMBER — DETAIL NUMBER

PR. CROSS VANE / J-HOOK

PR. BANK PROTECTION

PR. POOL

PR. BANKFULL CHANNEL

PR. TOE WOOD

REFERENCE DRAWINGS

X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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HEADWATERS ALLIANCE CREEDE, CO

TROUT UNLIMITED

PREPARED BY:
Matrix Excellence by Design

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION 60% DESIGN PLANS

GENERAL NOTES

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. N/A VERT. N/A
DATE ISSUED: August 2021
SHEET 02 OF 25
DRAWING No. GN01

REFERENCE DRAWINGS				
X-1183-MDG22x34 X-1183-EX-IMAGE X-1183-EX-TOPO Lower Willow Creek Survey 20201210				
	No.	DATE	DESCRIPTION	BY

REVISIONS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

EXISTING CONDITIONS

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. 1" = 600'		EX01
CHECKED BY: AJS	VERT. N/A	SHEET 03 OF 25	

PROJECT SURVEY CONTROL:

BENCHMARK STATEMENT: THE BENCHMARK USED FOR THIS PROJECT IS A NATIONAL GEODETIC SURVEY MONUMENT "D-168", DATED 1934, BEING A FOUND 3-1/4" ALUMINUM CAP IN CONCRETE APPROXIMATELY 4" ABOVE GROUND AND HAVING A PUBLISHED NAVD88 ELEVATION OF 8671.32 U.S. SURVEY FEET.

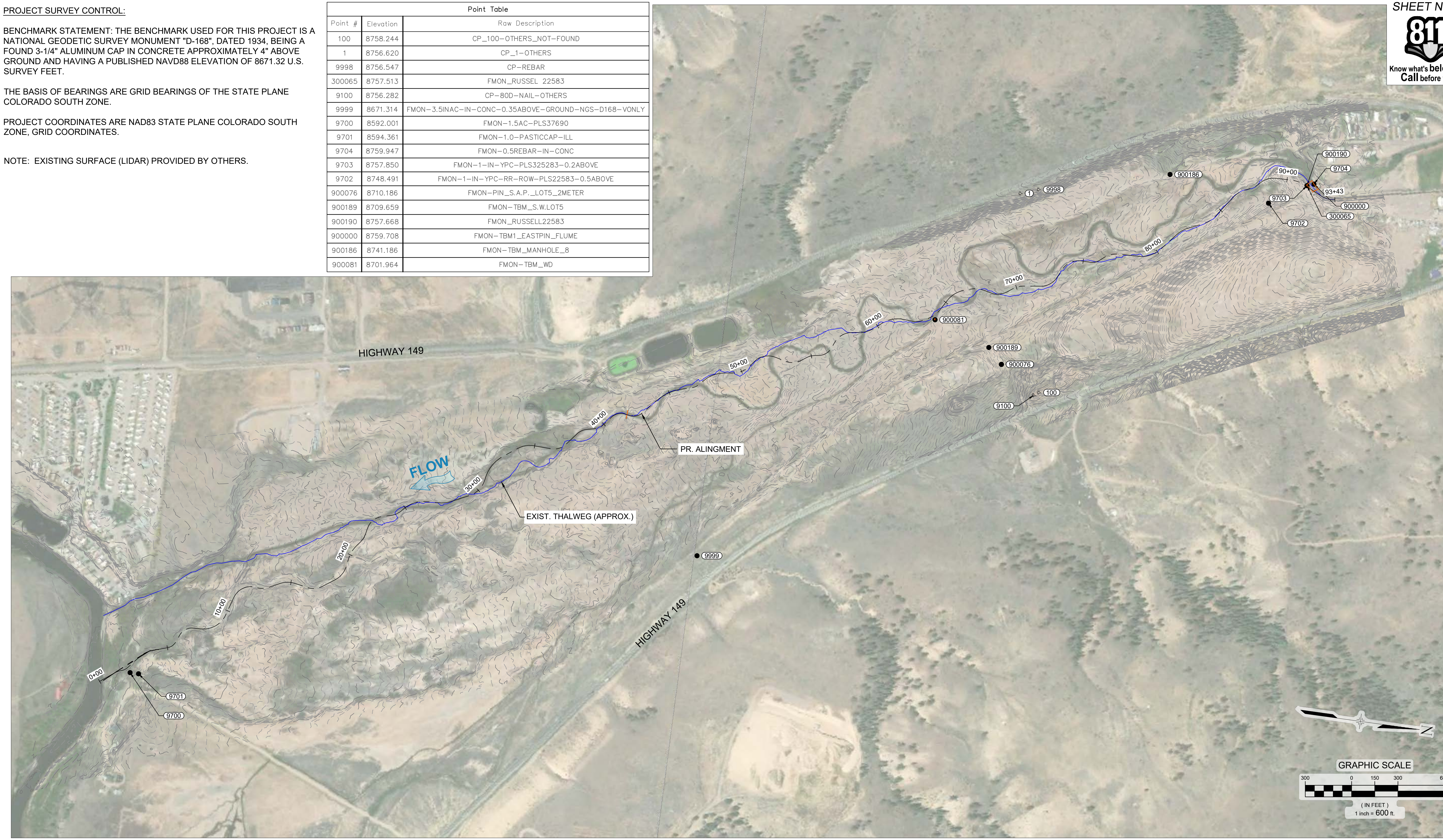
THE BASIS OF BEARINGS ARE GRID BEARINGS OF THE STATE PLANE COLORADO SOUTH ZONE.

PROJECT COORDINATES ARE NAD83 STATE PLANE COLORADO SOUTH ZONE, GRID COORDINATES.

NOTE: EXISTING SURFACE (LIDAR) PROVIDED BY OTHERS.

Point Table

Point #	Elevation	Raw Description
100	8758.244	CP_100-OTHERS_NOT-FOUND
1	8756.620	CP_1-OTHERS
9998	8756.547	CP-REBAR
300065	8757.513	FMON_RUSSEL 22583
9100	8756.282	CP-80D-NAIL-OTHERS
9999	8671.314	FMON-3.5INAC-IN-CONC-0.35ABOVE-GROUND-NGS-D168-VONLY
9700	8592.001	FMON-1.5AC-PLS37690
9701	8594.361	FMON-1.0-PASTICCAP-ILL
9704	8759.947	FMON-0.5REBAR-IN-CONC
9703	8757.850	FMON-1-IN-YPC-PLS325283-0.2ABOVE
9702	8748.491	FMON-1-IN-YPC-RR-ROW-PLS22583-0.5ABOVE
900076	8710.186	FMON-PIN_S.A.P._LOT5_2METER
900189	8709.659	FMON-TBM_S.W.LOT5
900190	8757.668	FMON_RUSSELL22583
900000	8759.708	FMON-TBM1_EASTPIN_FLUME
900186	8741.186	FMON-TBM_MANHOLE_8
900081	8701.964	FMON-TBM_WD



Know what's below. Call before you dig.

REFERENCE DRAWINGS

X-1183-MDG22x34
X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT

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60% DESIGN PLANS

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HEADWATERS ALLIANCE CREEDE, CO

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

HORIZONTAL CONTROL PLAN

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS

SCALE
HORIZ. 1" = 600'
VERT. N/A

DATE ISSUED: August 2021
SHEET 04 OF 25

DRAWING No. HZ01

811
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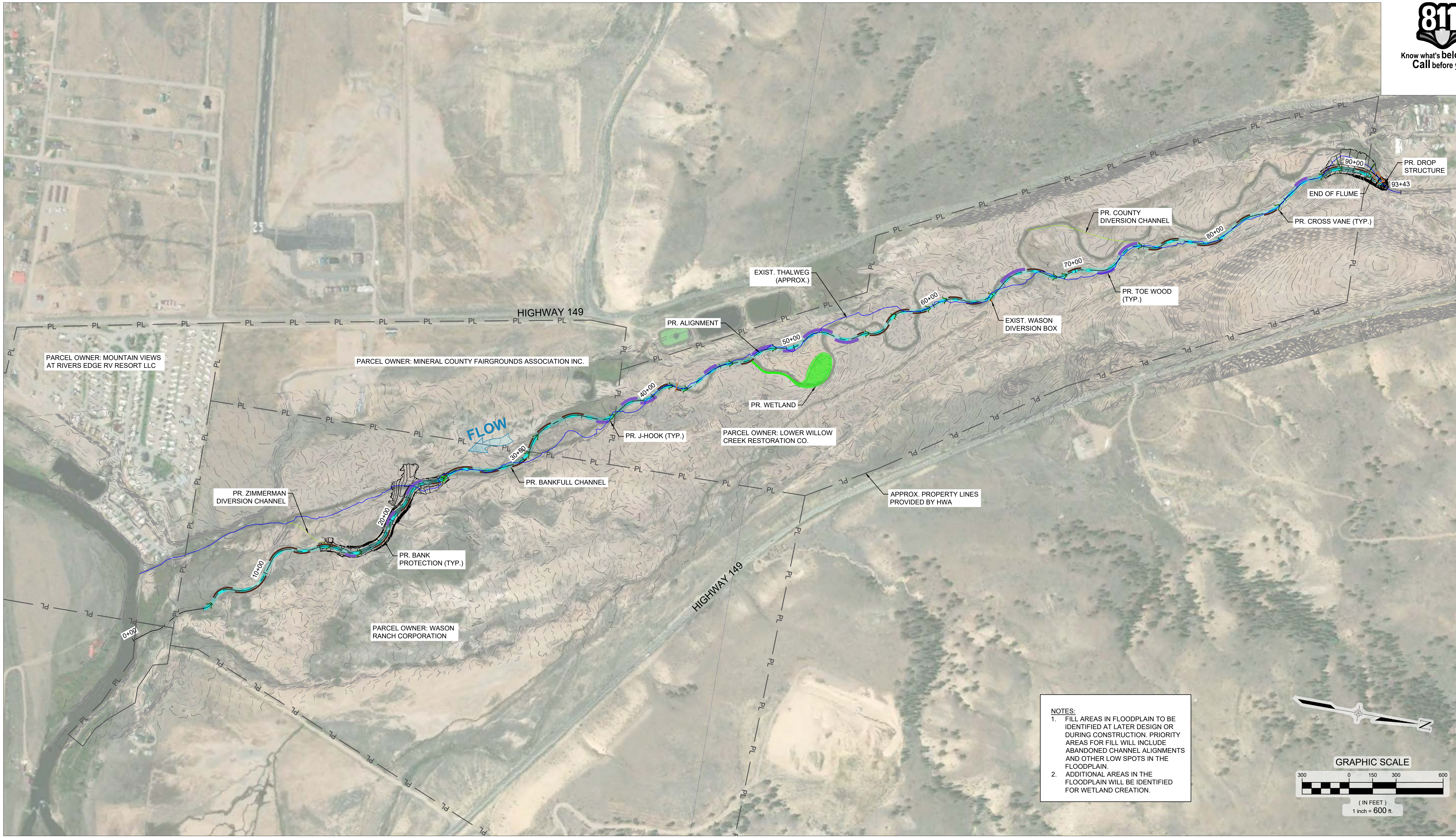

NOTES:
1. FILL AREAS IN FLOODPLAIN TO BE IDENTIFIED AT LATER DESIGN OR DURING CONSTRUCTION. PRIORITY AREAS FOR FILL WILL INCLUDE ABANDONED CHANNEL ALIGNMENTS AND OTHER LOW SPOTS IN THE FLOODPLAIN.
2. ADDITIONAL AREAS IN THE FLOODPLAIN WILL BE IDENTIFIED FOR WETLAND CREATION.

GRAPHIC SCALE
300 0 150 300 600
(IN FEET)
1 inch = 600 ft.

REFERENCE DRAWINGS
X-1183-MDG22x34
X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. 1" = 600'
VERT. N/A
DATE ISSUED: August 2021
SHEET 05 OF 25
DRAWING No. DR01

REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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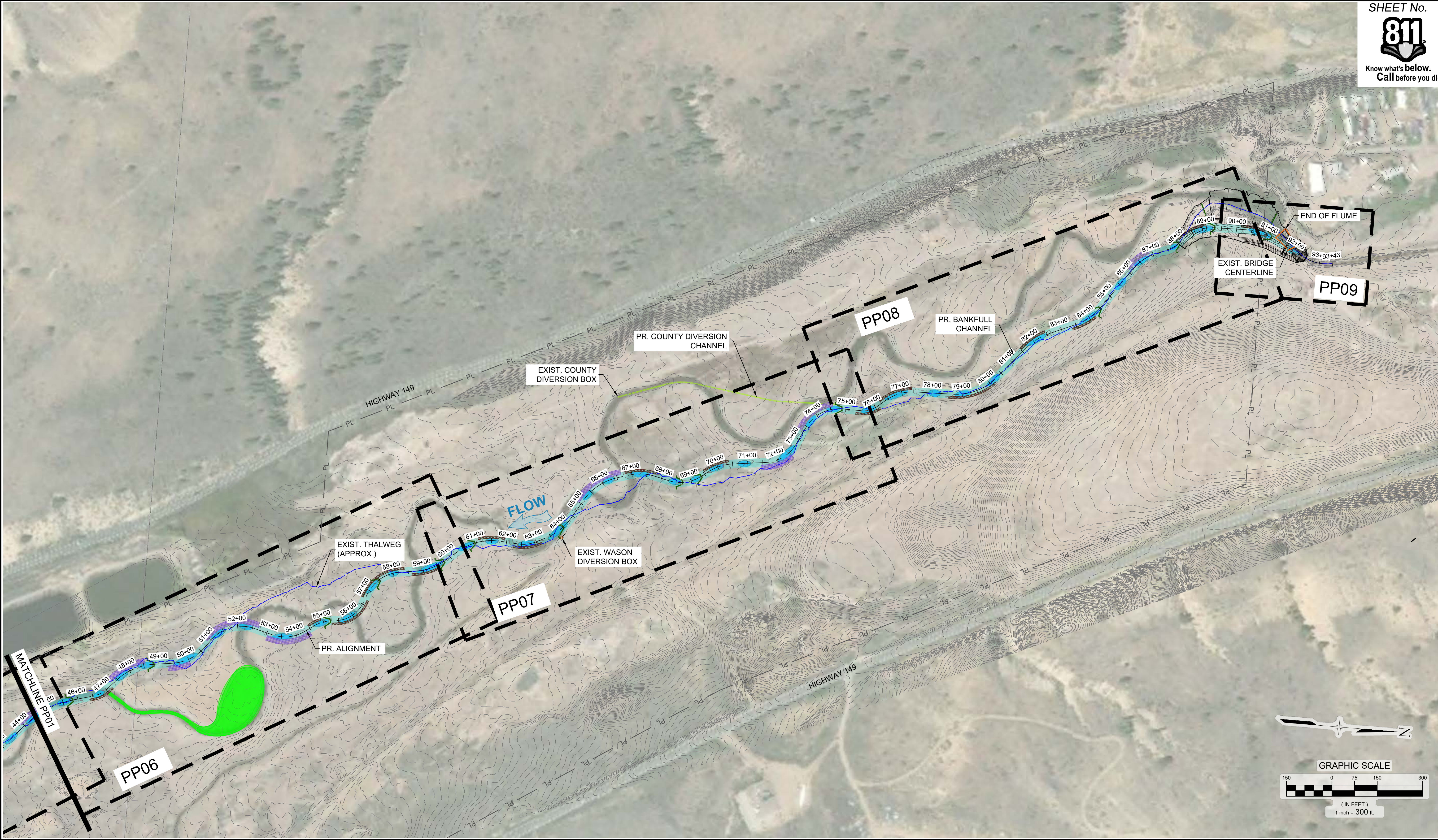
LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE OVERVIEW

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. 1" = 300'	SHEET 06 OF 25	PP01
CHECKED BY: AJS	VERT. N/A		

SHEET No. 07



REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE OVERVIEW

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. 1" = 300'	SHEET 07 OF 25	PP02
CHECKED BY: AJS	VERT. N/A		

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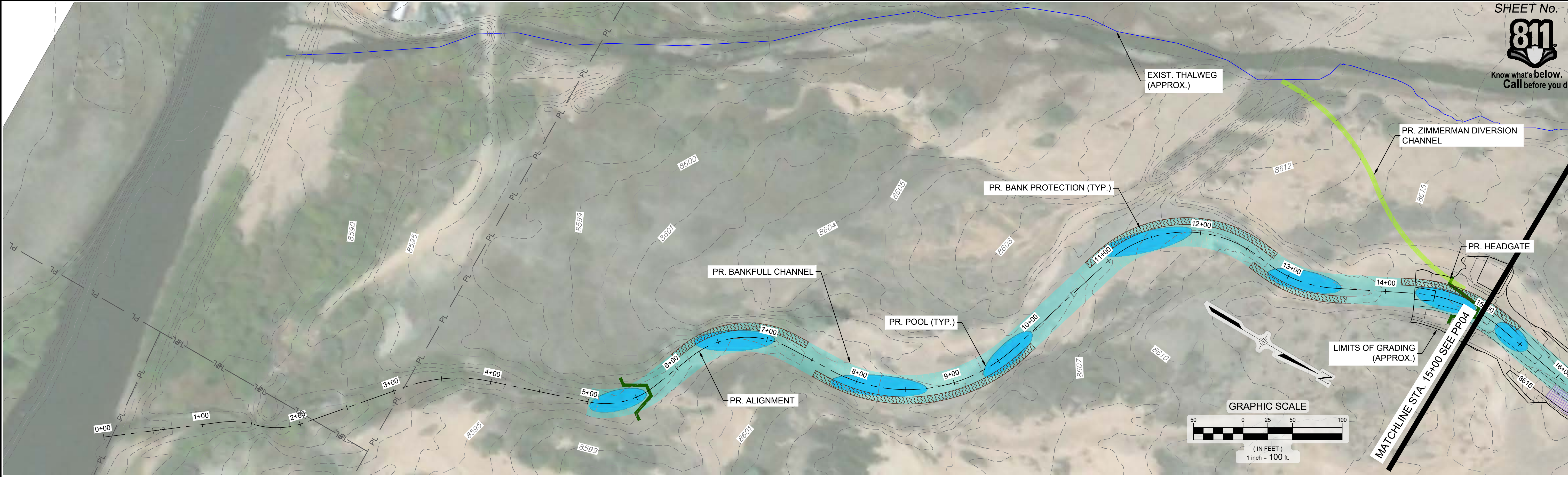

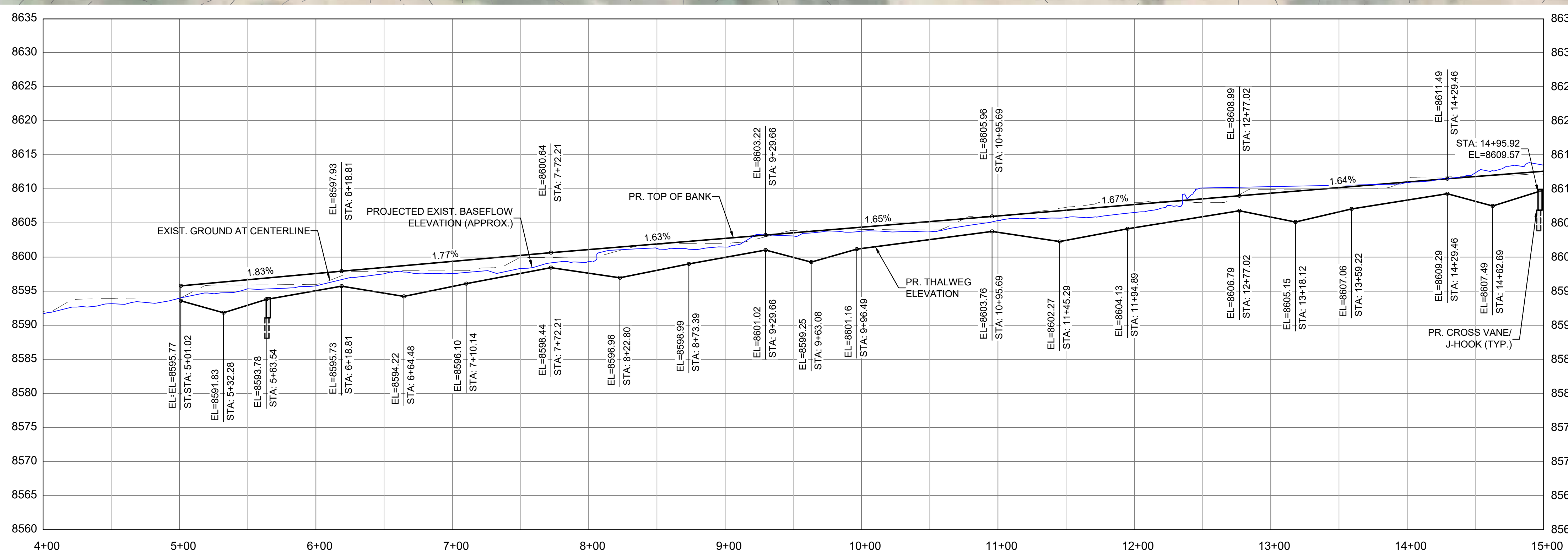

REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

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PROJECT No. 20.1183.001

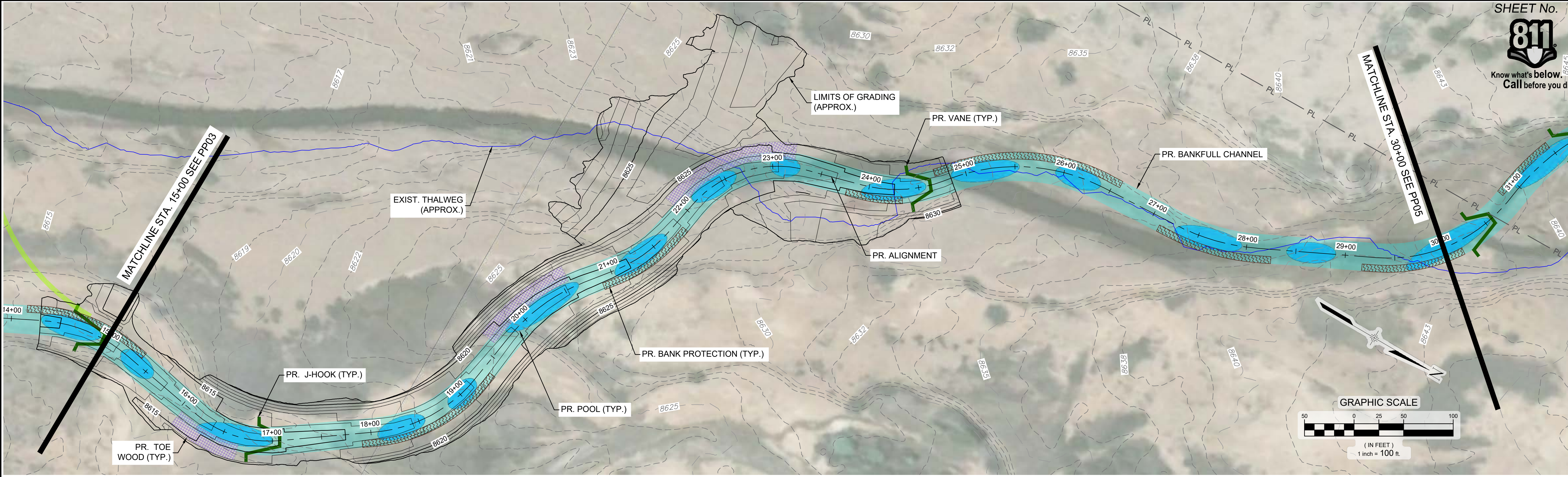
HEADWATERS ALLIANCE & TROUT UNLIMITED

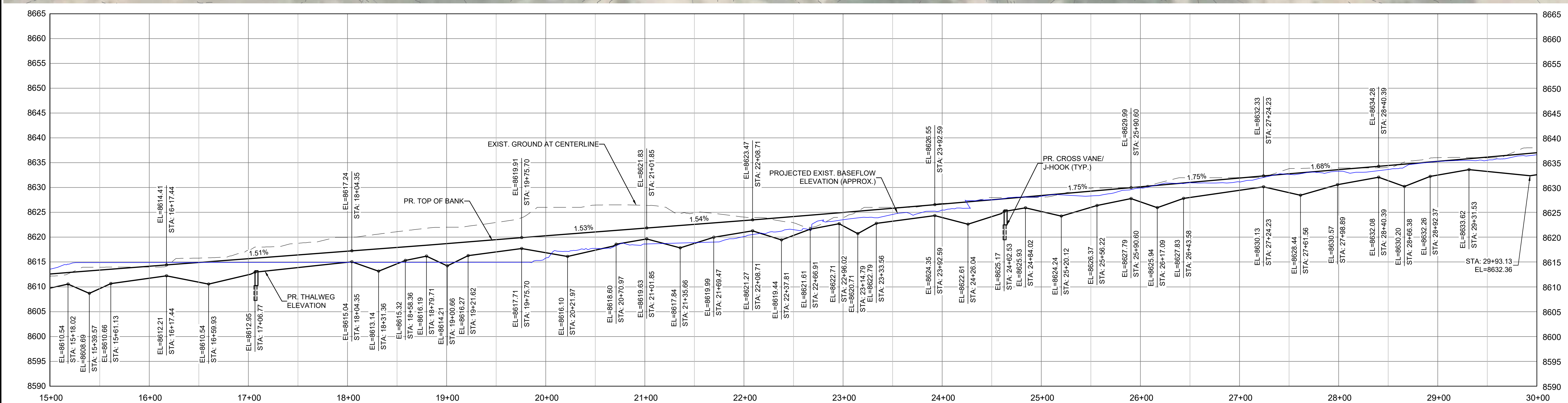
LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 0+00 - 15+00

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 100'	SHEET	08 OF 25	PP03
CHECKED BY:	AJS	VERT.	1" = 20'			

SHEET No. 09





REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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HEADWATERS ALLIANCE CREEDE, CO

TROUT UNLIMITED

PREPARED BY:

Matrix Excellence by Design

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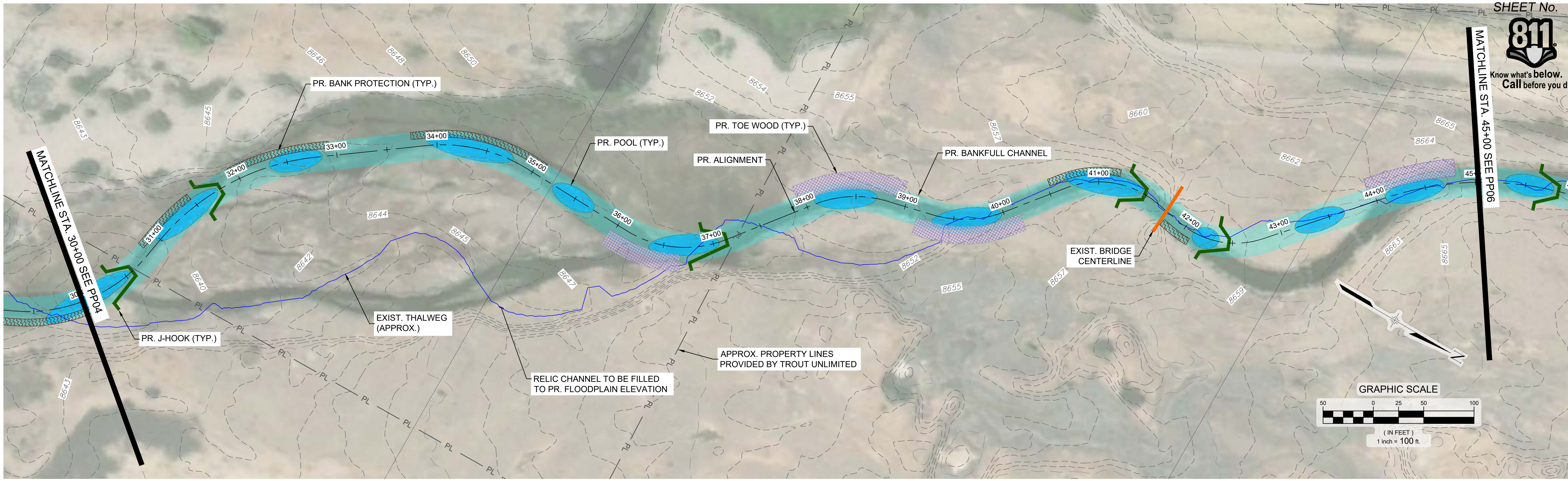
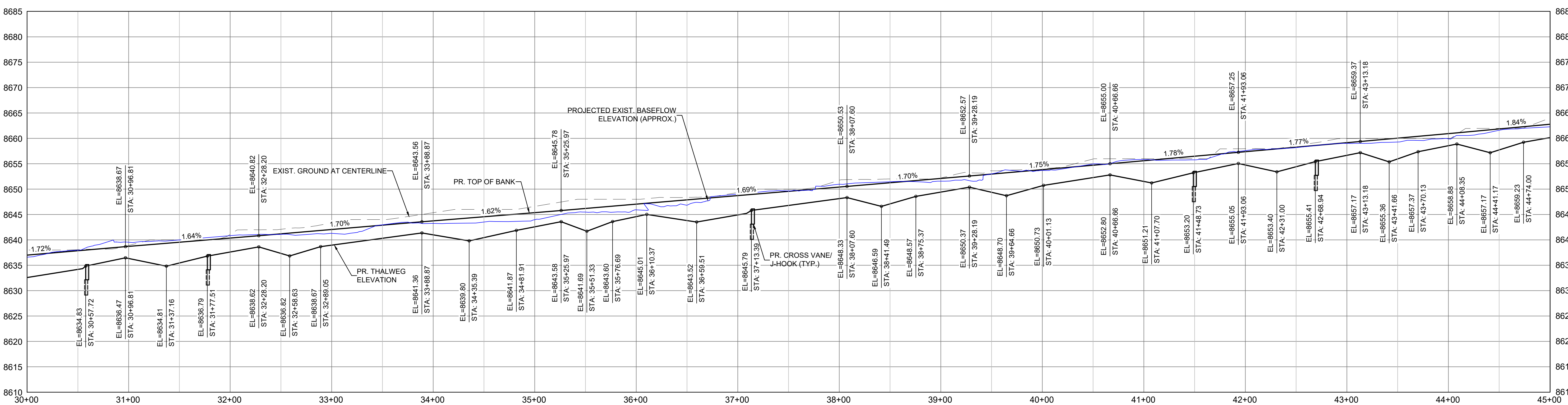
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 15+00 - 30+00

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 100'	SHEET	09 OF 25	PP04
CHECKED BY:	AJS	VERT.	1" = 20'			





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TROUT UNLIMITED

PREPARED BY:
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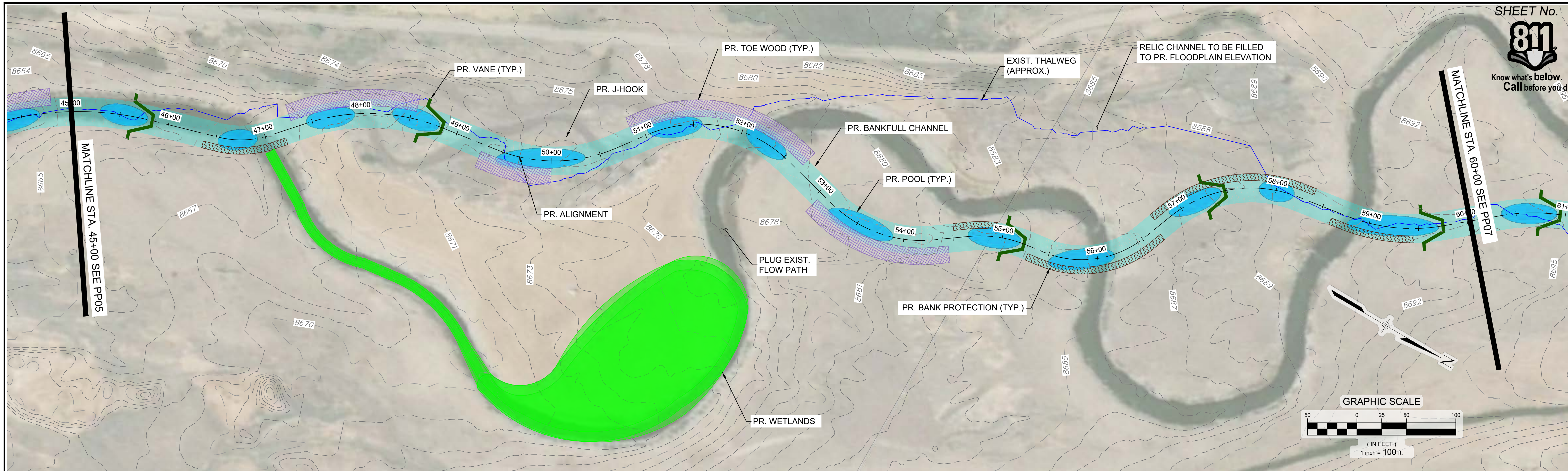
PROJECT No. 20.1183.001

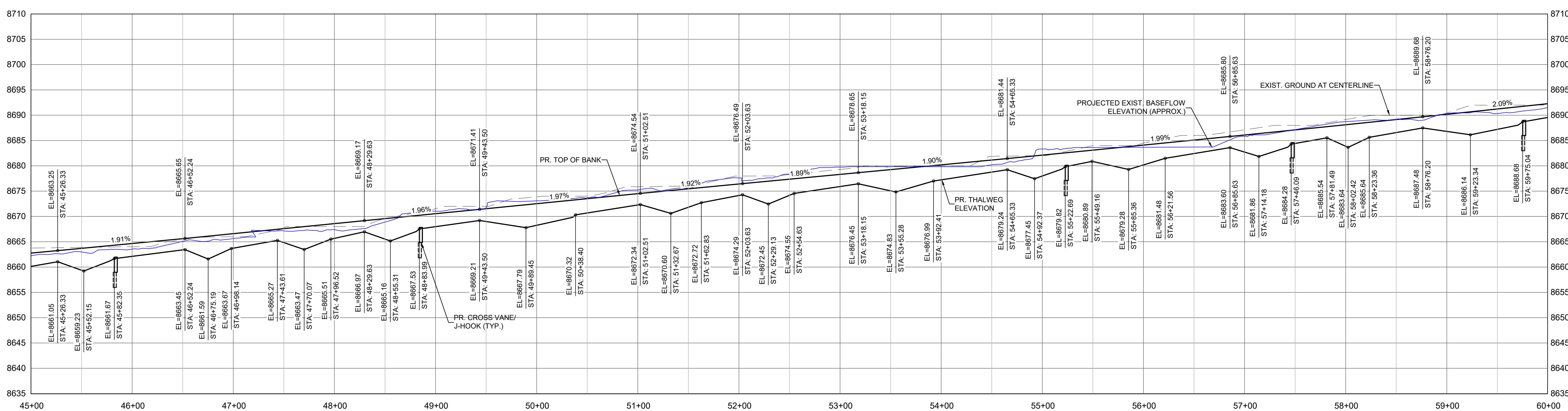
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 30+00 - 45+00

DESIGNED BY:	JAB	SCALE	DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ. 1" = 100'	SHEET	10 OF 25	PP05
CHECKED BY:	AJS	VERT. 1" = 20'			





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X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

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60% DESIGN PLANS

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HEADWATERS ALLIANCE CREEDE, CO

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PREPARED BY:
Matrix Excellence by Design

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 45+00 - 60+00

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
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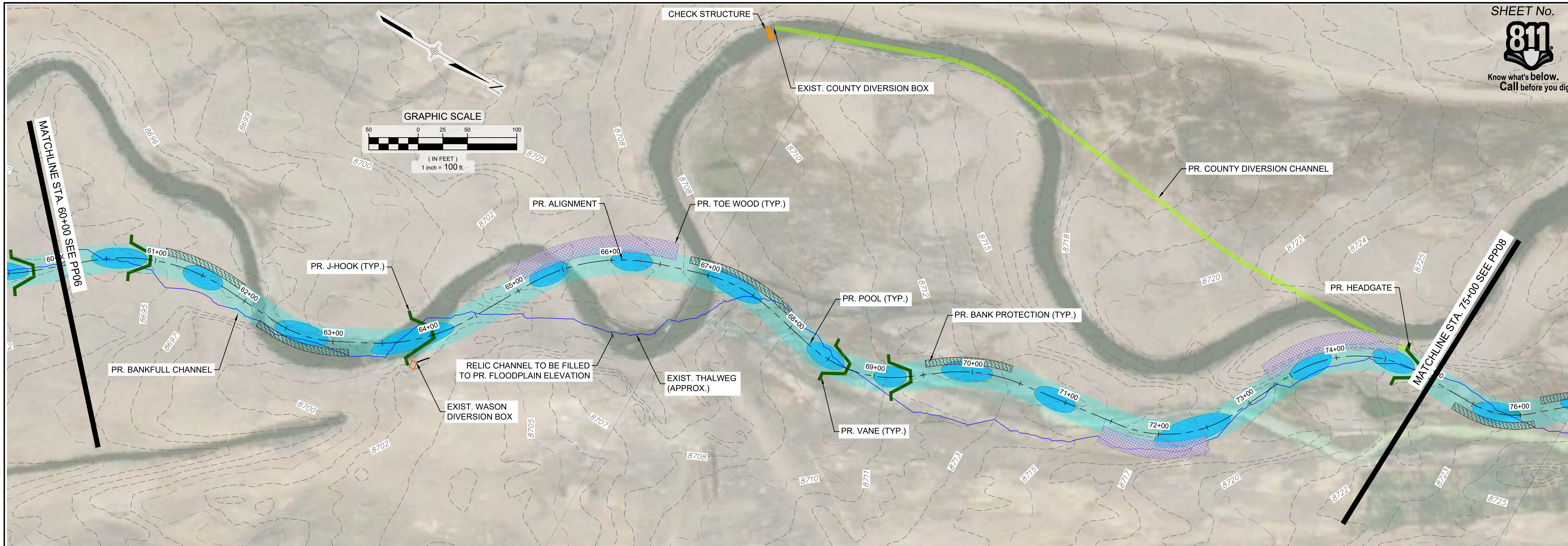
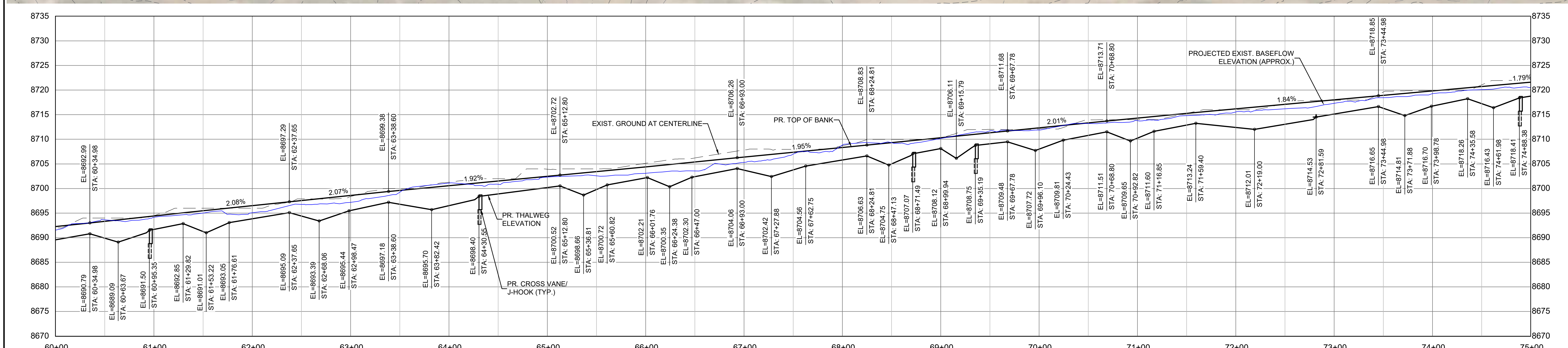
CHECKED BY:	AJS	VERT.	1" = 20'			

SHEET No. 12





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Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

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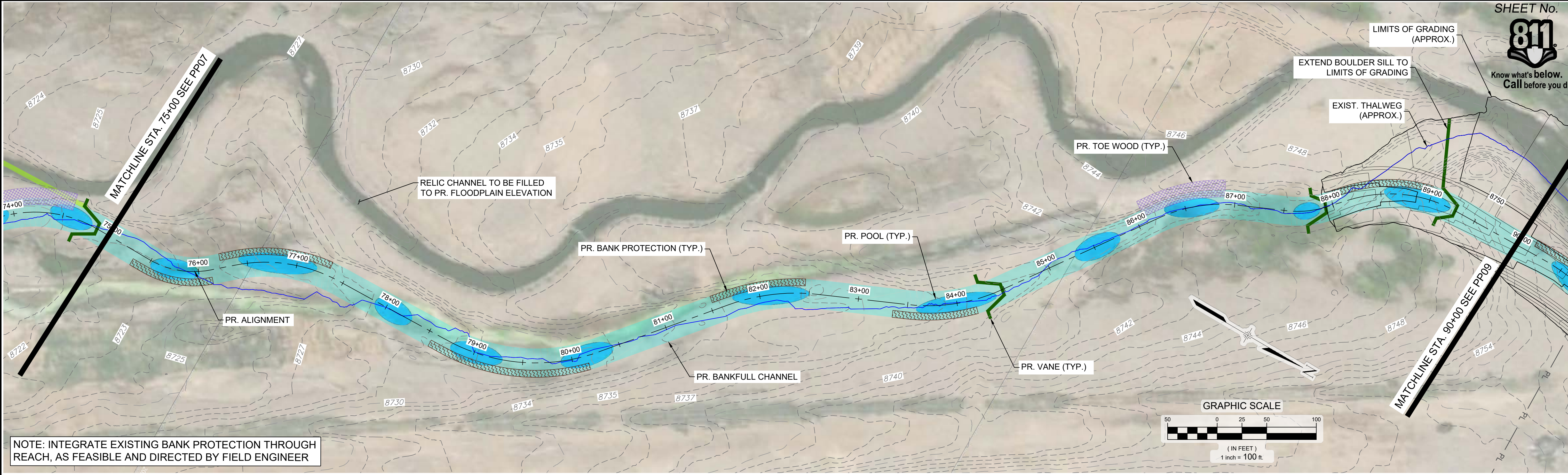
PROJECT No. 20.1183.001

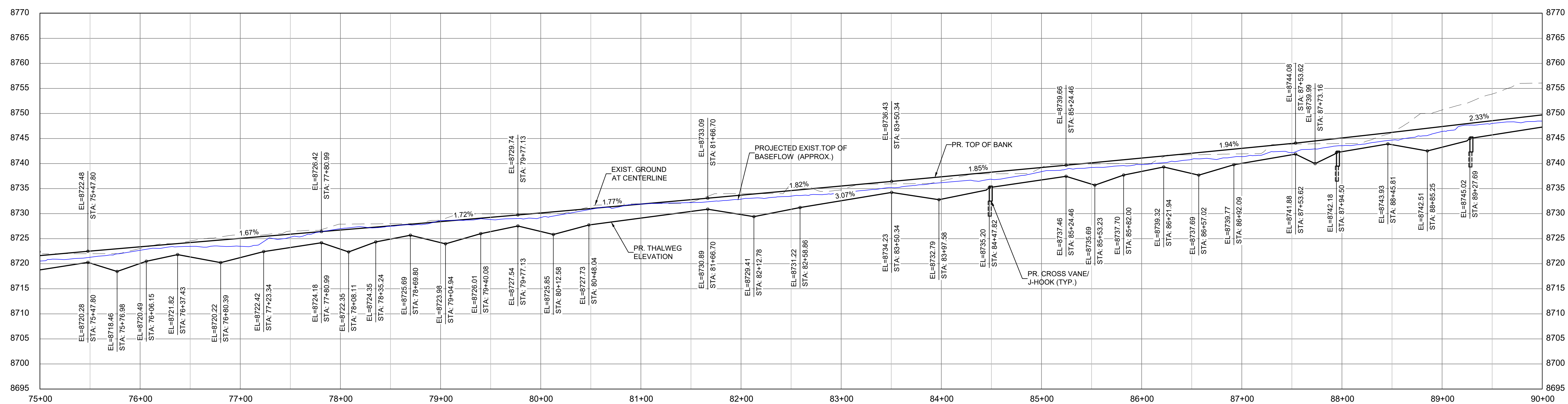
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 60+00 - 75+00

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. 1" = 100'
VERT. 1" = 20'
DATE ISSUED: August 2021
SHEET 12 OF 25
DRAWING No. PP07





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X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 75+00 - 90+00

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE: HORIZ. 1" = 100' VERT. 1" = 20'
DATE ISSUED: August 2021
SHEET 13 OF 25
DRAWING No. PP08

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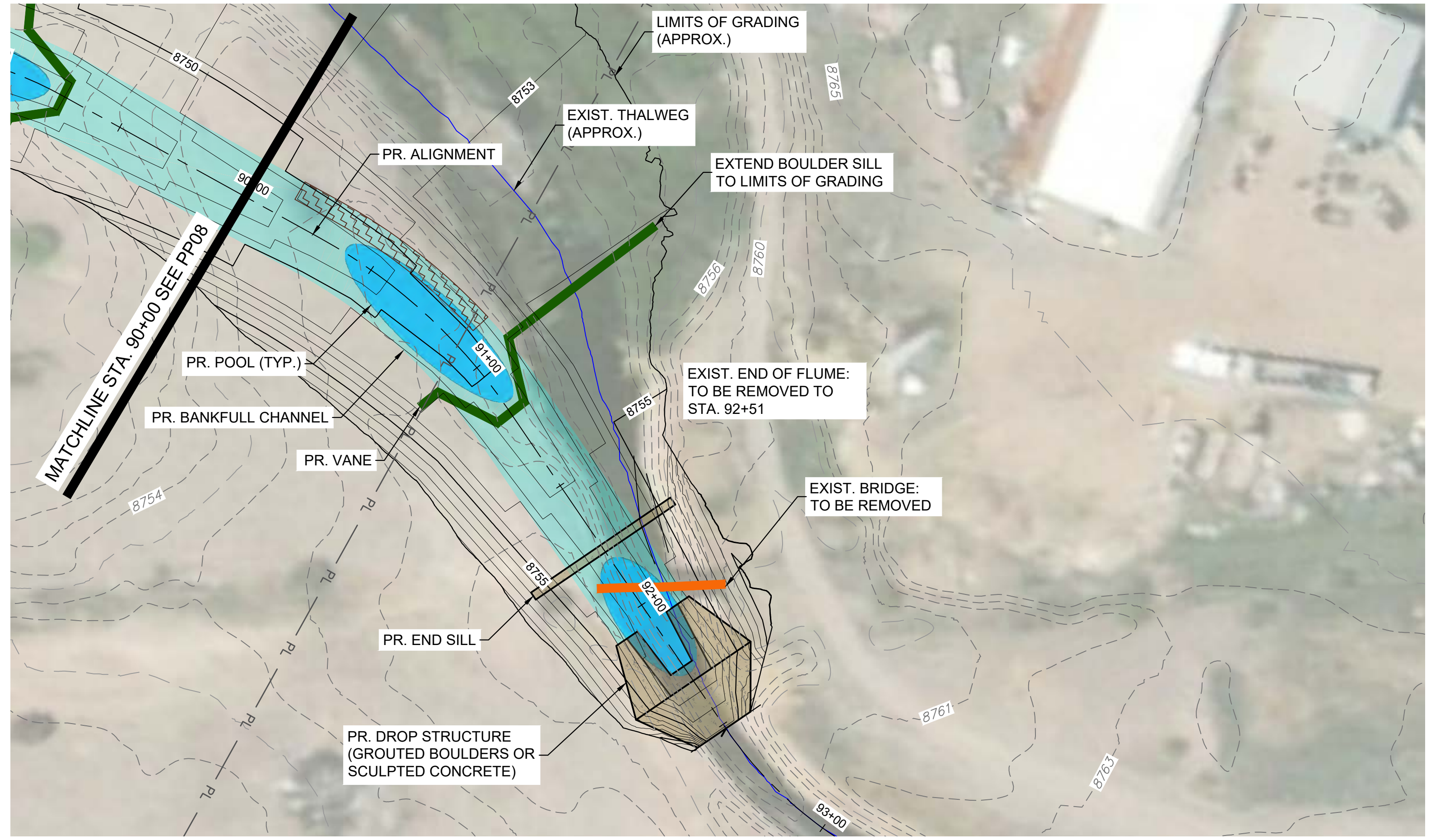

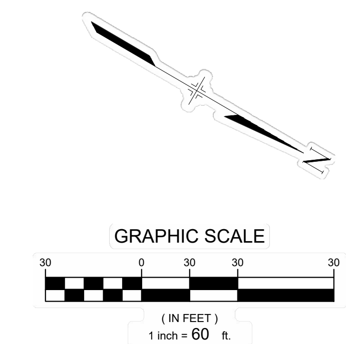

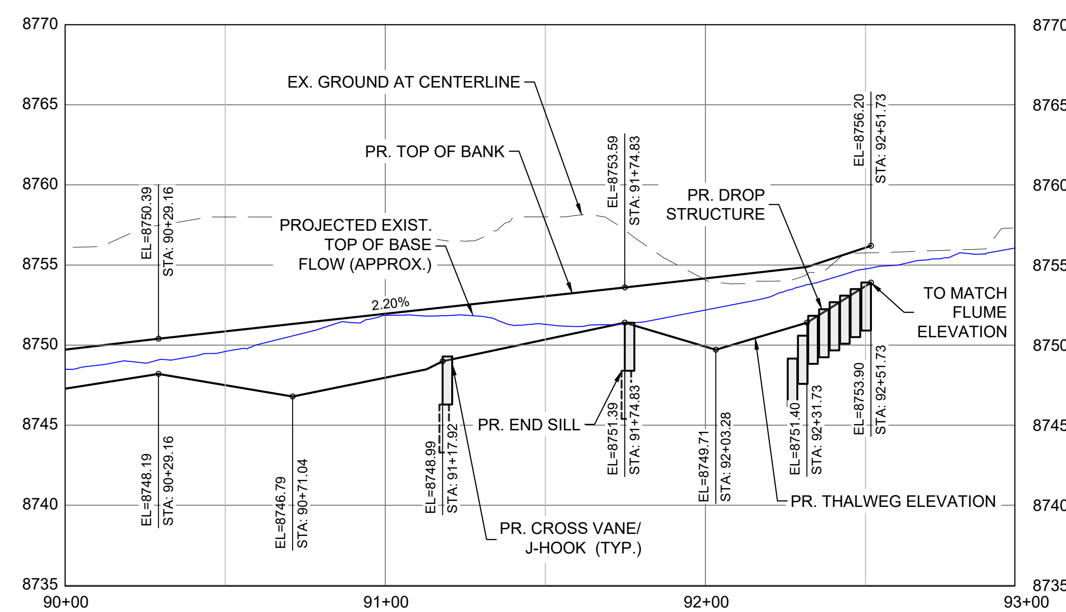

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X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

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PROJECT No. 20.1183.001

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 90+00 - 93+00

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 60'			
CHECKED BY:	AJS	VERT.	1" = 12'	SHEET	14 OF 25	PP09

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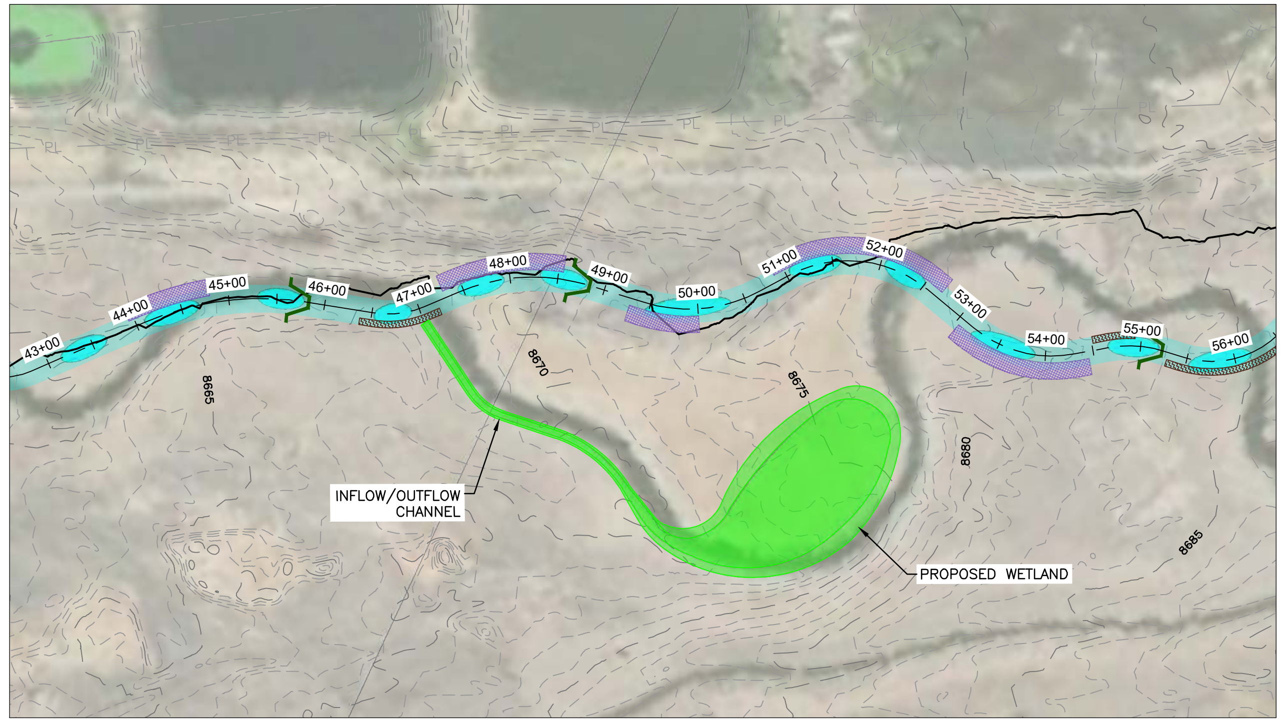
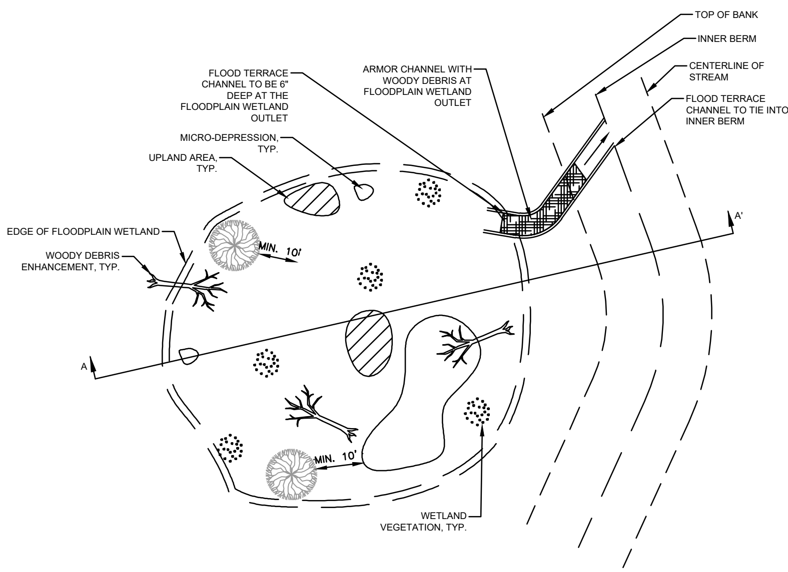


PLAN VIEW

SCALE: 1"=100'



PLAN VIEW

NOTES:

1. MICRO-DEPRESSIONS AND UPLAND AREAS ARE INTENDED TO INCREASE THE VARIABILITY OF WETLAND HABITAT WITHIN THE FLOODPLAIN WETLAND.

2. FLOODPLAIN WETLANDS SHALL BE LOCATED AND SIZED PER THE PROJECT PLAN SHEETS.

3. ALL SIDE SLOPES ASSOCIATED WITH THE FLOODPLAIN WETLAND SHALL BE NO GREATER THAN 4:1.

4. THE BOTTOM OF WETLAND SHALL BE ONE FOOT OFF ESTIMATED GROUNDWATER TABLE ELEVATION.

5. THE FLOODPLAIN WETLANDS ARE TO BE PLANTED PER WETLAND SEED MIX THIS SHEET.

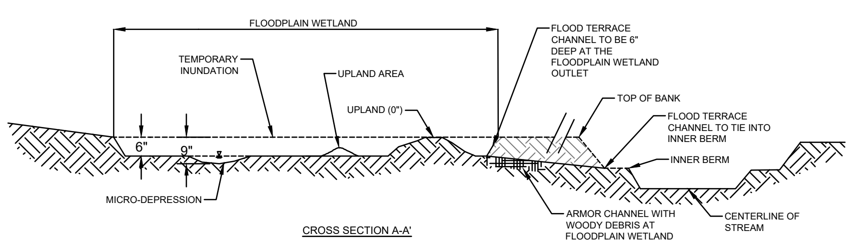
6. MICRO-DEPRESSIONS AND UPLAND AREAS ARE TO BE CREATED THROUGHOUT THE FLOODPLAIN DEPRESSTION IN A RANDOM PATTERN. THERE SHOULD BE NO MICRO-DEPRESSIONS OR FLOOD TERRACE CHANNEL EXCAVATED WITHIN 10' OF THE DRIP LINE OF ANY PLANTED TREES.

WETLAND SEED MIX

Common Name	*Scientific Name*	Recommended Seed Rate - PLS (lbs / acre)
Redtop	*Agrostis gigantea*	0.5
Smooth brome - Manchar	*Bromus inermis*	1.0
Water sedge	*Carex aquatilis*	1.5
Common beaked sedge	*Carex utriculata*	1.5
Tufted hairgrass	*Deschampsia cespitosa*	2.0
Streambank wheatgrass - Sodar	*Elymus lanceolatus ssp. lanceolatus*	2.0
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
TOTAL		**15.5**

2 WETLAND SEED MIXES

Scale: NTS



CROSS SECTION A-A'

1 DETAIL - FLOODPLAIN WETLAND

NOT TO SCALE

REFERENCE DRAWINGS

X-1183-MDG22x34
X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE-DEN-FILE02
63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

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TROUT UNLIMITED

PREPARED BY:

SWCA ENVIRONMENTAL CONSULTANTS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

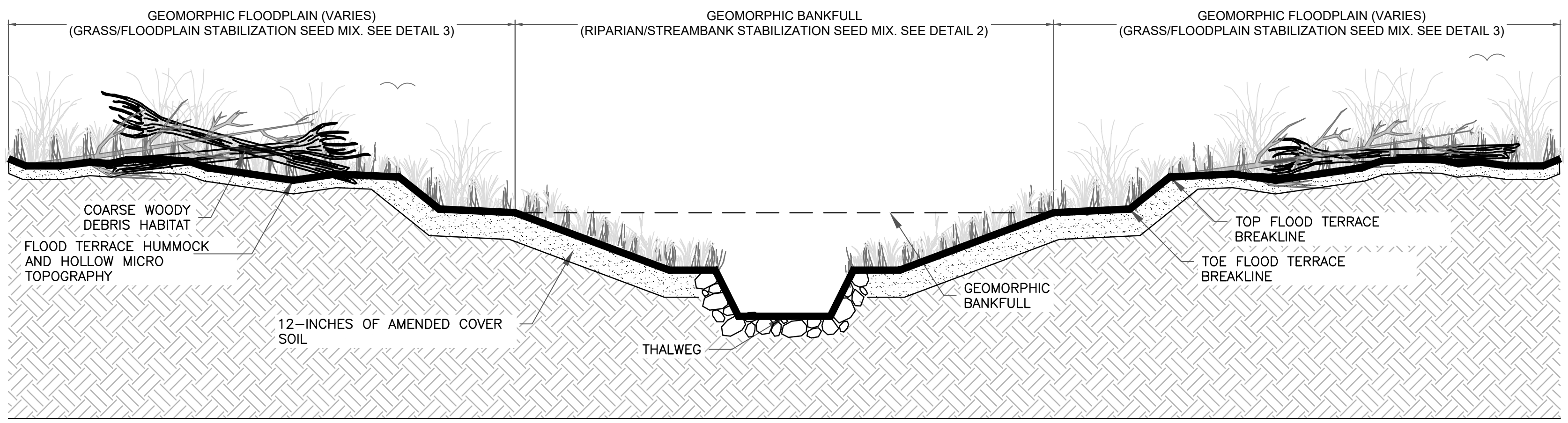
FLOODPLAIN WETLAND DETAIL

DESIGNED BY: --
DRAWN BY: TS
CHECKED BY: AH

SCALE
HORIZ. N/A
VERT. N/A

DATE ISSUED: August 2021
SHEET 15 OF 25

DRAWING No. RV01



1 TYPICAL SECTION - RIFFLE
Scale: NTS

RIPARIAN/STREAMBANK STABILIZATION SEED MIX

Common Name	Scientific Name	Recommended Seed Rate - PLS (lbs / acre)
Redtop	*Agrostis gigantea*	0.5
Smooth brome - Manchar	*Bromus inermis*	1.0
Water sedge	*Carex aquatilis*	1.5
Common beaked sedge	*Carex utriculata*	1.5
Tufted hairgrass	*Deschampsia cespitosa*	2.0
Streambank wheatgrass - Sodar	*Elymus lanceolatus ssp. lanceolatus*	2.0
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
TOTAL		**15.5**

2 RIPARIAN/STREAMBANK STABILIZATION SEED MIXES
Scale: NTS

GRASS/FLOODPLAIN STABILIZATION SEED MIX

Common Name	Scientific Name	Recommended Seed Rate - PLS
Indian ricegrass - Nezpar	*Achnatherum hymenoides*	1.0
Redtop	*Agrostis gigantea*	0.1
Smooth brome - Manchar	*Bromus inermis*	1.0
Tufted hairgrass	*Deschampsia cespitosa*	0.5
Streambank wheatgrass - Sodar	*Elymus lanceolatus* ssp. *lanceolatus*	1.0
Slender wheatgrass - San Luis	*Elymus trachycaulus*	1.5
Arizona fescue - Redondo	*Festuca arizonica*	0.5
Hard fescue - Durar	*Festuca ovina*	0.5
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
Blue flax - Lewis	*Linum lewisii*	0.3
Rocky mountain penstemon	*Penstemon strictus*	0.3
Alsike clover	*Trifolium hybridum*	0.5
	TOTAL	**14.1**

3 GRASS/FLOODPLAIN STABILIZATION SEED MIX
Scale: NTS

COVER SOIL PLACEMENT

- IMPORTED COVER SOIL TO BE FREE OF COARSE FRAGMENTS, IDEALLY LOAMY TEXTURE, PH 6.5-7.5
- AMENDMENTS MIXED IN AT RATES DESCRIBED BELOW
- HETEROGENIC SURFACE DEVELOPED BY POCKMARKING WITH MINI-EX OR EQUIVALENT
- WOODY DEBRIS PLACED RANDOMLY TO PRODUCE 10% COVER ACROSS FLOODPLAIN

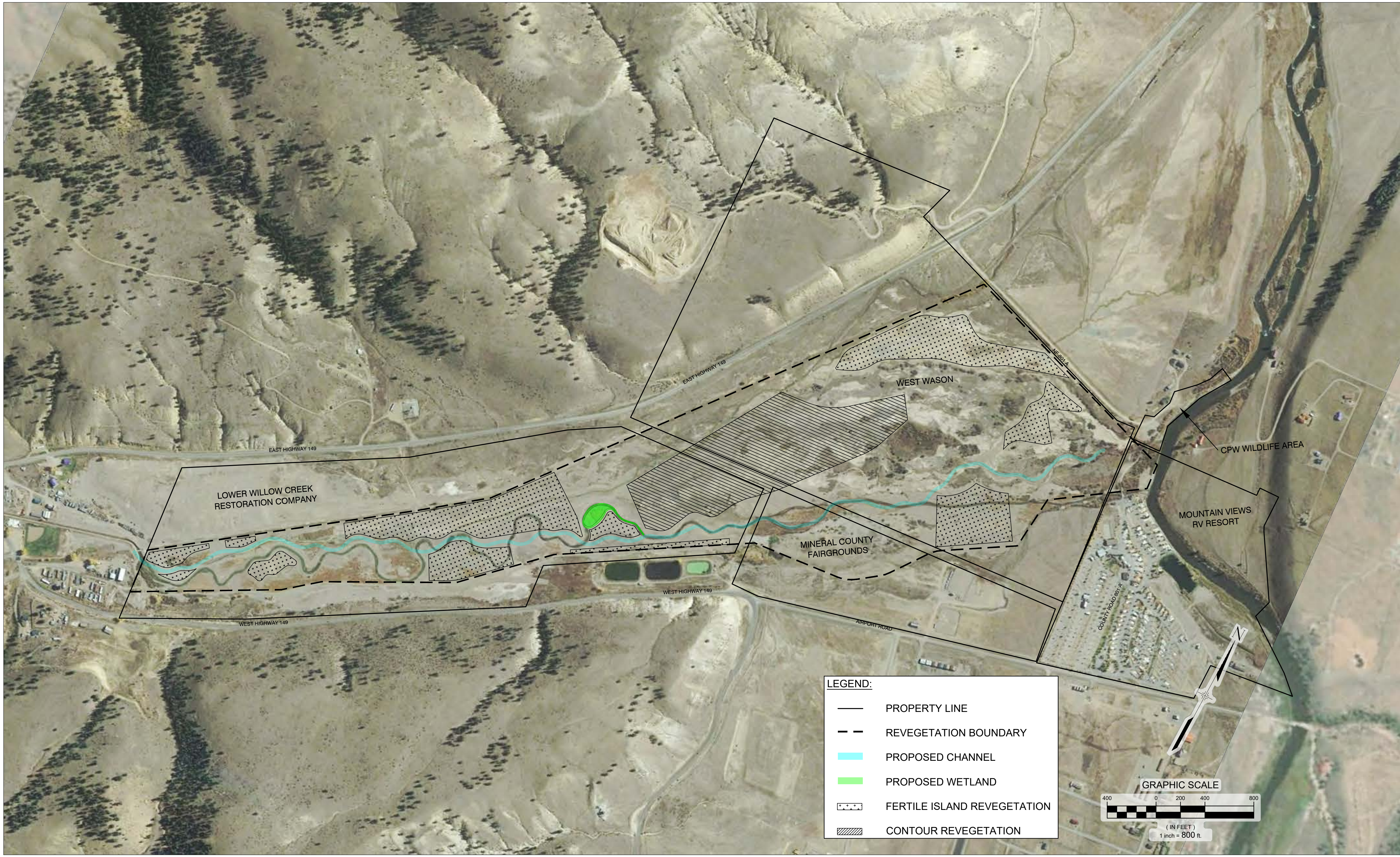
AMENDMENTS

- BIOCHAR MIXED INTO COVER MATERIAL AT 7.5% VOL/VOL
- RICHLAWN 3-6-3 WITH MYCORRHIZAE AND HUMATES 2,000 POUNDS/ACRE

SEEDING GUIDANCE

1. SEED METHODOLOGY: THE FOLLOWING METHODOLOGY PROVIDES SEQUENCING FOR ESTABLISHING THE SEED MIXES PRESCRIBED HEREIN. THIS PROCESS SHOULD BEGIN FOLLOWING FINAL GRADING. THE BEST TIME TO SEED FOR THIS PROJECT IS IN THE FALL AND NO LATER THAN NOVEMBER 30. THE SEEDING SEQUENCE SHOULD BEGIN NO LONGER THAN 48 HOURS AFTER FINAL GRADING. SITE STABILIZATION TECHNIQUES SHOULD BE UTILIZED IN THIS 48-HOUR TIME PERIOD.
2. SEED BED PREPARATION: SEED BED PREPARATION IS THE PROCESS OF LOOSENING THE SOIL SURFACE TO CREATE A LOOSE, FRIABLE, SOIL SURFACE. SOIL PREPARATION SHOULD ONLY OCCUR WHEN WEATHER, SOIL CONDITIONS, AND CONSTRUCTION PHASING ALLOWS FOR NO LONGER THAN 48 HOURS BETWEEN PREPARATION (THE BEGINNING OF THE SEEDING PROCESS) AND HYDROSEEDING. APPROPRIATE SEED RATES FOR EACH PRESCRIBED SEED MIX ARE SPECIFIED ON THE ACCOMPANYING DETAILS.
3. SEEDING: INITIAL DRILL SEEDING WILL OCCUR WITH ONE PASS OF A DRILL SEEDER. THE REMAINING SEED WILL BE INCORPORATED INTO AN HYDRAULIC MULCH (FLEXTERRA OR EQUIVALENT APPLIED AT 3,000 LB/ACRE) AND APPLIED TO ACHIEVE 100% COVER.
4. NATIVE HAY GRASS MULCHING/CRIMPING: NATIVE HAY GRASS MULCH WILL BE APPLIED TO SEEDED/RECLAIMED AREAS IMMEDIATELY FOLLOWING SEEDING APPLICATION TO PROVIDE ADDITIONAL SITE STABILIZATION AND A MORE SUITABLE SEEDBED. ALL NATIVE HAY GRASS MUST BE WEED-FREE CERTIFIED, WITH DOCUMENTED SOURCE AND SPECIES.
5. RESEEDING: AREAS TO BE RESEEDED SHALL FOLLOW THE SAME SEEDING SEQUENCE OUTLINED ABOVE. IT IS EXPECTED THAT SOME SEEDED AREAS MAY NOT GERMINATE, BUT THAT OVER TIME THE PLANTED AREAS SHALL FILL IN THROUGH SEED PROLIFERATION AND GROWTH HABITS. AREAS LARGE ENOUGH TO BE IDENTIFIED THROUGH MONITORING AS BEING DOMINATED BY WEEDS OR OTHER INVASIVE SPECIES THAT HAVE OUT COMPETED THE SPECIFIED SEED MIX OR AREAS DEEMED UNSTABLE DUE TO LOW PLANT GROWTH SHALL BE RESEEDED ACCORDINGLY.
6. PLANT SUCCESSION NOTES: IT IS POSSIBLE THAT OVER TIME SOME SEEDED AREAS MIGHT BECOME DOMINATED BY NATIVE PLANT SPECIES EXISTING IN THE SOIL SEED BANK. ONE EXAMPLE OF THIS IS THE LIKELIHOOD THAT VARIOUS TYPES OF NATIVE SEDGES NOT INCLUDED IN THE SEED MIX COULD EMERGE IN WETLAND AREAS. ESTABLISHED EXISTING NATIVE SPECIES ARE HIGHLY DESIRABLE BECAUSE THEY ARE PROVEN TO EXIST AND THRIVE IN THE IDENTIFIED PLANTING AREAS AND ADD TO LANDSCAPE DIVERSITY. NATIVE SPECIES THAT EMERGE DUE TO BEING IN THE SOIL SEED BANK SHOULD REMAIN. THOROUGH AND REGULAR MONITORING DURING THE MATURATION OF THE ESTABLISHMENT AREAS IS A KEY COMPONENT TO BALANCING AREAS TO BE RESEEDED AND AREAS WHERE SUCCESSIONAL PLANT GROWTH OF NATIVES SHOULD BE ALLOWED TO THRIVE.

Know what's **below.** **Call** before you dig.



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X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE-DEN-FILE02
63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU
63588-LowerWillow-PlantingPlanSet-07272021
63588-TitleBlock-ANSI-D

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PROJECT No. 20.1183.001

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION 60% DESIGN PLANS

FLOODPLAIN REVEGETATION PLAN - OVERVIEW

DESIGNED BY: --	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: TS	HORIZ. 1" = 800'		RV03
CHECKED BY: AH	VERT. N/A	SHEET 17 OF 25	

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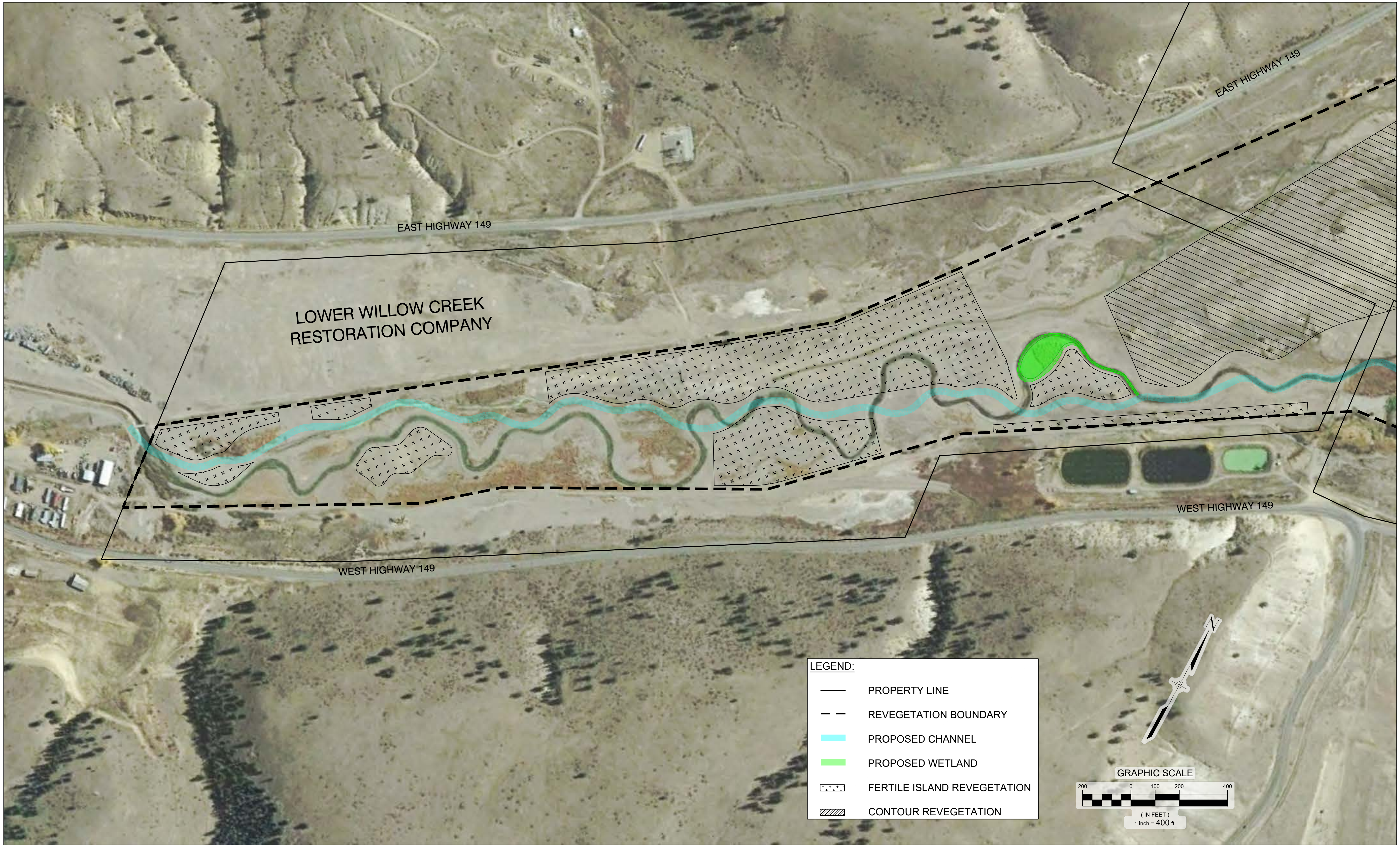

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63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU
63588-LowerWillow-PlantingPlanSet-07272021
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No.	DATE	DESCRIPTION	BY

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PROJECT No. 20.1183.001

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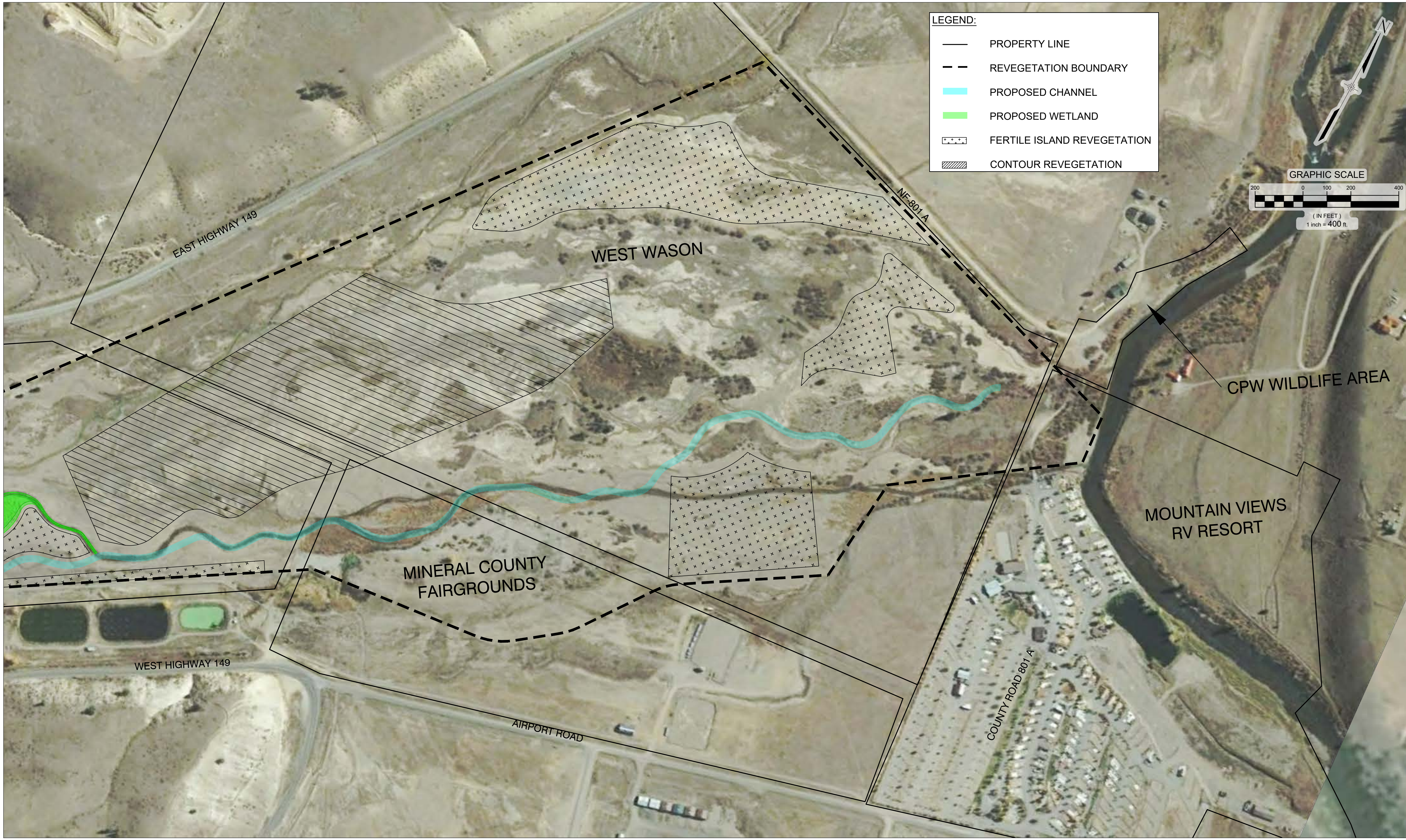
LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

FLOODPLAIN REVEGETATION PLAN - NORTH

DESIGNED BY:	--	SCALE		DATE ISSUED: August 2021	DRAWING No.
DRAWN BY:	TS	HORIZ.	1" = 400'	SHEET 18 OF 25	RV04
CHECKED BY:	AH	VERT.	N/A		



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GRAPHIC SCALE
200 0 100 200 400
(IN FEET)
1 inch = 400 ft.

REFERENCE DRAWINGS
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X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE-DEN-FILE02
63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU
63588-LowerWillow-PlantingPlanSet-07272021
63588-TitleBlock-ANSI-D

No.	DATE	DESCRIPTION	BY

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PROJECT No. 20.1183.001

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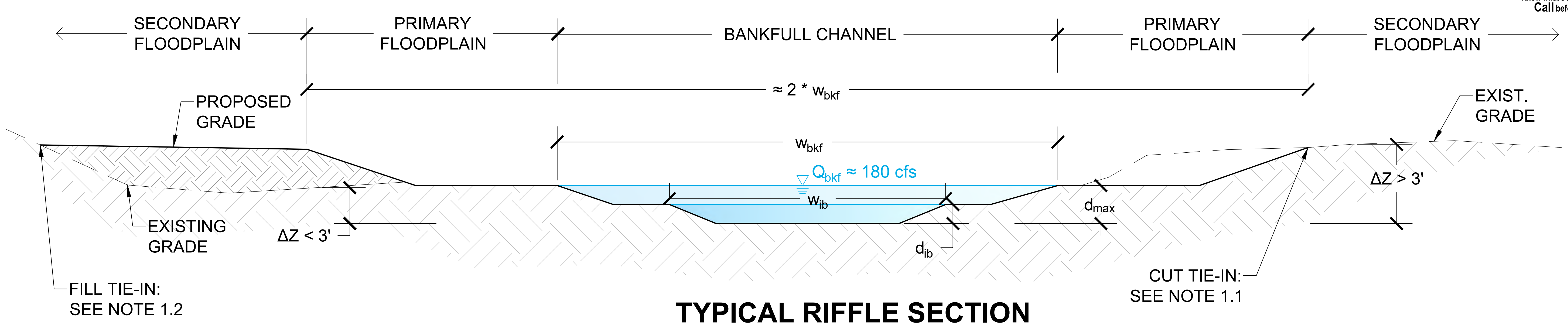
LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

FLOODPLAIN REVEGETATION PLAN - SOUTH

DESIGNED BY: --	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: TS	HORIZ. 1" = 400'	SHEET 19 OF 25	RV05
CHECKED BY: AH	VERT. N/A		



TYPICAL RIFFLE SECTION

NOT TO SCALE

NOTES ON BANKFULL CHANNEL GRADING:

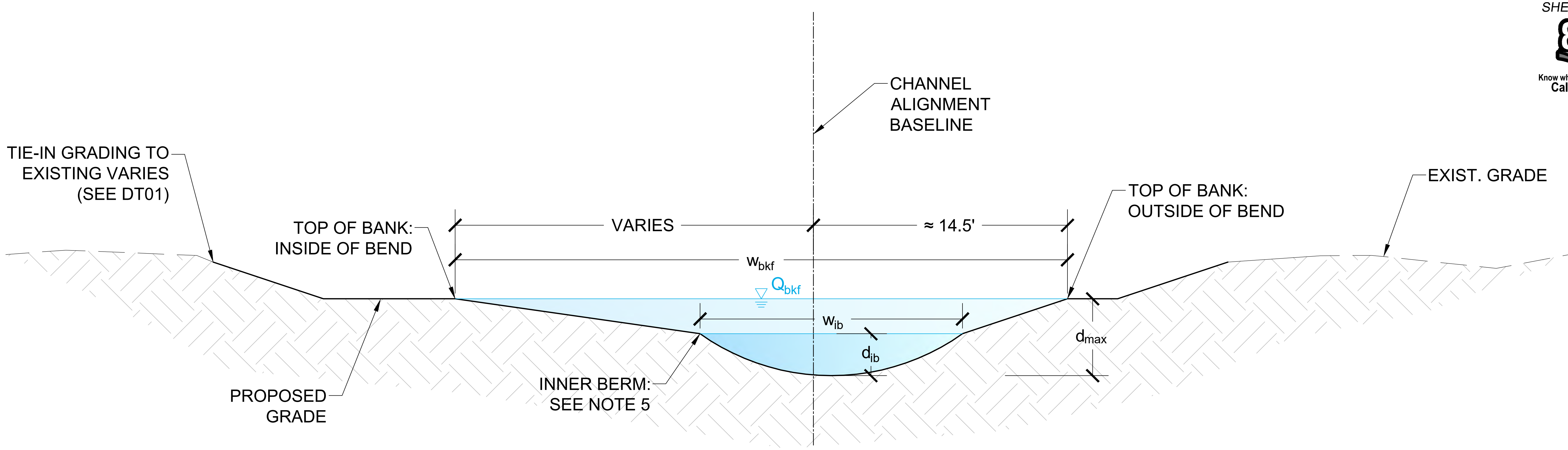
1. THE TYPICAL RIFFLE SECTION REPRESENTS THE CHANNEL CROSS SECTION AT THE HEAD OF THE RIFFLE FACET. THE LOCATIONS FOR THE HEAD OF RIFFLE ARE SHOWN IN THE PROFILE SHEET, CORRESPONDING TO THE TOP OF BANK STA./ELEV. CALLOUT.
2. SEE TABLE BELOW FOR TYPICAL VALUES FOR BANKFULL DIMENSIONS.
3. CREATE SMOOTH TRANSITIONS BETWEEN TYPICAL RIFFLE AND POOL SECTIONS.
4. BED MATERIAL PLACED IN THE CHANNEL BOTTOM SHOULD BE CONSISTENT WITH BED MATERIAL FOUND ONSITE (CONSISTING PRIMARILY OF COARSE GRAVEL/SMALL COBBLE).

DIMENSIONS FOR TYPICAL RIFFLE SECTION

		MINIMUM	TYPICAL	MAXIMUM
BANKFULL TOP WIDTH	W_{bkf}	27	29	31
BANKFULL MAX DEPTH	d_{max}	2.1	2.2	2.3
INNER BERM WIDTH	W_{ib}	14	16	22
INNER BERM MAX DEPTH	d_{ib}	1.0	1.1	1.2

NOTES ON FLOODPLAIN GRADING:

1. THE FLOODPLAIN GRADING DEPENDS UPON THE RELATIVE ELEVATION OF THE EXISTING FLOODPLAIN
   ΔZ = HEIGHT OF EXISTING ABOVE PROPOSED THALWEG ELEVATION
   THE FLOODPLAIN SHALL CONFORM TO THE FOLLOWING:
   - 1.1. CUT TIE-IN (ΔZ > 3'): TIE INTO EXISTING FLOODPLAIN AT APPROXIMATELY TWICE BANKFULL WIDTH (AS SHOWN ON THE RIGHT IN TYPICAL DETAIL).
   - 1.2. FILL TIE-IN (ΔZ < 3'): FILL WILL BE REQUIRED IN THE FLOODPLAIN OUTSIDE OF TWICE BANKFULL WIDTH (AS SHOWN ON LEFT IN TYPICAL DETAIL). FILL TO ACHIEVE A RELATIVE ELEVATION OF AT LEAST 3', WITH 4' BEING PREFERABLE. DO NOT CREATE A BERM IN THE FLOODPLAIN.
2. BY CONSTRUCTING FLOODPLAIN WIDTHS AND DEPTHS AT EACH RIFFLE SECTION PER THESE NOTES, SMOOTH TRANSITIONS CAN BE MADE IN THE FLOODPLAIN BETWEEN RIFFLE SECTIONS. IT SHOULD NOT BE THE CASE THAT THE FLOODPLAIN MEANDERS IDENTICALLY WITH THE CHANNEL. IN GENERAL, FLOODPLAIN WILL BE ORIENTED DOWN VALLEY, WITH MEANDERS MORE GRADUAL THAN THAT OF THE BANKFULL CHANNEL.
3. FLOODPLAIN GRADING WILL VARY BASED ON EXISTING CONDITIONS, AND THE ABOVE IS GENERAL GUIDANCE. FINAL TIE-IN GRADING TO BE VERIFIED BY ENGINEER.
4. SLOPES IN FLOODPLAIN SHOULD BE 3:1 OR FLATTER.
5. GRADING SHOULD HAVE NATURAL VARIABILITY TO AVOID UNIFORM APPEARANCE: E.G. AVOID IDENTICAL 3:1 SIDE SLOPES AND IDENTICAL FLOODPLAIN WIDTH.
6. PROPOSED GRADING COUNTOURS ARE SHOWN FROM STA. 14+30 TO 24+84 AND FROM STA. 87+92 TO 92+52. THESE TWO AREAS HAVE SIGNIFICANT CUT AND FILL FOR CONSTRUCTING THE PROPOSED CHANNEL AND FILLING THE EXISTING CHANNEL. THE PROPOSED CONTOURS SHOULD BE CONSIDERED APPROXIMATE. SPECIFICALLY:
   - 6.1. THE PROPOSED CONTOURS DO NOT SHOW VARYING SECTIONS WITHIN THE BANKFULL CHANNEL.
   - 6.2. THE PROPOSED FLOODPLAIN GRADING IS MOSTLY UNIFORM. FINAL FLOODPLAIN GRADING SHOULD MEET THE GUIDANCE OF THE PREVIOUS NOTE.



TYPICAL POOL SECTION

NOT TO SCALE

NOTES:

1. LOCATION OF POOL SECTIONS ARE SHOWN ON THE PROFILE SHEETS.
2. VARIATION IN BANKFULL WIDTH SHOULD PRIMARILY OCCUR ALONG THE INSIDE OF A BEND. THE OUTSIDE TOP OF BANK SHOULD MAINTAIN AN OFFSET OF APPROXIMATELY 14.5' FROM THE CENTERLINE ALIGNMENT, AS SHOWN ABOVE.
3. THE THALWEG POOL ELEVATION SHOWN IN THE PROFILE CORRESPONDS TO A MAX POOL DEPTH OF 4.5'. HOWEVER, VARIABILITY IN POOL DEPTH IS PREFERRED, WITH RANGES GIVEN IN THE TABLE AND GENERAL GUIDANCE AS FOLLOWS:
   - 3.1. EXCAVATE DEEPER POOLS IN TIGHTER/LONGER BENDS.
   - 3.2. EXCAVATE DEEPER POOLS THAT ARE DOWNSTREAM OF LONGER/STEEPER RIFFLES.
4. IN GENERAL, IT IS PREFERRED THAT POOLS ARE CONSTRUCTED DEEPER THAN SHALLOWER.
5. THE ELEVATION OF THE INNER BERM SHOULD BE SLIGHTLY HIGHER (APPROX. 0.1') THAN THE ELEVATION OF THE INNER BERM OF THE DOWNSTREAM RIFFLE.
6. FLOODPLAIN GRADING SHOULD FOLLOW THE GUIDANCE PROVIDED ON DT01 FOR THE TYPICAL RIFFLE SECTION. FLOODPLAIN GRADING ADJACENT TO THE POOL SECTIONS WILL BE ACCOMPLISHED BY SMOOTH TRANSITIONS IN FLOODPLAIN BETWEEN RIFFLE SECTIONS. GENERALLY, THERE WILL BE MORE FLOODPLAIN WIDTH ON THE INSIDE OF THE BEND, AS SHOWN ABOVE, PARTICULARLY AROUND LONGER/TIGHTER BENDS.
7. BED MATERIAL PLACED IN THE CHANNEL BOTTOM SHOULD BE CONSISTENT WITH BED MATERIAL FOUND ONSITE (CONSISTING PRIMARILY OF COARSE GRAVEL/SMALL COBBLE).

DIMENSIONS FOR TYPICAL POOL SECTION				
		MINIMUM	TYPICAL	MAXIMUM
BANKFULL TOP WIDTH	w_{bkf}	29	35	42
BANKFULL MAX DEPTH	d_{max}	3.6	4.5	5.1
INNER BERM WIDTH	w_{ib}	11	15	18
INNER BERM MAX DEPTH	d_{ib}	2.7	3.0	3.2

REFERENCE DRAWINGS
X-1183-MDG22x34

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60% DESIGN PLANS

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

TYPICAL POOL CROSS SECTION

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. N/A VERT. N/A
DATE ISSUED: August 2021
SHEET 21 OF 25
DRAWING No. DT02

DROP STRUCTURE EXAMPLES

MONUMENT CREEK IN COLORADO SPRINGS

MONUMENT CREEK IN COLORADO SPRINGS

MONUMENT CREEK IN COLORADO SPRINGS

CLEAR CREEK IN GOLDEN (BY OTHERS)

NOTE; DETAILS TO BE ADDED BASED ON STRUCTURE TYPE (SCULPTED CONCRETE OR GROUTED BOULDERS) AND FURTHER DESIGN.

SCULPTED CONCRETE

GROUTED BOULDERS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

DROP STRUCTURE DETAILS

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS

SCALE
HORIZ. N/A
VERT. N/A

DATE ISSUED: August 2021
SHEET 22 OF 25

DRAWING No. DT03

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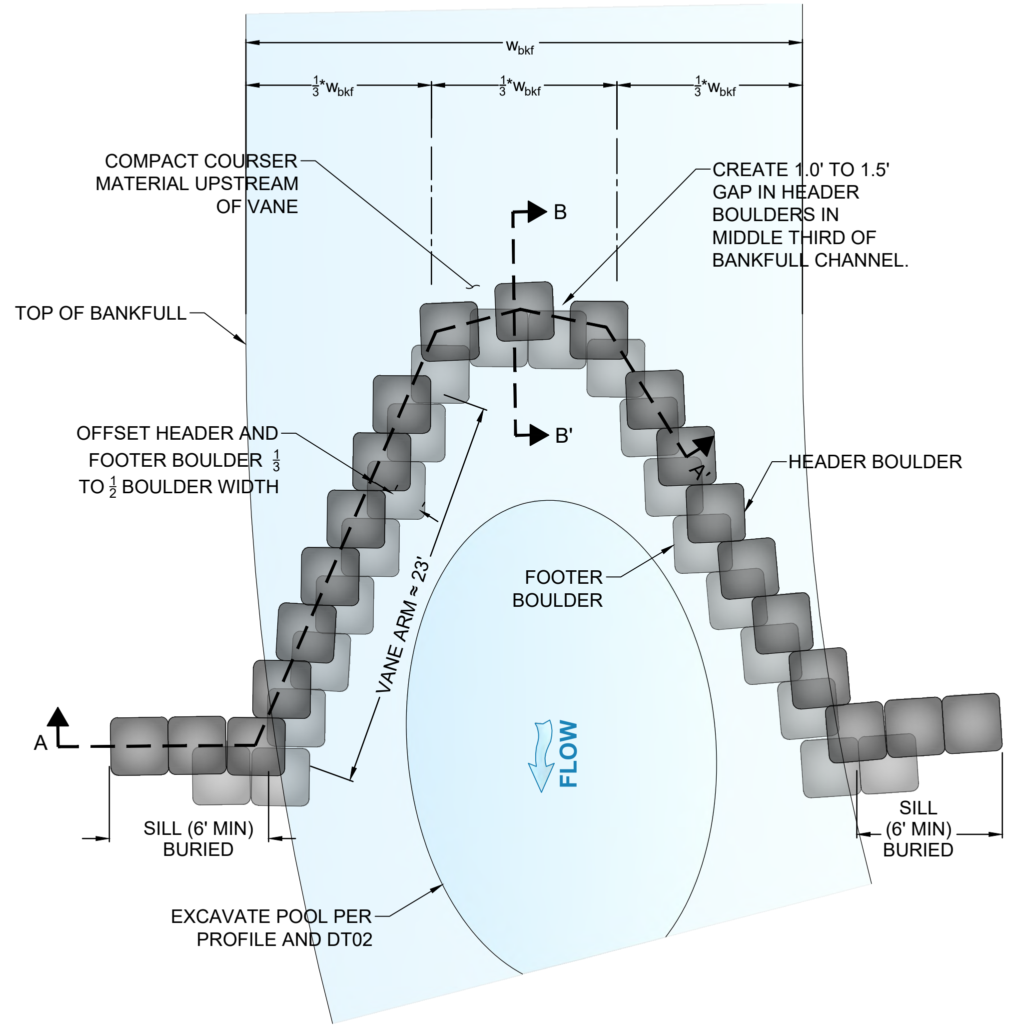
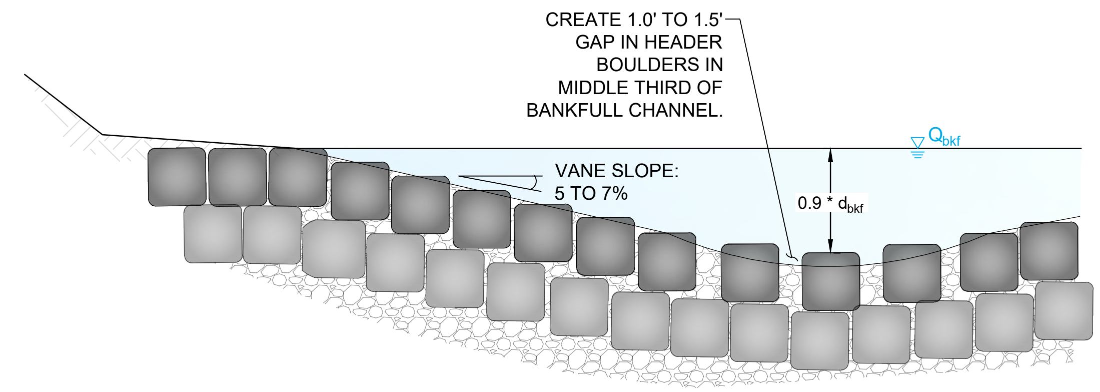


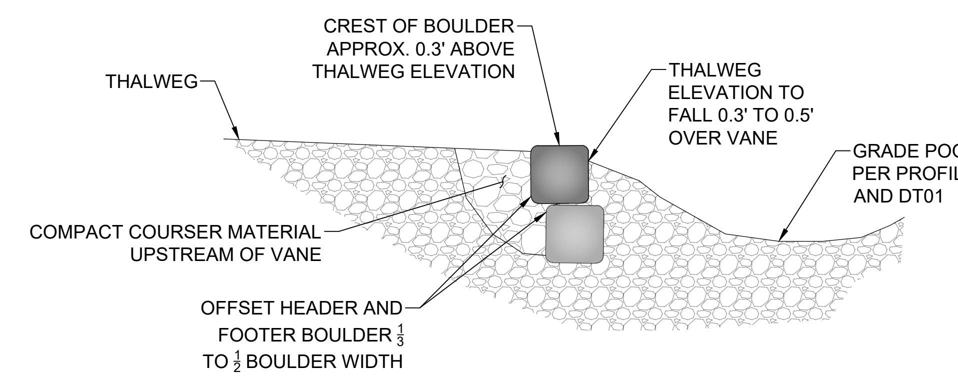
PLAN VIEW

NTS



CROSS VANE SECTION A-A'

LOOKING UPSTREAM NTS



CROSS VANE PROFILE B-B'

NTS

NOTES:
1. BOULDERS SHALL HAVE 3' NOMINAL DIAMETER OR LARGER.
2. GEOTEXTILE FABRIC SHALL BE MIRAFI FW 300 (OR APPROVED EQUAL).
3. FOR J-HOOKS, FOLLOW SAME DETAILS TO CONSTRUCT J-HOOK STRUCTURES. THE INSIDE OF BEND ARM WILL BE SHORTER, AS SHOWN IN PLAN VIEW ON THE PLAN AND PROFILE SHEETS. THE SILL ON THE INSIDE BEND WILL TIE-IN APPROXIMATELY 0.5' BELOW TOP OF BANKFULL.
4. LOGS MAY BE USED IN PLACE OF BOULDERS TO CONSTRUCT VANE ARMS, BASED ON AVAILABILITY OF MATERIALS. IF DESIRED, DETAILS FOR LOG VANES CAN BE PROVIDED.

TYPICAL ROCK CROSS VANE DETAILS

NOT TO SCALE

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PROJECT No. 20.1183.001

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

TYPICAL VANE/J-HOOK DETAIL

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DRAWN BY: EAL
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SCALE HORIZ. N/A VERT. N/A
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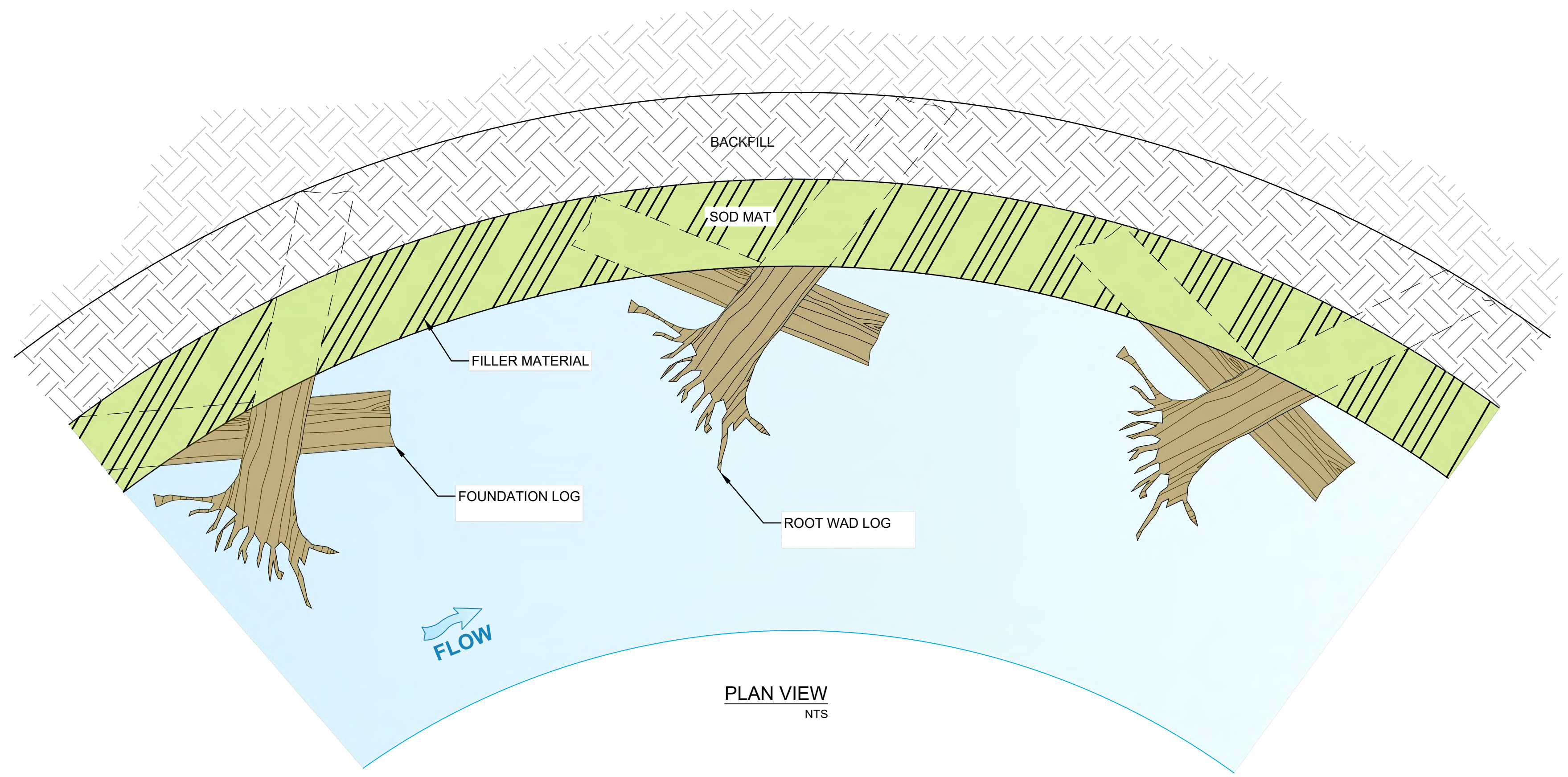
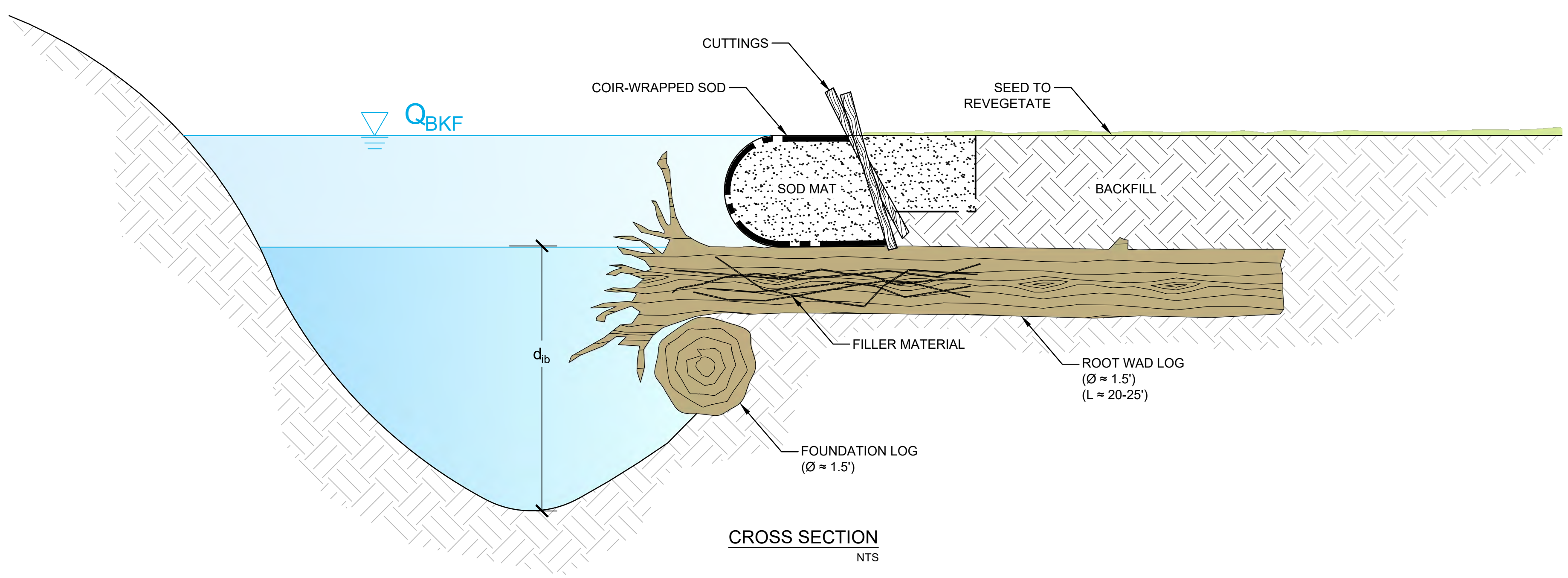


PLAN VIEW
NTS



CROSS SECTION
NTS

NOTES:

1. DIAMETER OF LOGS SHALL BE MIN. 1.5'. LENGTH OF ROOTWARD LOGS SHALL BE 20' TO 25'. LENGTH OF FOUNDTATION LOGS WILL DEPEND UPON ROOTWAD SPACING AND AVAILABILITY.
2. APPROXIMATELY 80% OF THE LENGTH OF FOUNDATION LOGS AND ROOTWAD LOGS SHALL BE BURIED BENEATH THE OUTSIDE BANK.
3. ROOTWAD DIAMATERS SHALL BE MIN. 6'.
4. SPACING OF ROOTWADS SHOULD BE APPROX. 12'.
5. THE TOP OF LOG ELEVATION SHOULD MATCH THE INNER BERM ELEVATION OF CHANNEL.
6. AFTER PLACEMENT OF FOUNDATION LOGS AND ROOTWADS:
   - 6.1. FILL SPACE BETWEEN ROOTWADS WITH LOGS OF DIAMETERS OF 6" TO 18")
   - 6.2. PLACE SLASH MATERIAL AS AVAILABLE OVER LOGS
   - 6.3. PLACE NATIVE SOIL MATERIAL OVER LOGS/SLASH TO ESTABLISH PROPER SUBGRADE ELEVATION FOR SODMAT SODMAT
   - 6.4. PLACE SODMAT AND COIR WRAP TO ESTABLISH TOP OF BANK. STAKE AS DIRECTED BY ENGINEER.
7. PLACE SILL LOGS AT BEGINNING AND END OF TOE WOOD PROTECTION.
8. ANCHORING OF TOE WOOD (SUCH AS WITH BOULDERS) MAY BE REQUIRED. FURTHER STRUCTURAL ANALYSIS REQUIRED BEFORE CONSTRUCTION OF TOE WOOD.

TYPICAL TOE WOOD DETAILS

NOT TO SCALE

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60% DESIGN PLANS

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

TYPICAL TOE WOOD DETAIL

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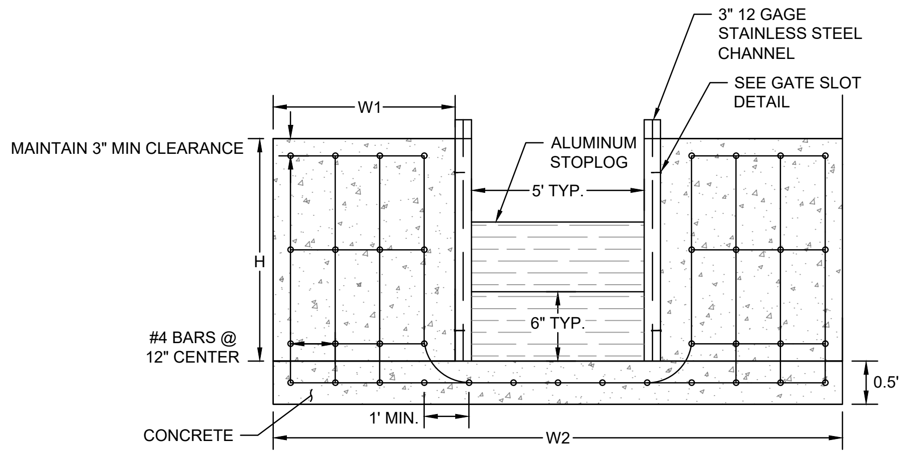

CHECK STRUCTURE
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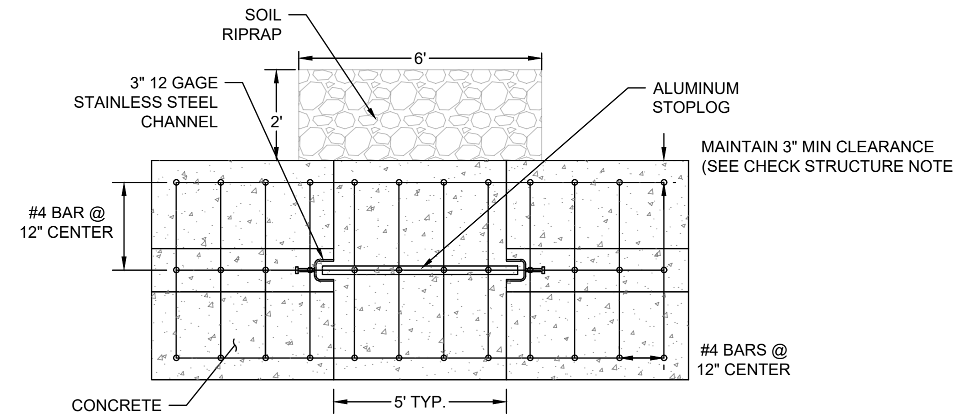

CHECK STRUCTURE TOP VIEW
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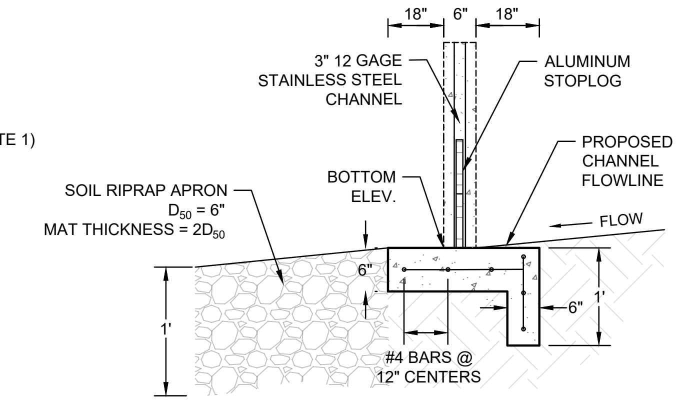

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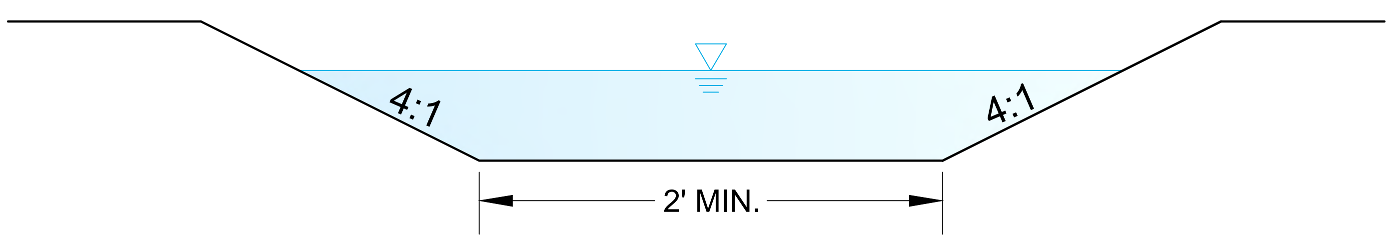

DIVERSION CHANNEL DETAIL
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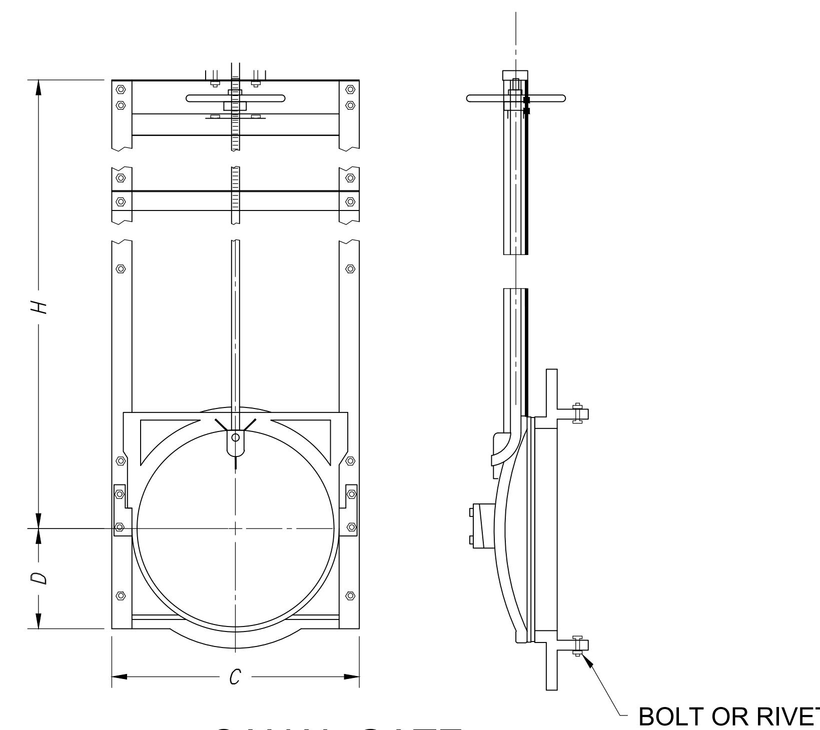

CANAL GATE
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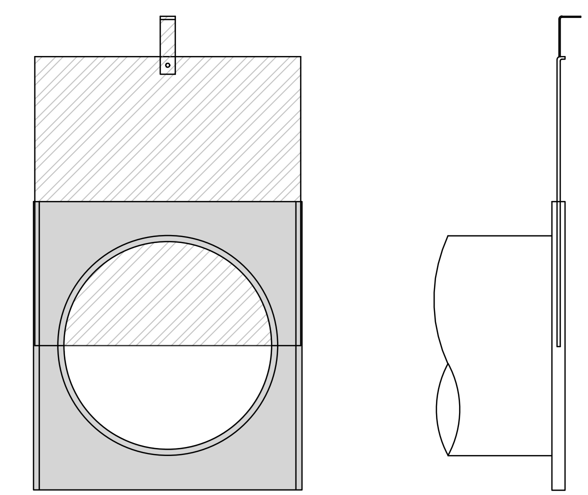

SLIDE GATE
NOT TO SCALE

CANAL GATE NOTES:

1. SHALL BE WATERMAN CANAL GATE MODEL NO. C-10 OR APPROVED EQUAL.
2. REFER TO WATERMAN STANDARD DRAWINGS AND MANUFACTURERS SPECIFICATIONS FOR ALL DIMENSION VALUES.
3. CONSULT MANUFACTURER FOR PIPE ADAPTER SPECIFICATIONS AND INSTALLATION.

SIDE GATE NOTES:

1. SHALL BE WATERMAN C-2 SLIDE GATE OR APPROVED EQUAL.

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

DIVERSION DETAILS

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. N/A VERT. N/A
DATE ISSUED: August 2021
SHEET 25 OF 25
DRAWING No. DT06

2435 Research Parkway, Suite 300
Colorado Springs, Colorado 80920
Phone: 719-575-0100
www.matrixdesigngroup.com

TECHNICAL MEMORANDUM

Date: August 16, 2021

To: Heather Greenwolf, Headwaters Alliance
Jason Willis, P.E., Trout Unlimited

From: Aaron Sutherlin, P.E. – Matrix Design Group, Inc.
Andrew Harley, PhD – SWCA Environmental Consultants

RE: Draft 60% Design Memorandum – Lower Willow Creek Floodplain Restoration

---

Purpose

The purpose of this memorandum is to provide technical details and context for the design approach used in developing a 60% Design Plan Set for the Stream Restoration and Environmental Design of Lower Willow Creek Floodplain (Project) located in Creede, Colorado. This memorandum references and, where applicable, summarizes available background and existing data provided by others.

Background

The project area extends approximately 1.7 miles along Lower Willow Creek starting at the downstream end of "the flume" that conveys water through the City of Creede and ending downstream at the confluence with the Rio Grande River. The contributing watershed at the confluence is 39.8 mi^2. The area includes approximately 300 acres of heavily disturbed, debilitated floodplain and involves five landowners including (Figure 1):

- Lower Willow Creek Restoration Company (LWCRCo)
- Mineral County Fairgrounds Association
- Wason Ranch, LLC
- Mountain Views RV Park
- Colorado Parks and Wildlife.

A floodplain rehabilitation design was implemented from 2012 to 2018. In 2019 the improvements were compromised by an approximate 690 cfs snowpack runoff event. The design channel was flanked along the eastern edge of the project area resulting in an unstable multithread channel with limited sediment transport capacity, and has left the Mineral Fairgrounds diversion structure hydraulically disconnected from Lower Willow Creek. Topsoil was lost in the adjacent floodplain, leaving much of the project area void of desirable vegetation and reducing the effectiveness of metal remediation efforts.

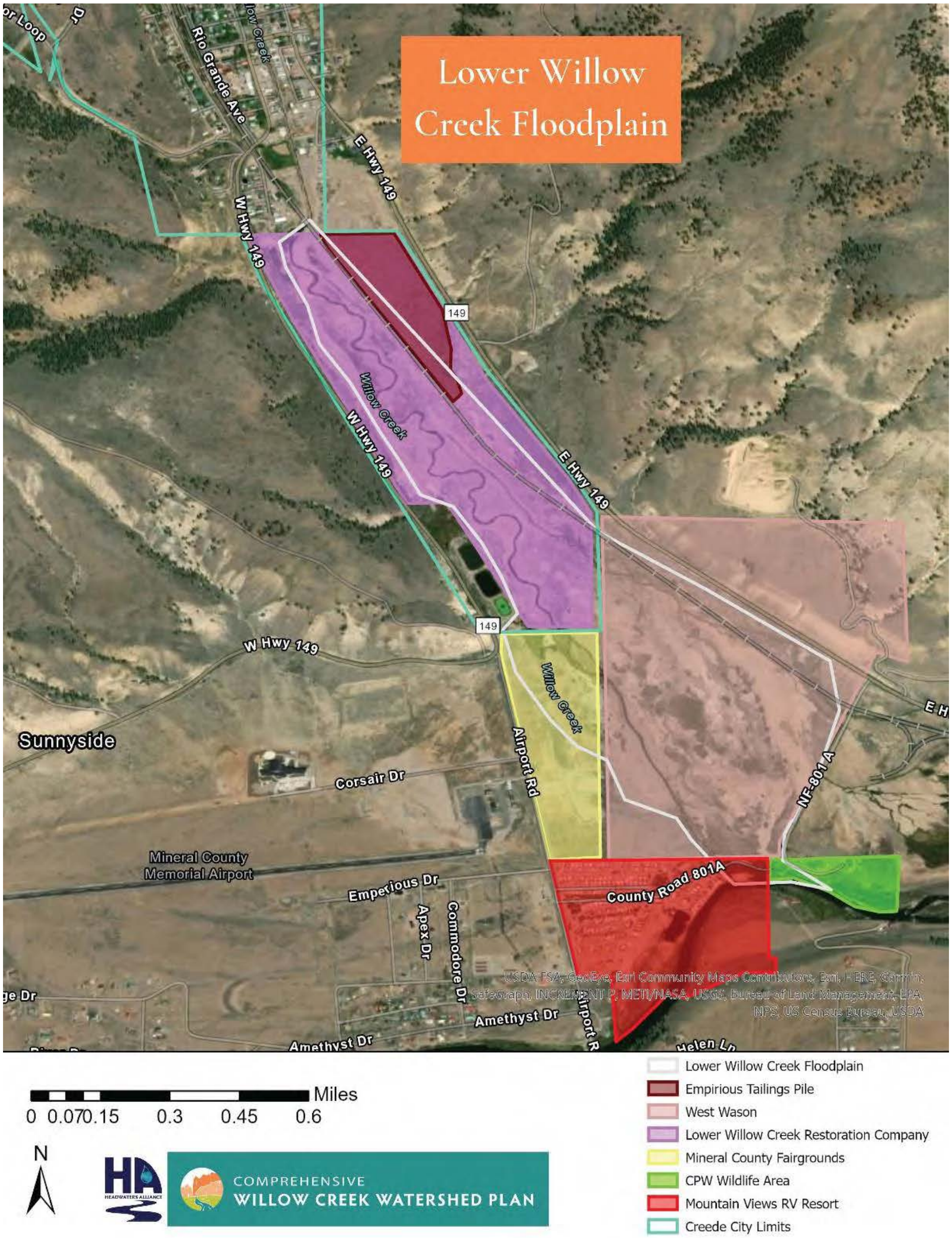

Figure 1: Lower Willow Creek Floodplain Area with Approximate Property Boundaries (figure provided by HWA)

The LWCRCo property includes a Voluntary Cleanup Plan (VCUP) prepared by Casey Resources (CRI, 2011) and an accompanying Materials Management Plan (MMP) (CRI, 2012). Components of the VCUP and MMP to be incorporated into construction activities on LWCRCo:

- Restoration Action Levels: A value of 1,500 mg/kg for lead has been selected within the channel. Floodplain material above this Action Levels is to be placed 20 feet or more away from the edge of the new channel alignment. Field determination of lead was by means of portable XRF and may require field calibration.
- Imported Soil Action Levels: Soil imported for construction will need to meet the Restoration Action Level.
- Surface and Groundwater Action Levels: No action level has been established as water remediation will not be undertaken.
- Dust Action Level: The site has a zero visible dust standard.

Remediation during 1995-1996 excavated 5,000 cubic yards of material within the floodplain and placed the impacted materials in a repository at the southern end of the Emperius tailings pile. Reclamation and restoration activities between 2012-2018 included the engineering, reconstruction, and revegetation of the Lower Willow Creek Channel and installation of approximately 12 inches of cover soil over 22 acres of lead impacted soils to meet the Restoration Action Level of 1,500 mg/kg lead in accordance with the Materials Management Plan (CRI, 2012).

Prior to erosion associated with the 2019 runoff event, seeded areas on the surface capping were becoming established and planted willow cuttings within the bank were showing noticeable growth. The high-water event required re-design of the channel to account for additional peak flow events. Historical data related to remediation and revegetation of the Lower Willow Creek floodplain has been reviewed with respect to current stream design plans and to support the restoration effort.

A new design is required to meet the following pre-established baseline parameters:

1. Reconstruction of the Lower Willow Creek channel to establish a connective design between the stream channel, floodplain and Rio Grande. This plan should provide and promote fish and macroinvertebrate habitat.

2. Provides a reliable degree of permanence from a hydraulic perspective to protect open space features, infrastructure, and property during high flow/flood events from either rain events or melting of snowpack. Design may and/or will:

    a. Possess characteristics of a single thread channel that also incorporates wetlands, oxbows, backwater channels, and a connected floodplain.

    b. Address the discharge at the flume which will require energy dissipation or diversion to slow flow velocity and/or to increase channel capacity during high flow.

    c. Address the two confluences of Willow Creek with the Rio Grande, including addressing the temporary diversion installed in the 2019 runoff event.

   d. Meet or exceed 100-year flow volume as defined in the *CHAMP Phase III, Mineral County, Colorado Hydrologic Analyses Report, December 2019*.

3. Provides streamflow to the two adjudicated water diversions (Wason Property and Mineral County Fairgrounds) currently constructed in the floodplain.

4. Provide stabilization so as to protect the existing infrastructure (railroad bed, sewer interceptor and treatment lagoons).

5. Focus on site-specific vegetation plan to include minimizing disturbance to active/current vegetation; revegetation of areas disturbed adjacent to channel reconstruction and those areas that were flood impacted and/or require capping.

6. Complies with the State of Colorado VCUP prepared for the floodplain and approved by the Colorado Department of Public Health and Environment (CDPHE) for the Lower Willow Creek Reclamation Company (LWCRC) property. This may include the re-establishment of the 1-foot thick soil cap per the approved VCUP for LWCRC form a yet-to-be established soil borrow area.

Current Site Conditions

Alluvial floodplain sediment consists of poorly sorted, sub-angular to sub-rounded gravely to stony coarse material with a fine-grained matrix (Figure 2). Vegetation is sparse, establishing in areas of localized moisture retention (Figure 3). Established vegetation was consistently seen around woody debris that had captured additional fine materials from high water events and are able to retain moisture for longer durations throughout the growing season (Figure 4).

Approximately 21,000 cubic yards of fine-grained material was placed in the upper portion of the floodplain (RSA, 2016). Where observable, cover thickness was approximately 12 inches (Figure 5). Revegetation was variable ranging from reasonable cover (Figure 6) to sparsely vegetated/bare ground (Figure 7). Vegetation growth appears to be influenced by proximity to the channel and available soil moisture.

Woody vegetation consisted of willows planted for channel stabilization (Figure 8) and flood management (Figure 9). Plantings were added to the prior channel before the breakthrough flow. The willows had established well. However, following channel realignment, the willows became stressed although new growth was observed during Spring 2021 (Figure 8). A constructed wetland in the middle portion of the floodplain is well established and is receiving sufficient water to sustain healthy growth.

Figure 2: Rocky alluvial sediments

Figure 3: Sparsely vegetated rocky surface

Figure 4: Enhanced vegetative growth associated with woody debris.

Figure 5: Cover material overlying alluvial sediments

Figure 6: Revegetated surface of cover material.

Figure 7: Sparsely vegetated cover material

Figure 8: Planted willows in the former channel.

Figure 9: Existing constructed wetlands

Soil Characteristics

Soils in the highly disturbed floodplain between Creede and the confluence with the Rio Grande have been mapped as Aquic Cryofluvents[1] (EPA, 2005; NRCS, 2007), and described as follows:

- Deep very gravelly and very cobbly stratified sands with very low available water holding capacity.
- Depth to a seasonal high-water table ranges between 0.5 to 3.0 feet.
- pH ranges 5.4 to 6.8 and localized salinity observed at the surface.

Soil sampling conducted by Colorado Department of Public Health and Environment (CDPHE, 2009) indicated elevated concentrations of total arsenic, lead and zinc, with limited leaching potential. In general, metal concentrations were higher in the northern portion of the floodplain compared to the southern portion (CRI, 2017). Several remedial actions have been undertaken:

- During 1995 and 1996, approximately 5,000 cubic yards of remnant dams, dikes and historical tailings were removed from the floodplain, placed in a repository, capped with a geo-synthetic liner, covered with six inches of topsoil and seeded (CRI, 2012).
- In accordance with a Materials Management Plan (CRI, 2012) and subsequent variance (CRI, 2017), channel reconstruction removed fine grained sediment with lead concentrations above an initial action level of 1,500 mg/kg. Management of the fines separated from the coarse material has not been documented, however discussion with Headwaters Alliance indicate that this material has been placed on the upper portions of the floodplain.

A review of restoration potential was undertaken in 2014 (KCH, 2014) identified several limitations to revegetation in Lower Willow Creek, including:

- Limited available water holding capacity in a semi-arid environment.
- Lack of organic matter and poor nutrient status leading to low biological function.
- Excessive coarse fractions including gravels and cobbles.
- Presence of mine waste with geochemical-limiting properties including low pH and high metal content.
- Presence of localized surface salts.

Vegetation Communities

The Landtype Unit is characterized as Tufted Hairgrass/Sedge on floodplains (NRCS, 2007). Vegetation along the floodplain is primarily found along the water courses and areas that are subirrigated. Existing vegetation is dominated by graminoids, interspersed with wetlands and bands of willows.

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[1] Aquic: Periodically saturated with reducing conditions. Cryo: Cold. Fluvents: Recent water deposited sediments. i.e. recent floodplain sediments deposited within a cold climate that are periodically inundated leading to saturated and reduced conditions within the soil profile.

Dominant graminoids included tufted hairgrass (*Deschampsia cespitosa*), redtop (*Agrostis gigantea*), bluejoint reedgrass (*Calamagrostis canadensis*), and water sedge (*Carex aquatilis*). In drier, gravelly areas, wheatgrass (*Elymus* and *Pascopyrum* spp.), fescue (*Festuca* spp.), bluegrass (*Poa* spp.), brome (*Bromus* spp.), and squirreltail (*Elymus elymoides*). Wetlands are dominated by water sedge and many species of willows (*Salix* spp.) are observed throughout the floodplain.

Grass revegetation trials in an upland area were conducted during the growing season from 1999 to 2003 (Willow Creek Reclamation Committee, undated report). Results were highly dependent on water availability, with amended plots responding well during favorable moisture years, regardless of specific amendments. Trees planted midway up the bank performed the best, again dependent on water availability.

Tree planting trials were undertaken with willow fascines, cottonwood poles and potted trees (NRCS, 2007). Potted trees had the highest survival rates with pole plantings midway up the bank performed best – lower plantings rotted and higher plantings suffered water stress.

Following earthmoving and capping activities in 2016 and 2017 (CRI, 2017), a grass mix (Western wheatgrass [*Pascopyrum smithii*], Blue gramma [*Bouteloua gracilis*], Arizona fescue [*Festuca arizonica*] and crested wheatgrass [*Agropyron cristatum*]) was applied with a hydromulch on newly constructed areas and 50 feet on either side of Lower Willow Creek.

Approach

The restoration approach focuses primarily on two elements: a stable channel and a functional, productive floodplain. For the Project a low sinuosity, moderately entrenched, multi-staged, single-thread channel is proposed, with a vegetated floodplain on both sides. A single-thread channel will replace the currently-avulsed multithread channel. A single-thread channel was chosen to maintain sediment transport capacity and allow for desired irrigation diversion tie in points. The design intent is to convey frequent, minor runoff events within the channel corridor, and to engage the floodplain with less frequent, major runoff events. This approach provides for flood flows to be distributed across the floodplain at shallow depths, with diminished scour potential, allowing natural processes to provide long term stability and ecological resiliency.

Further, the restoration approach addresses four items identified by the design team from the existing conditions and the previous design that were deemed high priority for addressing stability in the proposed project. The items follow:

1. Stabilization and energy dissipation at the outlet of the flume,
2. Maintain an active channel at the low point in the existing valley,
3. Increase the channel entrenchment
4. Decrease channel sinuosity.

Site Survey

In December 2020 Matrix and Blue Mountain Consultants (Blue Mountain) collected topographic survey data within the Project area. Data was strategically collected to supplement LiDAR data (provided by others) collected in 2019. Transects were taken perpendicular to the channel corridor from the upstream limits of the Project down to the confluence with the Rio Grande. Survey data was also collected at key tie-in points including the flume outlet, and the Wason and County diversion structures. Detailed cross section and longitudinal profile data was collected along a reach near the confluence. This reach, shown below in Figure 10, appeared to be stable and was used to guide channel design decisions.

Figure 10: Stable Downstream Reach

Reference Reach Data

The reference reach is used to develop natural channel design criteria based upon measured morphological relations associated with the bankfull stage for a specific stable stream type. Specific data on stream channel dimension, pattern and profile are collected and presented by dimensionless ratios by stream type. The reference reach is a portion of a river segment that represents a stable channel within a particular valley morphology. The morphological data collected is used for extrapolation to disturbed or unstable reaches in similar valley types for the purposes of restoration, stream enhancement, stabilization, and stream naturalization schemes. Bankfull discharge and dimensions from streamgage stations for particular hydro-physiographic provinces are correlated with drainage area to develop regional curves for extrapolation to non-gaged reaches. If the condition of the river being restored is extremely unstable, a dilemma often exists in the selection of the potential stream type and the associated morphological characteristics for a given flow and sediment regime, valley slope, and channel materials. Reference reach data using dimensionless ratios can be used to establish design values as long as the reference reach is representative of the same valley type and sediment regime (Rosgen, 1998).

Reference reach data, collected and compiled by Blue Mountain, was used as guidance for channel planform, profile and geometry. The reference reach is located on Trail Creek in both Teller and Douglas Counties (Figure 11). Data from this reach has been used successfully by the design team to guide the channel design on alluvial fans in Colorado and Arizona.

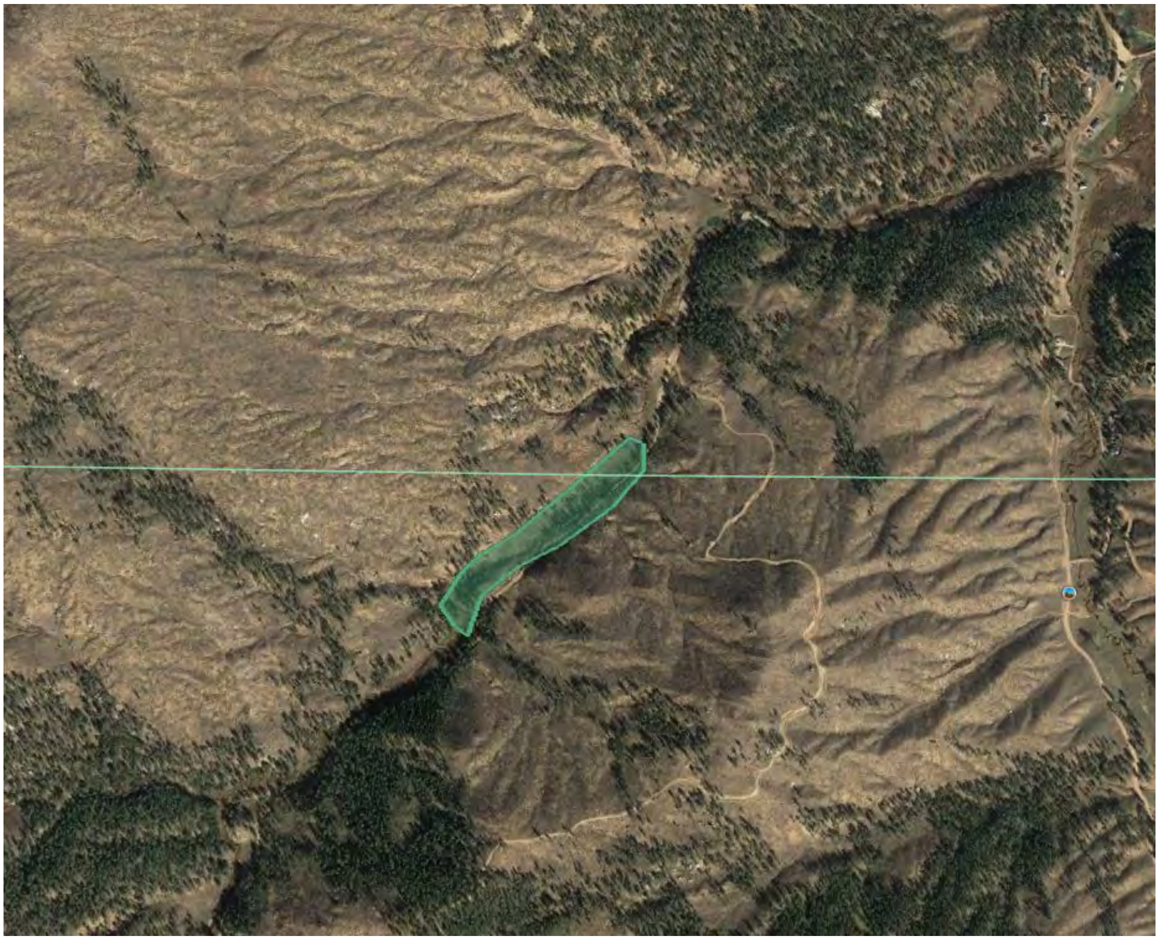

Figure 11: Approximate Reference Reach Location (39° 7'44.09"N, 105°10'22.84"W)

A summary of reference reach parameters are summarized below in the *Channel Design* section.

The Project reach is classified as multithread, gravel-dominated Stream Type D4 located on an active alluvial fan, based on Rosgen's "River Stability Field Guide." Due to upstream conditions including the flume and a sediment removal basin directly upstream of town, sediment supply is disrupted, causing the active fan to behave similarly to an inactive fan. This observation contributed to the design team selecting a Stream Type B3/4 for design.

Hydraulic calculations (described below in the *Hydraulics* section) were used to further assess parameter dimensions.

Hydrology

Hydrology for design was taken from the CHAMP Phase III, Mineral County, Colorado Hydrologic Report dated December 3, 2019. A summary of major recurrence interval runoff events is provided in Table 1.

Table 1: Willow Creek at Rio Grande Projected Flows (CWCB, 2019)

Recurrence Interval	**10-Year**	**25-Year**	**50-Year**	**100-Year**	**500-Year**
Discharge (ft^3/s)	591	831	1,030	1,250	1,840

For channel forming bankfull flow, gage data from 18 watersheds in the upper Rio Grande basin was used to develop regional regression equations relevant to the Project area (LWCRC, 2012). The flows for the 1.5 and 2-year recurrence intervals were 130 and 210 cfs, respectively. Using these regression equations, the bankfull discharge was estimated to be 170 cfs. Based on comprehensive literature review the design team estimates a bankfull discharge between 170 and 180 cfs is sufficient for bankfull channel design.

Hydraulics

The existing channel and floodplain hydraulics were assessed using the U.S. Army Corps of Engineers Hydrologic Engineering Center's River Analysis System v5.0.7 (HEC-RAS) hydraulic software. Proposed hydraulic calculations were completed for a general validation to support reference reach parameters for the channel configuration. Capacity calculations were completed with FHWA Hydraulic Toolbox v4.4 for the bankfull channel and for the floodplain area to assess capacity (Figure 12). Shear stresses were calculated along the floodplain and

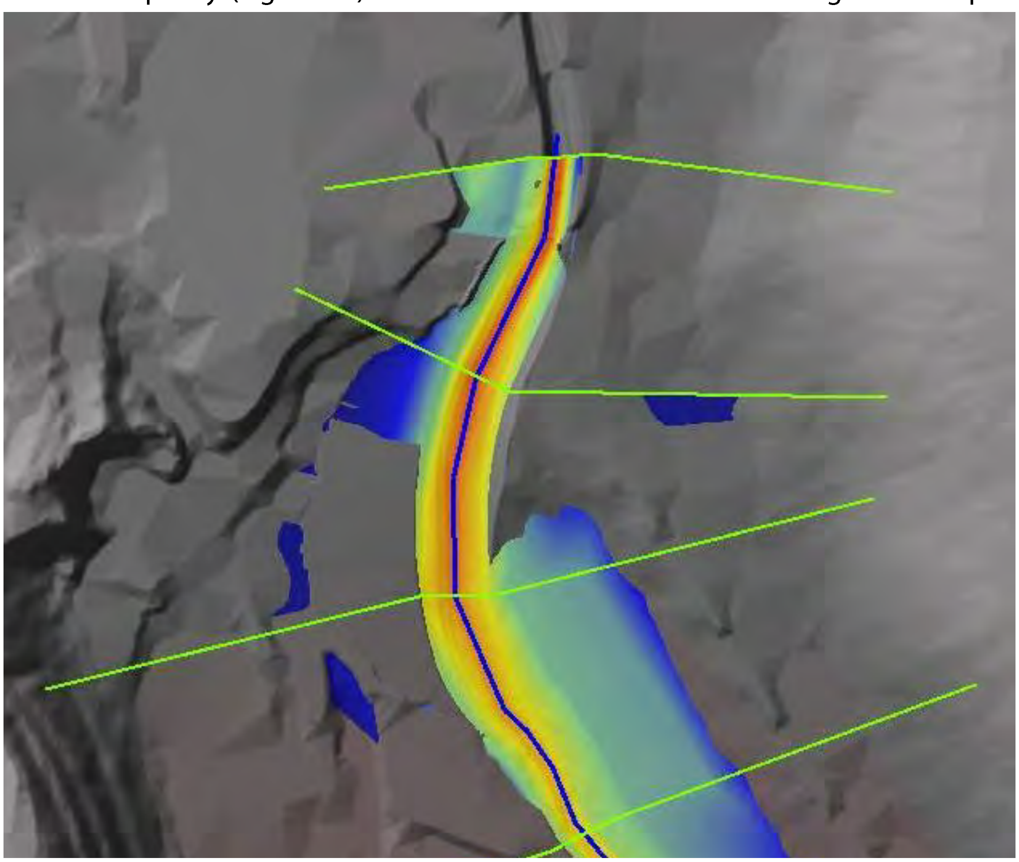

Figure 12: Preliminary Proposed Conditions HEC-RAS Model Showing Velocity Distribution at Flume Outlet

compared to permissible shear stresses associated with riparian vegetation and temporary erosion control measures (CWCB, 2016). Detailed results are included in Appendix B.

To further assess hydraulic conditions across the Project area, detailed grading and corresponding 1- and 2-dimensional models are recommended. A 2-dimensional model will easily identify areas of concern and help represent the alluvial fan-type characteristics with multiple diverging and converging flow paths through the overbanks, by illustrating a shear stress and velocity distribution.

Sediment Transport

Analysis of the sediment transport capacity of the proposed cross section was completed using the FLOWSED/POWERSED module of RIVERMorph® 5.2. This model analyzed the sediment transport capacity of the design cross section as compared to the flume section.

A flow duration curve was created at the USGS Gage upstream of Creede, CO, to provide annual flow data for the sediment transport analysis (Figure 13). An appropriate sediment rating curve and regional sediment curve was selected and the Parker (1990) transport equations were used. A summary of the sediment transport analysis is provided in Table 2.

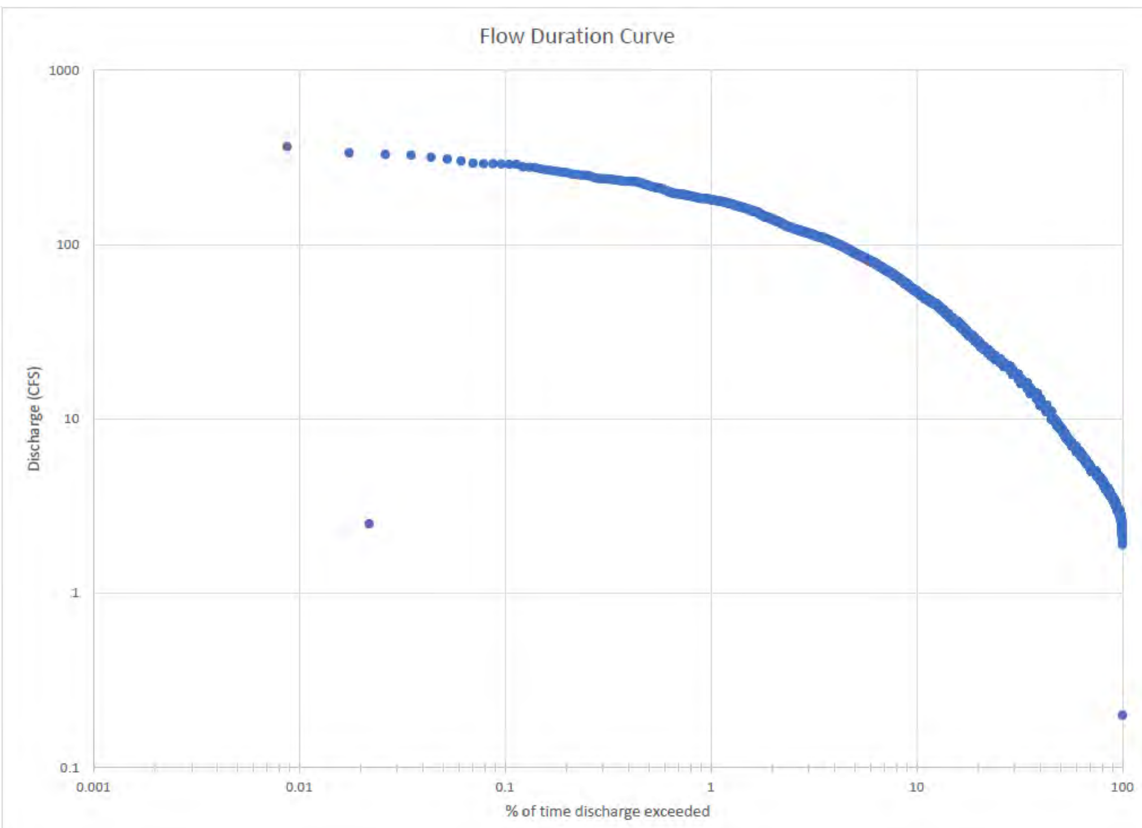

Figure 13: Flow Duration Curve from Upper Willow Creek USGS Gage

Table 2: Sediment Transport Capacity

	Total Annual Sediment Transport Capacity (tons/yr)
Sediment Rating Curve	South Platte Basin, CO: Good
Design Riffle	387.6
Contributing Reach (Flume)	330.1
Difference	+17%

This analysis shows an increase in the sediment transport capacity of the design riffle when compared to the flume, but is considered to be within an appropriate range of variability.

Channel Design

The proposed channel design provides a single-thread channel with hydraulic connection to an adjacent functional floodplain. "Fish friendly" boulder cross vane structures (described in further detail in the Project Elements section) are included as needed to provide both grade control and bank protection throughout the channel alignment.

Careful consideration is required to transition Lower Willow Creek from the flume to a natural channel continuing to the confluence with the Rio Grande. The channel will tie into a modified flume outlet (described in further detail in the Project Elements section) and robust grade control and energy dissipation elements will be constructed to provide for the channel transition. The flume conveys both minor and major flood events which typically correspond to channel and floodplain flow areas. Earthwork grading and structure placement at the flume outlet will be implemented to encourage multiple flow regimes to engage the natural channel at various stages and larger major flood flows to engage a vegetated functional floodplain. The establishment of floodplain benches will also help to reduce erosion by connecting the water table for vegetation establishment and by reducing the magnitude of shear stress experienced in the channel.

Channel design parameters including pattern (or planform), profile (or slope) and cross section (or geometry) are described below. Values were obtained by applying dimensionless relationships based on (width, depth and slope). Dimensionless relationships are defined as:

> *A ratio of a measured variable divided by a normalization variable generally related to the same variable but at the bankfull condition; e.g., depth divided bankfull depth (d/d_{bkf}) or bank height divided by bankfull height. Dimensionless ratios are used to adjust for scale and extrapolation of river properties. Dimensionless relations can be converted to dimensional relations by multiplying the numerator by the normalization parameter; e.g., (d/d_{bkf})(d_{bkf}) = actual value of depth at the bankfull condition for a river of different size and location but of similar morphological condition* (Rosgen, 2009).

Pattern

Channel pattern parameters are summarized in Table 3 below. Design values were obtained by normalizing the reference reach data by the bankfull width.

Table 3: Channel Parameters

DIMENSIONS FOR PLANFORM						
Parameter	**Design**			**Reference Reach**		
	Min	Typical	Max	Min	Typical	Max
STREAM MEANDER LENGTH	233	276	332	95	112	135
RADIUS OF CURVATURE	99	157	203	11	39	76
ARC LENGTH	57	148	249	10	40	71
RIFFLE LENGTH	6.6	36	69	2.7	14.7	28

Profile

Profile parameters are summarized in Tabel 4 below. Design dimensions were obtained by normalizing the reference reach data by the average bankfull slope.

Table 4: Profile Parameters

DIMENSIONS FOR PROFILE						
Parameter	**Design**			**Reference Reach**		
	Min	Typical	Max	Min	Typical	Max
RIFFLE SLOPE	1.20%	2.57%	4.43%	1.59%	3.40%	5.85%
POOL SLOPE	0.00%	0.21%	0.75%	0.00%	0.27%	1.00%

Cross Section

The bankfull flow investigation resulted in a design bankfull discharge of approximately 180 cfs. Analysis also indicated a bankfull channel depth of 2.2' (at riffle facet). A base flow channel was also incorporated into the bankfull channel. In addition to bankfull flow, the proposed design cross section accommodates the 100 year recurrence interval runoff by spreading and distributing flows between primary and secondary constructed floodplains as shown in Figure 14. Channel design cross section parameters are summarized in Tables 5 and 6 below. Dimensions were obtained by normalizing the reference reach data by the bankfull width. Figure 14 below shows proposed typical riffle cross section details.

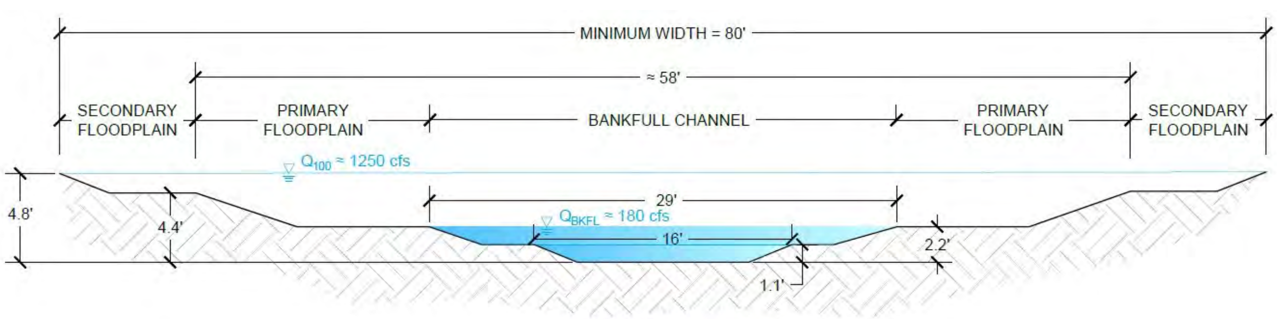

Figure 14: Typical Riffle Cross Section

Table 5: Riffle Parameters

DIMENSIONS FOR TYPICAL RIFFLE SECTION						
Parameter	Design			Reference Reach		
	Min	Typical	Max	Min	Typ	Max
BANKFULL TOP WIDTH (FT)	-	29	-	8	-	11
BANKFULL MAX DEPTH (FT)	2.1	2.2	2.3	1.08	1.13	1.18
BANKFULL MEAN DEPTH (FT)	--	1.46	--	0.67	0.75	0.83
BANKFULL AREA (SF)	--	42.2	--	6.9	7.1	7.3

Table 6: Pool Parameters

DIMENSIONS FOR TYPICAL POOL SECTION						
Parameter	Design			Reference Reach		
	Min	Typical	Max	Min	Typ	Max
BANKFULL TOP WIDTH (FT)	29	35	42	-	-	-
BANKFULL MAX DEPTH (FT)	3.6	4.5	5.1	1.33	1.56	1.85
BANKFULL MEAN DEPTH (FT)	0.59	0.8	1.05	1.15	1.56	2.04
BANKFULL AREA (SF)	50.4	52.9	57.2	8.5	8.9	9.6

Project Elements

Earthwork

Lower Willow Creek Restoration Company Properties

Prior to earthwork activities, surface debris will be removed and segregated according to woody debris to be used in surface restoration activities described below and trash to be removed from site and disposed of accordingly.

General conditions for earthworks undertaken on the LWCRCo will conform with the MMP (CRI, 2011):

- Floodplain materials will be sorted and sized in the field to separate out coarser materials that will be used to line the creek bottom and banks. Finer material will be screened and segregated according to the Restoration Action Levels (RAL). Fine material less than the RAL can be used for construction or revegetation. Fine material above the RAL will be used as fill material greater than 20 feet from the new channel.
- Groundwater encountered during construction will be managed in accordance with a Colorado Dewatering General Permit Program and Construction Discharge Permit Program.
- In accordance with a zero-dust emissions standard, fugitive dust will be controlled through the use of water. A Property Specific Dust Control Plan will be prepared prior to construction activities.
- Workers involved in regulated materials management will do so in accordance with OSHA regulation 29 CFR 1910.120.
- Equipment decontamination will be conducted in an established decontamination containment area in accordance with a Property Specific Decontamination Plan prepared by the contractor.

Based on previous investigations as summarized in the VCUP (CRI, 2011) and implementation of the VCUP (CRI, 2017), metal impacted sediments are greatest in the northern end of the channel, decreasing southwards towards Wason Ranch. Previous field screening indicates that material in the upper 2,000 feet of the channel have the potential to require segregation. Implementation of the 60% design indicates that channel construction will consist of cut and fill in pre-determined sections by the contractor. The design allows for fines to be incorporated into the channel bed. Review of available data provided by Casey Resources, Inc. and discussions with Mr Paul Casey, Figure 15 shows the location of the proposed channel with respect to lead concentrations in soil. These results indicate that the majority of the channel will pass through material below the Restoration Action Level, with the exception of one location as shown in Figure 15.

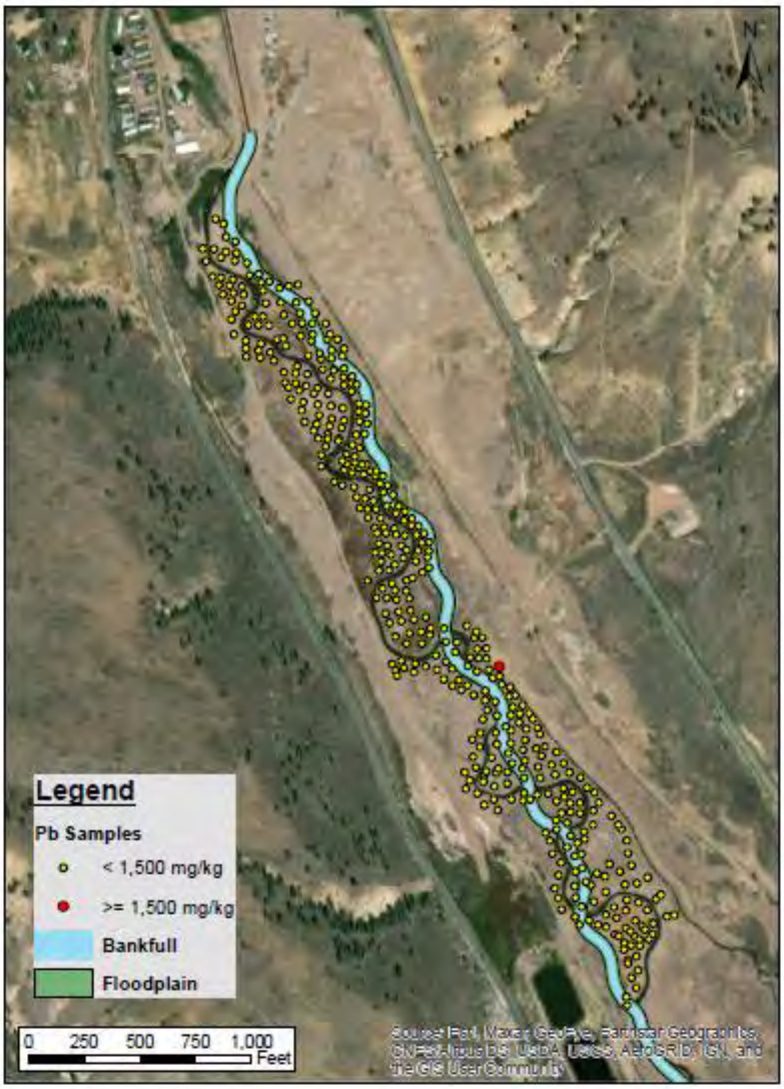

Figure 15: Total Lead Concentrations in Floodplain Sediments Lower Willow Creek Restoration Company with respect to proposed channel.

Characterization will be required prior to construction to identify area that may need additional management during construction in accordance with the Materials Management Plan. Previous characterization efforts collected samples every 100 feet (CRI, 2017). Adopting sampling techniques from previous characterization, potholes will be advanced to the water table at 100 foot intervals along the proposed channel to collect a composite sample from surface to water table. A third pothole will be located at the midpoint between the two location to collect a third sample. The three samples for each section will be analyzed with a portable XRF. The mean of the three samples will provide an indication of material handling options discussed below. To calibrate the XRF results, 1 sample for every 20 samples (i.e. 5%) of the samples will be submitted a certified laboratory for analysis of total lead as pre USEPA Method 6200. Adjustments to the field concentrations will be made based on the results of the laboratory analysis.

Based on the pre-construction screening, the channel construction will be divided into 100 foot sections and classified according to the Restoration Action Level. Sections above the RAL will be managed by screening out the fine (<6 inch) material in the field by portable screener. The fine material will be loaded directly onto a truck and five representative samples will be analyzed with a portable XRF. The average lead concentration will be compared with the field adjusted RAL of 1,500 mg/kg. The fine material will be used for plugging the former channel as described below. Following the removal of fine material above the RAL, the constructed channel will be screened with a portable XRF to document the concentrations of lead remaining in the channel walls. The coarse material retained from the screen will be used to line the channel following construction.

The current stream design requires cut-and fill to produce the stream channel, intersecting the current alignment in several locations, and constructing below the water table. The following permits will be required:

- US Army Corps of Engineer authorization. A Nationwide Permit (NWP) NWP 27 Aquatic Habitat Restoration, Establishment and Enhancement Activities (Action No. SPA-2012) was issued for the previous construction.
- Colorado Department of Public Health and Environment (CDPHE) Construction Discharge Stormwater General Permit.
- CDPHE Dewatering General Permit COG317000 – Discharges from Short-term (< 2 year) Remediation Activities which can include volunteer cleanup short-term dewatering activities, and as such, treatment may be required to meet water quality based permit limits.

Mineral County Fairground, West Wason Properties
In situ material will be used for cut/fill as required for grading. Where feasible, topsoil will be retained and spread uniformly over disturbed areas for revegetation. Imported topsoil or soil amendments may be required as described below in the *Surface Cover Restoration Options*.

Flume Modification

The flume outlet will be adjusted to divert flows more parallel with the existing valley, and to reduce stresses along the west side of the valley. The flume will be cut 118' from the existing outlet, and a drop structure (described below in the *Grouted Boulder or Sculpted Concrete Structure at Flume* section), will connect at the cutoff to transition flows into the channel and floodplain corridor.

Grade Control

Boulder Cross Vanes and J-Hooks

Boulder cross vanes and J-hooks will be installed along the channel as shown on the plans. In general, boulder vanes allow for 1'-2' vertical scour. Vanes and J-hooks are generally applied at channel bends and orientated to concentrate flow into the center of the channel and away from banks. They are designed with stacked boulders that increase in elevation in the downstream direction up to the bankfull elevation. The bottom row of boulders remains buried and are embedded below anticipated scour depths. The general orientation and layout was adapted from *"The Cross-Vane, W-Weir and J-Hook Structures…Their Description, Design and Application for Stream Stabilization and River Restoration"* (Rosgen 2001).

Grouted Boulder or Sculpted Concrete Structure at Flume

The structure type at the flume outlet has yet to be determined. Based on stakeholder feedback the structure will either be grouted boulders, sculpted reinforced concrete, or a combination of the two. The structure will consist of an approximate 2.5' vertical drop into a stilling basin that will transition into the more natural features of the stream corridor design.

Bank Protection

Toe Wood

A toe wood structure topped with wrapped soil lifts was considered for bank protection. The toe wood structure will consist of two individual components, a log with the rootwad attached and a foundation log, placed in a cross-hatch pattern and connected together with vertical rebar. The dimensions of the rootwad logs and foundation logs are calculated based on flow, scour, and velocity calculations in the channel. The rootwad structures will be constructed up from the bottom of the low-flow channel and will be built up to the top of the low-flow channel.

Soil Lifts

Wrapped soil lifts consist of a mix of topsoil and fill soil placed in erosion control fabric. The soil is placed to build the lift to its specified height, and the fabric is pulled back over the top before the next soil lift is placed on top. The lifts are set back to conform to final grading, providing a bench used to plant and seed for revegetation. Willow brush layering may be placed in between

Figure 16: Toe Wood with Soil Lifts

soil lift measures.

Irrigation Diversions

Irrigation diversion structures include a check structure near the County diversion, as well as a head/sluice gate apparatus to provide diversions from the channel to both the County and Mountain View RV properties. The designed channel will tie into the Wason diversion structure and it is anticipated that minor modifications will be need at that location (to be field determined). Irrigation channel and structures are detailed on Sheet 25 of the Design Plans.

Surface Cover Restoration Options

Success criteria for restoration is multi-faceted and integrates regulatory obligations, stakeholder desires, institutional needs, and ecological and landscape goals, as well as available funding. Channel reconstruction has been designed to manage high flows to meet stakeholder criteria. Soils and water management during channel construction will be implemented to meet regulatory criteria. The following discussion is regarding ecological and landscape success is based on current understanding of stakeholder needs. As discussions progress, plans are reviewed and revegetation results are monitored, plan revisions will be undertaken. This section is intended to be a living document, with the input of all stakeholders.

Riparian Zone Restoration

The ultimate outcome of any restoration strategy of a riparian zone is site stabilization through the establishment of self-sustaining native and/or desirable vegetation that becomes the most cost-effective form of erosion control and bank stability. Integrating ecological processes that control vegetation composition at a specific site needs to be configured into the overall reclamation strategy.

The ultimate objective is a long-term succession of plant communities that promotes soil development processes, microbial diversity and to restore soil ecosystem functions to a state of self-sustainability. Successful land reclamation is thus a function of the following:

- Optimal soil conditions and amendments.
- Appropriate plant species for chemistry and climate.
- Erosion control design.
- Proper installation.
- Ongoing monitoring and maintenance.

The current engineering design straightens the Lower Willow Creek channel and moves to the east in the upper portion of the floodplain and then follows the approximate current channel location further downstream. Intermittent bank protection features are included in the channel design. Revegetation will tie into these features to provide an integrated riparian ecosystem.

Based on previous revegetation efforts, and current site conditions, the addition of a plant growth cover material provides the best opportunity for successful revegetation. Approximately 12 inches of material overlying the stony alluvial sediments provides sufficient cover for supportive root growth for deeper root development into the underlaying subsoil. Previous plant growth studies have shown that vegetation within 1.5 feet of the water table have sufficient soil water for growth. It is estimated that these conditions will be found within the twice bank full width, extending approximately 30 feet from channel centerline either side of the channel.

Two sources of borrow material have been identified:

- Material from the Parker Borrow Area located on CO149 to the west of the floodplain; and
- Material excavated behind the Humphries Dam past the 4UR Ranch south of the floodplain.

Amendments applied to the cover soil improve the long-term success of revegetation processes. Many restoration sites have little or no soil organic matter. While pioneering species will serve to build organic matter, organic amendments are generally initially applied to serve several additional functions:

- Decrease metal bioavailability.
- Act as a slow-release fertilizer.
- Provide microbial inoculation.
- Improve soil structure.
- Increase infiltration and water holding capacity.
- Reduce erosion.

Biotic soil amendments increase the biological elements of well-functioning soils. Effective amendments are designed to promote natural microbial activity, and natural topsoil forming processes. Key components of soil amendments include:

- **Humic Compounds**: Humic compounds are largest constituents of soil organic matter, being responsible for many complex chemical reactions in soil. The interaction between the humic compounds, physiological and metabolic processes stimulate nutrient uptake, especially those in low concentrations, enhancing root, shoot and leaf growth.
- **Beneficial Soil Microorganisms**: Plant-microbial interactions in soil determine plant health and soil fertility. Beneficial microorganisms include those that create symbiotic associations with plant roots (rhizobia, mycorrhizal fungi, actinomycetes, diazotrophic bacteria), promote nutrient mineralization and availability, produce plant growth hormones, and are antagonists of plant pests, parasites or diseases (biocontrol agents). Enhancement of naturally-occurring mycorrhizal populations in reclamation work enhance resiliency and sustainability.
- **Plant Hormones**: Often obtained from seaweed extract to enhance growth and root mass, delay plant aging and enhance plant cell division, plant nutrient and nutrient minerals.

- **<u>Biochar</u>**: A carbon-rich solid produced by pyrolysis (heating biomass in the absence of oxygen) and can be manufactured with the intent of producing biochar, or as a bio-product of energy generation. The porous and recalcitrant nature of biochar has a range of physical (decreased soil bulk density, increased infiltration, decreased erodibility, increased water retention), nutritional (slow nutrient release, organic matter stabilization, increased microbial activity, habitat for mycorrhizal fungi, increased plant productivity) and toxicity (liming agent, sorption) factors.

Available commercial products include Richlawn and BioSol, or local suppliers of suitable compost and amendments can be mixed with the cover soil prior to seeding to establish a self-sustaining vegetative ecosystem. The recommended amendments for the riparian zone is:

- Biochar mixed at 7.5% vol/vol ratio
- Richlawn 3-6-3 with mycorrhizae and humates at 2,000 pounds/acre.

A Riparian/Streambank Stabilization Mix (Table 6) is proposed for the geomorphic bankfull portion of the channel and a Grass/Floodplain Stabilization Seed Mix (Table 7) for the flood terrace. The seed mix will be applied via drill seeding followed by application of a native hay grass mulch. To ensure stability during the first growing season and to protect against spring runoff, a tackifier (FlocLoc) or equivalent should be applied.

Installation of woody debris and creation of rough and loose surface configurations provides increased diversity of habitat to improve ecological resiliency (Holling, 1973).

Table 6: Riparian/Streambank Stabilization Mix

Common Name	***Scientific Name***	**Recommended Seed Rate - PLS (lbs / acre)**
Redtop	*Agrostis gigantea*	0.5
Smooth brome - Manchar	*Bromus inermis*	1.0
Water sedge†	*Carex aquatilis*	1.5
Common beaked sedge†	*Carex utriculata*	1.5
Tufted hairgrass	*Deschampsia cespitosa*	2.0
Streambank wheatgrass - Sodar	*Elymus lanceolatus* ssp. *lanceolatus*	2.0
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
TOTAL		**15.5**

Table 7: Grass/Floodplain Stabilization Seed Mix

Common Name	***Scientific Name***	**Recommended Seed Rate - PLS**
Indian ricegrass - Nezpar	*Achnatherum hymenoides*	1.0
Redtop	*Agrostis gigantea*	0.1
Smooth brome - Manchar	*Bromus inermis*	1.0
Tufted hairgrass	*Deschampsia cespitosa*	0.5
Streambank wheatgrass - Sodar	*Elymus lanceolatus* ssp. *lanceolatus*	1.0
Slender wheatgrass - San Luis	*Elymus trachycaulus*	1.5
Arizona fescue - Redondo	*Festuca arizonica*	0.5
Hard fescue - Durar	*Festuca ovina*	0.5
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
Blue flax - Lewis	*Linum lewisii*	0.3
Rocky mountain penstemon	*Penstemon strictus*	0.3
Alsike clover	*Trifolium hybridum*	0.5
TOTAL		**14.1**

WETLAND HABITAT CONSTRUCTION/INSTALLATION

A proposed wetland habitat has been shown on the channel design drawings. The wetland habitat will be connected to the main channel to provide seasonal and intermittent inundation and to remain moist during the growing season. The habitat will be constructed to within approximately 1.0-1.5 feet of the water table. Expected hydrology will be determined following earthwork to match design grade.

Prior to plant installation, soil sampling and analysis would be conducted to determine if amendments are needed as well as possible revisions to the planting plan (e.g., selecting halophytes if soils are high in chlorides). Based on available data, the Riparian/Streambank Stabilization Mix (Table 6) is recommended for the wetland. The area located between the wetland and the newly constructed channel should be prepared and seeded as per the process described for the Geomorphic Floodplain revegetation.

Installation of seed and plant material would occur under the supervision of restoration ecologists during appropriate seasons, typically fall, and based on site conditions. Post plant installation inspections and maintenance are expected to be required to repair erosion, manage weed infestations, and evaluate site success.

Broader Floodplain Adjacent to Channel Construction

Following revegetation of the riparian zone, the following is restoration plan for the floodplain approximately 200 feet on either side of the constructed channel:

- Former Channel: To prevent the former channel from re-activating, the channel will be backfilled and compacted to ensure that these channels are sufficiently plugged. Following construction, the surface will be hydroseeded with Grass/Floodplain Stabilization Seed Mix. Soil for backfilling will be sources from material segregated during construction or imported from sources identified for cover soil above.
- Previously Capped Areas: Approximately 12 inches of cover material was emplaced during the previous construction activities. Some of these areas were impacted from the previous high-flow event and require re-cover. The previously capped area will be mapped to identify areas that need recapping. Prior to placement of cover, representative surface samples will be analyzed with a portable XRF. Following the importation of clean fill, the surface will be hydroseeded with Grass/Floodplain Stabilization Seed Mix.
- Areas Disturbed During Construction: Areas including access roads, lay down and staging areas, and screening areas will be regraded and tied into the floodplain following channel construction. Following regrading, the disturbed areas will be hydroseeded with Grass/Floodplain Stabilization Seed Mix.
- Existing Vegetative Areas: Areas that were not damaged during the high water event and do not require capping will be inspected and spot seeding will be undertaken to promote additional growth as needed.

Wider Floodplain Restoration

Following stabilization of the floodplain and restoration of the immediate and broader floodplain as described above, a longer term, landscape restoration approach is required for the wider floodplain covering approximately 300 acres (Sheets 18 and 19 in the Design Plans). The wider floodplain covers multiple properties, however the landscape needs to be considered as a whole. With restoration sites viewed as an integral components of a larger, highly interconnected landscape. Landscape function is the interaction among the landscape elements that involves the flow of energy, materials, water and species among the elements. Restoration strategies that initiate autogenic succession, using natural processes, are most appropriate for extensively managed arid ecosystems.

Focusing on landscape and ecosystem functions, precipitation will be the single largest driver of plant cover in this arid, and potentially drying, environment (Kimball et al, 2015). Mean annual precipitation is 15.5 inches (393 mm), however is driven by substantial interannual variation and summer monsoonal rainfall with potentially extreme daily variation (Figures 17 and 18)

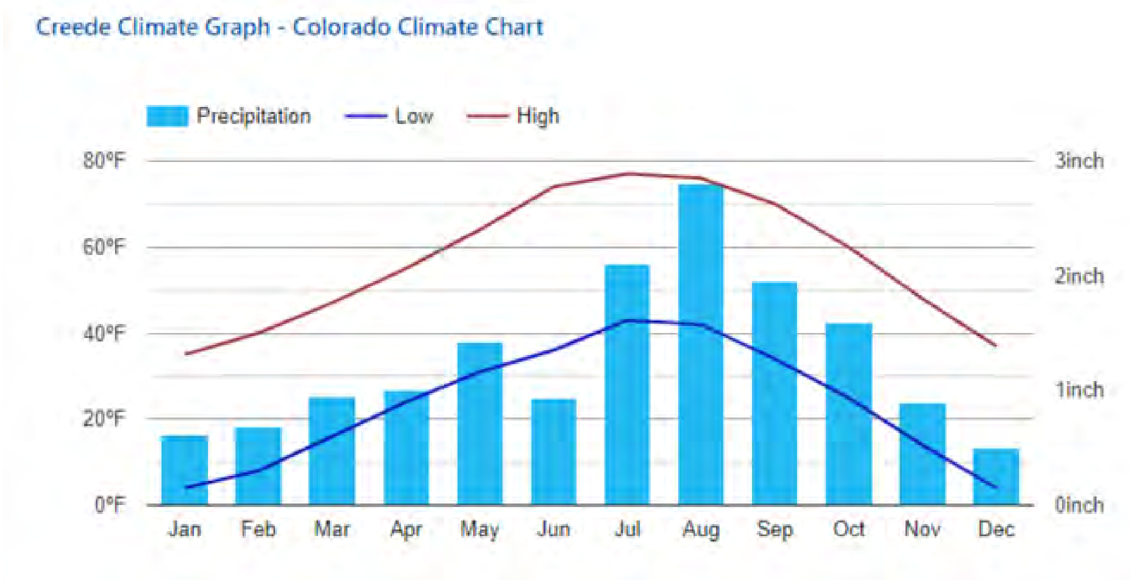

Figure 17: Monthly Precipitation in Creede, CO

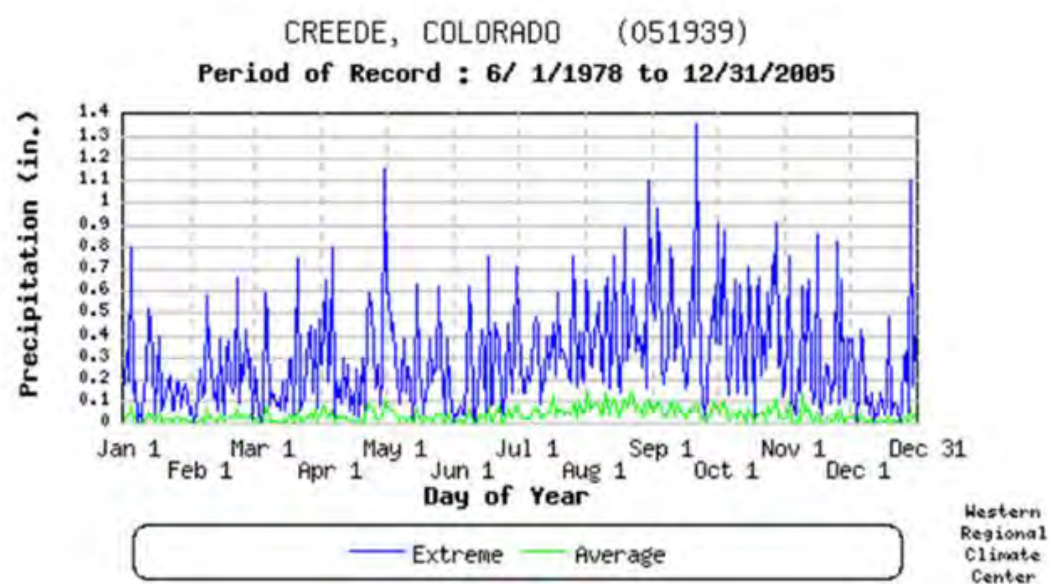

Figure 18: Daily Average and Maximum Precipitation

Successful restoration strategies increase water availability and/or reduce evaporation and transpiration. Water availability is increased with strategies that harvest water, increase infiltration and increase water retention. Landscape approaches that identify processes controlling the flows of limiting resources into and through landscapes are likely to be most effective.

Immediate soil improvement objectives include preventing soil crusts, reducing soil erosion, retaining precipitation on site. Longer term objectives to soil improvement include increasing soil organic matter content, increasing water holding capacity, improving soil structure, restoring sustainable nutrient dynamics to the soil system.

Strategies to meet these objectives include:

- Soil surface treatment e.g. pitting reduce runoff and increase infiltration. Micro catchment, pits, and contour furrows retain water and increases infiltration and storage of water.
- Recalcitrant organic materials may be desirable in arid environments as the decomposition of stable soil decomposition processes require soil biota.
- The sparse resources typical of many degraded arid ecosystems often occur in a clustered spatial arrangement. Microenvironmental parameters and soil characteristics vary around individual shrubs, resulting in microbial and plant organizational patterns interacting on a scale of a few centimeters.
- Developing sink areas contain significantly higher nutrient pools and higher rate processes than the source areas.
- Deep-rooted shrubs or trees on parts of a landscape may regulate the hydrology and nutrient retention capacity for the larger landscape. Woody plants can improve microenvironmental conditions, capture flows of scarce resources, initiate soil development, capture propagules.
- By concentrating resources on many donor sites distributed over the entire landscape , we provide a continuing source of propagules. In arid ecosystems where seedling establishment is episodic, this increases the odds of having seeds in the right place at the right time.

Based on these strategies, two restoration techniques have been identified as being appropriate for landscape restoration of the wider floodplain:

- Fertile Island Restoration: To take advantage of the clustered spatial arrangement of vegetation in an arid environment, this approach has been shown to work with systematically installing and seeding 25% of disturbed landscapes with strategically placed, broadcast seeded, small-scale plots (10 m^2) with native species. The hypothesis being that by installing and seeding specific patterns and quantities of small-scale disturbances with native species, a self-sustaining community will be established that will generate a constant source of propagules which over time, and when conditions are favorable, will colonize the surrounding vegetation matrix, thus increasing native species diversity (Grygeil et al., 2010). Grygeil et al. (2009) found that in the first 5 years, this approach was as effective as standard methods of roto-tilling and broadcast seeding the entire area for increasing total species richness, native seeded forb richness, native seeded forb density, and native seeded grass frequency. Deep rooted shrubs can be added into these islands to support water and nutrient cycling.
- Contour Restoration: As vegetation closer to Willow Creek is supported by a shallow water table, installation of furrows parallel to contour to within 1.5 feet of the water table is proposed. These will be broad, shallow furrows that are designed to capture

and store precipitation and provide accumulation of carbon sources by preventing removal from these systems. Addition of organic materials can support vegetative establishment as well as potential carbon offsets as described below.

The proposed landscape approach for each restoration technique is shown in Sheets 18 and 19 of the Design Plans.

Fertile Island Restoration is considered appropriate for the majority of the Lower Willow Creek Restoration Company due to VCUP requirements to minimize disturbance of materials and the largely fragmented existing vegetation. Additionally portions of the West Wason property that have fragmented existing vegetation are higher in the landscape. The first stage would be installation for several test plots covering 10% of the proposed restoration sites shown in Sheets 18 and 19 of the Design Plans.

Contour Revegetation is proposed in the southern portion of LWCRCo and northern section of West Wason due to the largely unvegetated areas and the location between the two drainages. Installation of a test furrow will help evaluate the efficacy of this approach. The test furrow will include testing of different amendments to support growth along the length of the furrow in conjunction with testing different strategies for deep rooted species.

Restoration as a Carbon Offset and Funding Opportunity

Recent reports from the Intergovernmental Panel on Climate Change (IPCC) suggest that efforts to sequester previously emitted atmospheric carbon dioxide will be necessary to mitigate climate change, even if significant carbon emissions reductions occur in the near future. Soil carbon capture involves biological processes that utilize soil carbon as an energy source to increase both above ground (vegetation) and below ground (roots, microbial populations) to produce a net negative carbon balance. Carbon sequestration on disturbed lands can be accomplished through soil management strategies with a large effect if implemented widely. Small adjustments to agricultural and/or land management may offer agricultural soils as a viable, cost-effective, and significant carbon sink. Reclaimed landscapes have the potential to be managed in way to enhance carbon sequestration due to:

- Being most impacted from historical loss of soil organic carbon.
- Providing an opportunity for physical manipulation.
- Having an industrial infrastructure in place to implement alternative management strategies.
- The side benefit of an increase in carbon, due to enhanced soil organic matter and its associated increase in soil fertility.

The following strategies help support carbon sequestration.

- **Microbial Enhancement**: Biologically, soil organic carbon (SOC) provides an energy source for many soil microorganisms, the primary decomposers breaking down organic materials such as plant residues and animal wastes into simple compounds (Rice et al., 2007). As soil microorganisms decompose these materials, a portion is converted to SOC that can capture carbon dioxide (CO_2) (Ahmed et al., 2019). Long-term carbon storage is influenced by microbial activity including development of carbon-mineral complexes and protective soil aggregates. Addition of specific microbial populations can enhance these processes for long-term carbon storage.

- **Biochar**: Biochar is a by-product pyrolization of plant biomass into a very persistent, solid form of carbon (biochar) that degrades extremely slowly under natural conditions. If biochar is introduced directly into soils or indirectly into agricultural soils via its use in animal feed, livestock bedding, slurry management, compost, or anaerobic digesters, a conservative estimate of approximately 75% of the original carbon in biochar could still be accounted for as sequestered carbon. Application of biochar improves soil quality while enhancing both the magnitude and the residence time of the SOC pool (Lal & Follett, 2009). Biochar has been shown to improve soil health through improved nutrient efficiency including phosphorus and nitrogen, improved water efficiency and metal sequestration, improving plant productivity and ultimately the formation and durability of soil organic carbon pools.

Several greenhouse gas registries exist to validate the integrity of climate mitigation strategies. The registries focus on storage of carbon in the following pools that have implication for Lower Willow Creek restoration.

- **Above- and Below-Ground Biomass Pool**: The mean carbon stock in aboveground and belowground biomass per unit area is estimated based on field measurements in sample fixed area plots. Root-to-shoot ratios are coupled with above-ground biomass to calculate belowground from above-ground biomass.

- **Dead Wood Pools**: Dead wood included in the methodology comprises two components: standing dead wood that is fully dead (i.e. absence of green leaves and green cambium) and lying dead wood. Considering the differences in the two components, different sampling and estimation procedures shall be used to calculate stocks in dead wood biomass of the two components.

- **Litter Pool**: Litter is the dead organic surface material <10cm diameter. Where litter is an included pool monitoring must occur at least every ten years for baseline renewal. Where carbon stock enhancement is included, and litter is an included pool monitoring shall occur at least every five years.

- **Soil Organic Carbon Pool**: Depth of sampling for soil organic carbon is centered on the upper soil horizons where root biomass and organic matter inputs are concentrated, depending on soil type and ecosystem, typically between 20 cm and 100 cm. Depth of soil sampling employed in inventories is held constant for the duration of the project. For soil carbon determination, an aggregate sample is collected from within a sample plot in the field, thoroughly mixed and sieved through a 2 mm sieve. The prepared sample is analyzed for percent organic carbon.

Implementing an offset project requires design, submittal of a methodology to a registry for approval, stakeholder consultation, project validation, registration, and implementation. Following implementation, project developers are required to maintain records quantifying the emission reductions achieved during a project's implementation phase. Emission reductions are issued based on the monitoring report. Therefore, a project developer must make the tradeoff between having continuous offset credit income (more frequent monitoring reports) and lower administrative costs (less frequent monitoring reports). There are no requirements as to how long or short a monitoring period must be, as they range from a few weeks to several years. The monitoring that the project developer has done is then evaluated and approved by a third-party auditor. Once verified and certified, a project developer sells the offset credits from a project to a buyer.

The following stages for project development include:

- Opportunity Assessment: Develop property and project information outlining the processes designed to improve soil carbon during the restoration process. This information is used to develop an Opportunity Assessment including volumetric forecasts and project cash flow pro forma to facilitate project owner decision making.
- Feasibility Confirmation: Prepare a detailed evaluation of all legal, financial, technical, environmental and managerial factors impacting project eligibility and economics to confirm the initial projections prior to project launch.
- Inventory Development: For land-use carbon projects an inventory model will need to be developed that is aligned with specific protocol standards and methodologies.
- Carbon Stock Development and Yield Modeling: Develop detailed models of carbon stock development during the project life to project the number of carbon credits to be generated, factoring in leakage, risk and uncertainty.
- Project Design and Documentation: Document all eligibility requirements and volume calculations in detailed Project Design Documents in accordance with the selected protocols and standards.
- Third-Party Verification: On an upfront and ongoing basis, third-party verifiers must be retained to audit carbon calculations, eligibility and conformance with the protocol and standard.
- Public Registration: Following successful verification, carbon credits are issued and registered on accredited carbon registries.
- Carbon Marketing, Sales and Contracting: Develop revenue generation strategies among prominent buyers.

Several established corporate climate and energy advisors offer turnkey partnerships to support the development of carbon projects. Initial conversations with one such partner has shown interest in supporting, and potentially financing, a project such as restoring the Willow Creek Floodplain. Partnering includes facilitating transactions in environmental markets, strategic and tactical advisory services and capital formation. With potentially 300 acres of land to implement a carbon project, combined with the benefits to the watershed, the Willow Creek Floodplain certainly is an attractive pilot project for development. The initial step will be to develop the plan to discuss the Opportunity Assessment with a Project Developer.

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Appendices

A – Design Plans
B – HEC-RAS Existing Conditions Modeling
C – FHWA Hydraulic Toolbox Hydraulic Calculations
D – RiverMORPH Sediment Transport Output

APPENDIX A

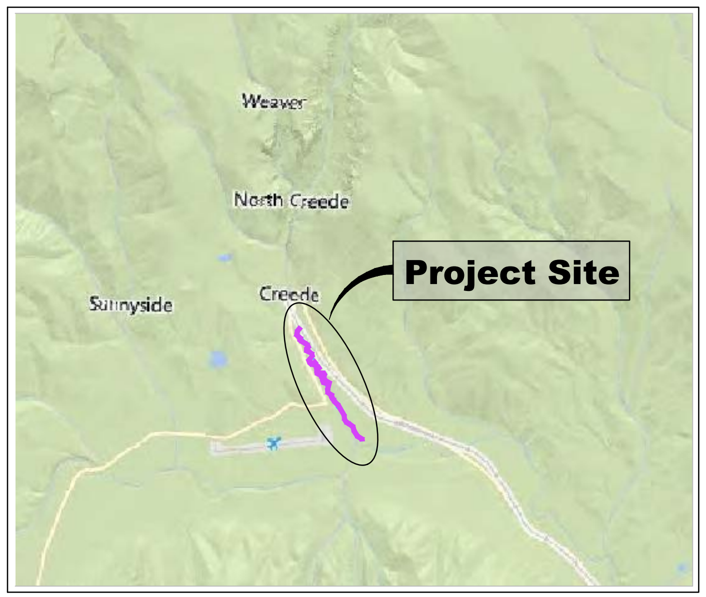
Design Plans

LOWER WILLOW CREEK FLOODPLAIN RESTORATION

HEADWATERS ALLIANCE & TROUT UNLIMITED

60% DESIGN PLANS
August 2021

MATRIX PROJECT No. 20.1183.001



VICINITY MAP

N.T.S.

VERTICAL DATUM: THE ELEVATIONS ON THIS PROJECT ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.

HORIZONTAL DATUM: THE BASIS OF BEARINGS ARE GRID BEARINGS OF THE STATE PLANE COLORADO SOUTH ZONE. PROJECT COORDINATES ARE NAD83/2011 STATE PLANE COLORADO SOUTH ZONE, GRID COORDINATES.

AERIAL PHOTO: PROVIDED BY MICROSOFT BING AERIAL IMAGERY

BENCHMARK STATEMENT: THE BENCHMARK USED FOR THIS PROJECT IS A NATIONAL GEODETIC SURVEY MONUMENT "D-168", DATED 1934, BEING A FOUND 3-1/4" ALUMINUM CAP IN CONCRETE APPROXIMATELY 4" ABOVE GROUND AND HAVING A PUBLISHED NAVD88 ELEVATION OF 8671.32 U.S. SURVEY FEET.

LOCATION MAP

SCALE: 1" = 4,000'

SHEET INDEX

REFERENCE DRAWINGS

X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

REVISIONS

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HEADWATERS ALLIANCE
CREEDE, CO

TROUT UNLIMITED

PREPARED BY:
Matrix
Excellence by Design

SEAL

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

TITLE SHEET

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. N/A	SHEET 01 OF 25	TS01
CHECKED BY: AJS	VERT. N/A		

GENERAL NOTES:

1. THE LOCATIONS OF KNOWN ABOVE GROUND AND UNDERGROUND UTILITIES ARE SHOWN IN THEIR APPROXIMATE LOCATIONS ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. CONTRACTOR TO CALL FOR UTILITY LOCATOR AT LEAST 3 CALENDAR DAYS BEFORE EXCAVATION. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY THEIR FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL ABOVE GROUND AND UNDERGROUND UTILITIES. IN THE EVENT THAT THE CONTRACTOR UTILITY VERIFICATION RESULTS IN EXISTING STRUCTURES OR UTILITIES BEING IN CONFLICT WITH THE PROPOSED WORK OF THIS CONTRACT, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY UTILITIES AND COORDINATE ANY NEEDED MODIFICATIONS TO THE PROPOSED WORK AS DIRECTED BY THE DISTRICT.
2. THE CONTRACTOR SHALL COORDINATE WITH ALL AFFECTED UTILITY OWNERS TO ESTABLISH THE REQUIREMENTS AND METHODS TO ACCOMMODATE THE PROTECTION, TEMPORARY SUPPORT, ADJUSTMENT OR RELOCATION OF UTILITIES PRIOR TO THE START OF CONSTRUCTION.
3. OVERHEAD UTILITIES ARE NOT INDICATED ON PROFILE OR SECTION DRAWINGS.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING AND MAINTAINING IN CONTINUOUS OPERATION, ALL EXISTING STRUCTURES. NOT ALL POTENTIALLY IMPACTED STRUCTURES MAY BE SHOWN ON THE DRAWINGS AND IT IS THE CONTRACTOR'S RESPONSIBILITY TO IDENTIFY AND PROTECT ALL STRUCTURES INCLUDING BUT NOT LIMITED TO STREETS, CURB AND GUTTER, BRIDGE PIERS AND ABUTMENTS, CREEK BANK PROTECTION OF VARIOUS TYPES, CREEK DROP STRUCTURES, SIGNS, PEDESTRIAN WALKS, RETAINING WALLS AND FENCING. IN THE EVENT THAT A STRUCTURE OR UTILITY IS DAMAGED DURING CONSTRUCTION THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE OWNER OF THE FACILITY IN WRITING AND MAKE REPAIRS PER THE APPROPRIATE SPECIFICATIONS.
5. THE CONTRACTOR SHALL CONFIRM THE RECEIPT OF ALL NECESSARY PERMITS AND APPROVALS BEFORE THE START OF CONSTRUCTION.
6. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE STANDARDS OF CDOT UNLESS SPECIFICALLY DETAILED OTHERWISE ON THESE PLANS AND ASSOCIATED SPECIFICATIONS. ANY ELEMENT OF CONSTRUCTION WHICH IS NOT ADDRESSED EITHER BY THESE PLANS AND SPECIFICATIONS OR BY THE STANDARDS OF CDOT SHALL CONFORM TO THE STANDARD SPECIFICATIONS OF MILE HIGH FLOOD DISTRICT AND AGREEMENT DOCUMENTS.
7. THE CONTRACTOR SHALL MAINTAIN AT THE SITE AT ALL TIMES ONE SIGNED COPY OF THE PROJECT DRAWINGS AND SPECIFICATIONS, ONE COPY OF THE STORMWATER MANAGEMENT PLAN AND ONE COPY OF ALL REQUIRED PERMITS.
8. THE CONTRACTOR SHALL CONDUCT THEIR OPERATIONS IN SUCH A WAY THAT THE AREA OF DISTURBANCE IS MINIMIZED. ALL EXISTING TREES, SHRUBS AND VEGETATION SHALL BE PROTECTED UNLESS OTHERWISE NOTED ON THE DRAWINGS. NO TREES SHALL BE REMOVED WITHOUT APPROVAL.
9. FOR ALL SITE GRADING, SMOOTH, PARABOLIC TRANSITIONS SHALL BE MADE BETWEEN CHANGES IN SLOPE.
10. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR PROVIDING STABLE EXCAVATIONS AND TEMPORARY SLOPES AND FOR SATISFYING ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS.
11. CONSTRUCTION OF THE PROPOSED WORK WILL TAKE PLACE WITHIN THE CHANNEL AND WATER CONTROL MEASURES WILL BE REQUIRED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE ACCEPTANCE AND CONTROL OF DRAINAGE WATER FROM AREAS ADJACENT TO WILLOW CREEK AND FOR FLOW WITHIN WILLOW CREEK AND ITS TRIBUTARIES INCLUDING STORMWATER OUTFALLS AND DIVERSION RETURN FLOWS. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ESTABLISHING MEANS AND METHODS OF GROUND AND SURFACE WATER CONTROL APPROPRIATE FOR CONSTRUCTION IN ACCORDANCE WITH THE REQUIREMENTS OF THE PROJECT DRAWINGS AND SPECIFICATIONS AND ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS AND PERMITS.
12. THE CONTRACTOR SHALL PREPARE AND MAINTAIN THE STORMWATER MANAGEMENT PLAN AND OBTAIN THE NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT THROUGH THE COLORADO DEPARTMENT OF PUBLIC HEALTH (CDPHE) AND ALL OTHER APPROPRIATE FEDERAL, STATE AND LOCAL PERMITS.
13. CONTRACTOR SHALL BE RESPONSIBLE FOR AS-BUILT DRAWINGS TO BE MAINTAINED AND SUBMITTED TO HEADWATERS ALLIANCE, IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
14. THE CONTRACTOR SHALL PROVIDE AND MAINTAIN ON-SITE SURVEY CONTROL.
15. CONTRACTOR SHALL FENCE OFF CRITICAL AREAS TO BE PROTECTED AT THE DISCRETION OF HEADWATERS ALLIANCE OR APPROVED REPRESENTATIVE.
16. THE CONTRACTOR SHALL DEVELOP A TRAFFIC CONTROL PLAN FOR PLANNED ACCESS TO THE SITE AND FOR EXITING AND ENTERING PUBLIC ROADS.
17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IDENTIFYING AND MAINTAINING PHYSICAL AND LEGAL ACCESS TO THE PROJECT SITE AND SHALL LIMIT TRANSPORTATION TO AND FROM THE SITE TO THOSE APPROVED BY HEADWATERS ALLIANCE.

ABBREVIATIONS

℄	CENTER LINE	APPROX.	APPROXIMATE
HCL	HORIZONTAL CONTROL LINE	MIN.	MINIMUM
DIA	DIAMETER	MAX.	MAXIMUM
EX/EXIST	EXISTING	HORIZ	HORIZONTAL
EL./ELEV	ELEVATION	VERT.	VERTICAL
FT.	FEET	DIST.	DISTANCE
INV.	INVERT	NTS	NOT TO SCALE
LF	LINEAR FEET	TYP	TYPICAL
LT	LEFT	O.C.	ON CENTER
N,S,E,W	NORTH, SOUTH, EAST, WEST	L.O.C.	LIMITS OF CONSTRUCTION
ℙ	PROPERTY LINE	RR	RAILROAD
ROW	RIGHT-OF-WAY	BCL	BANKFULL CONTROL LINE
RT	RIGHT	TCL	THALWEG CONTROL LINE
SF	SQUARE FEET	LPSTP	LONGITUDINAL PEAKED STONE TOE PROTECTION
STA.	STATION		
PR.	PROPOSED		

STANDARD SYMBOLS

CENTER LINE

EXISTING CONTOURS

PROPOSED CONTOURS

L.O.C.

CONSTRUCTION ACCESS

ROW

RAILROAD ROW

PROTECT EXISTING VEGETATION

LEGEND

DT03.1 — DETAIL REFERENCE LABEL

DRAWING NUMBER — DETAIL NUMBER

PR. CROSS VANE / J-HOOK

PR. BANK PROTECTION

PR. POOL

PR. BANKFULL CHANNEL

PR. TOE WOOD

REFERENCE DRAWINGS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

GENERAL NOTES

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS

SCALE
HORIZ. N/A
VERT. N/A

DATE ISSUED: August 2021
SHEET 02 OF 25

DRAWING No. GN01

NOTE: THE EXISTING ALIGNMENT SHOWN IN THESE PLANS WAS DERIVED DIGITALLY FROM THE LIDAR SURVEY. THE CURRENT EXISTING ALIGNMENT WILL LIKELY DIFFER IN PLACES, DUE TO LIMITS IN THE LIDAR SURVEY AND DUE TO ACTIVE CREEK MIGRATION. THE AERIAL PHOTO SHOWN IN THE PLANS PRE-DATES THE LIDAR SURVEY; MUCH OF THE CHANNEL VISIBLE IN THE AERIAL IS NO LONGER ACTIVE FLOW PATH.

Know what's below. Call before you dig.

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

EXISTING CONDITIONS

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 600'			EX01
CHECKED BY:	AJS	VERT.	N/A	SHEET	03 OF 25	

SHEET No. 04

PROJECT SURVEY CONTROL:

BENCHMARK STATEMENT: THE BENCHMARK USED FOR THIS PROJECT IS A NATIONAL GEODETIC SURVEY MONUMENT "D-168", DATED 1934, BEING A FOUND 3-1/4" ALUMINUM CAP IN CONCRETE APPROXIMATELY 4" ABOVE GROUND AND HAVING A PUBLISHED NAVD88 ELEVATION OF 8671.32 U.S. SURVEY FEET.

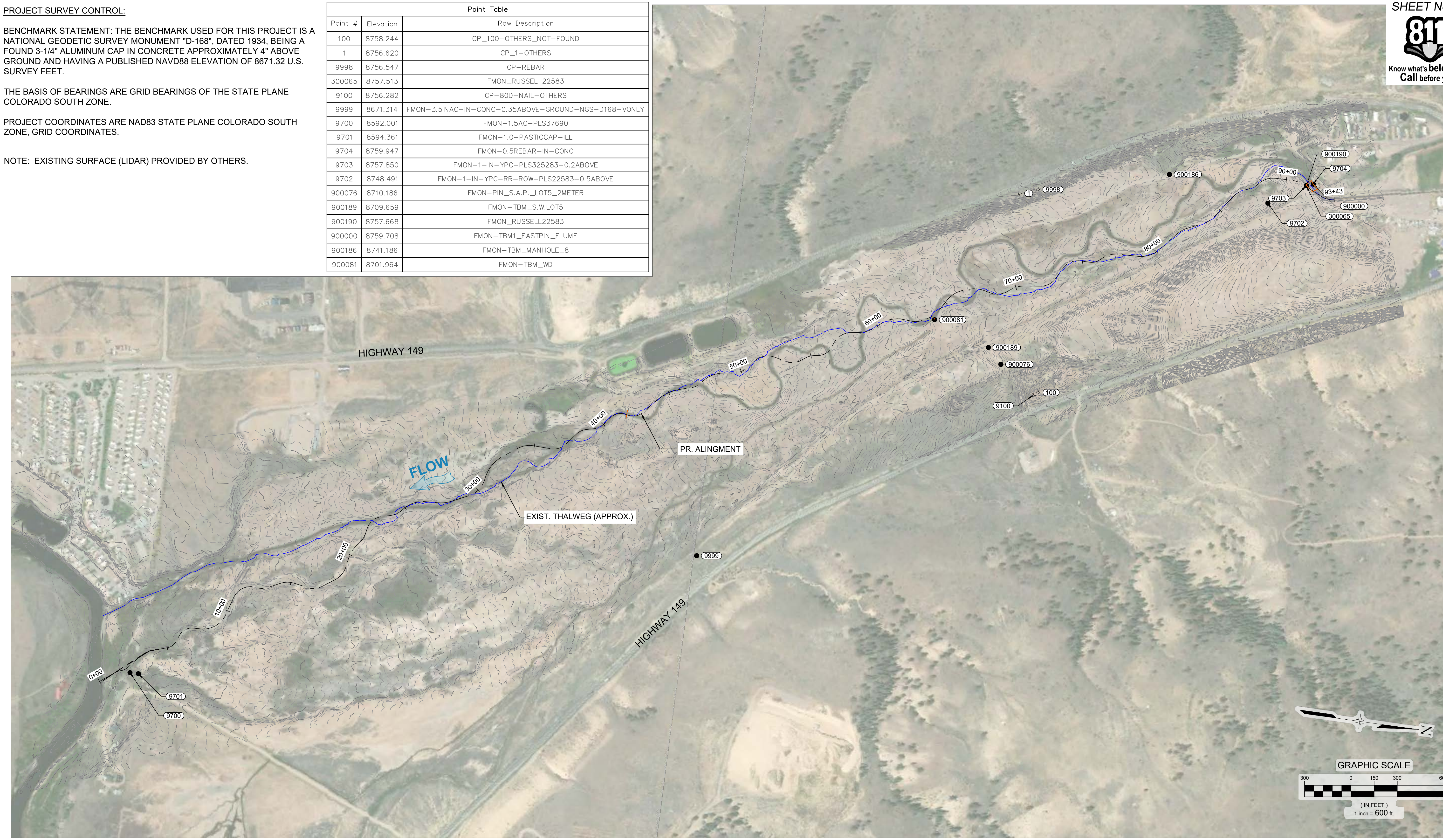
THE BASIS OF BEARINGS ARE GRID BEARINGS OF THE STATE PLANE COLORADO SOUTH ZONE.

PROJECT COORDINATES ARE NAD83 STATE PLANE COLORADO SOUTH ZONE, GRID COORDINATES.

NOTE: EXISTING SURFACE (LIDAR) PROVIDED BY OTHERS.

Point Table

Point #	Elevation	Raw Description
100	8758.244	CP_100-OTHERS_NOT-FOUND
1	8756.620	CP_1-OTHERS
9998	8756.547	CP-REBAR
300065	8757.513	FMON_RUSSEL 22583
9100	8756.282	CP-80D-NAIL-OTHERS
9999	8671.314	FMON-3.5INAC-IN-CONC-0.35ABOVE-GROUND-NGS-D168-VONLY
9700	8592.001	FMON-1.5AC-PLS37690
9701	8594.361	FMON-1.0-PASTICCAP-ILL
9704	8759.947	FMON-0.5REBAR-IN-CONC
9703	8757.850	FMON-1-IN-YPC-PLS325283-0.2ABOVE
9702	8748.491	FMON-1-IN-YPC-RR-ROW-PLS22583-0.5ABOVE
900076	8710.186	FMON-PIN_S.A.P._LOT5_2METER
900189	8709.659	FMON-TBM_S.W.LOT5
900190	8757.668	FMON_RUSSELL22583
900000	8759.708	FMON-TBM1_EASTPIN_FLUME
900186	8741.186	FMON-TBM_MANHOLE_8
900081	8701.964	FMON-TBM_WD



REFERENCE DRAWINGS
X-1183-MDG22x34
X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210

No.	DATE	DESCRIPTION	BY

REVISIONS

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CTB FILE: Matrix(black).ctb
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60% DESIGN PLANS

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HEADWATERS ALLIANCE CREEDE, CO

TROUT UNLIMITED

PREPARED BY:
Matrix
Excellence by Design

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

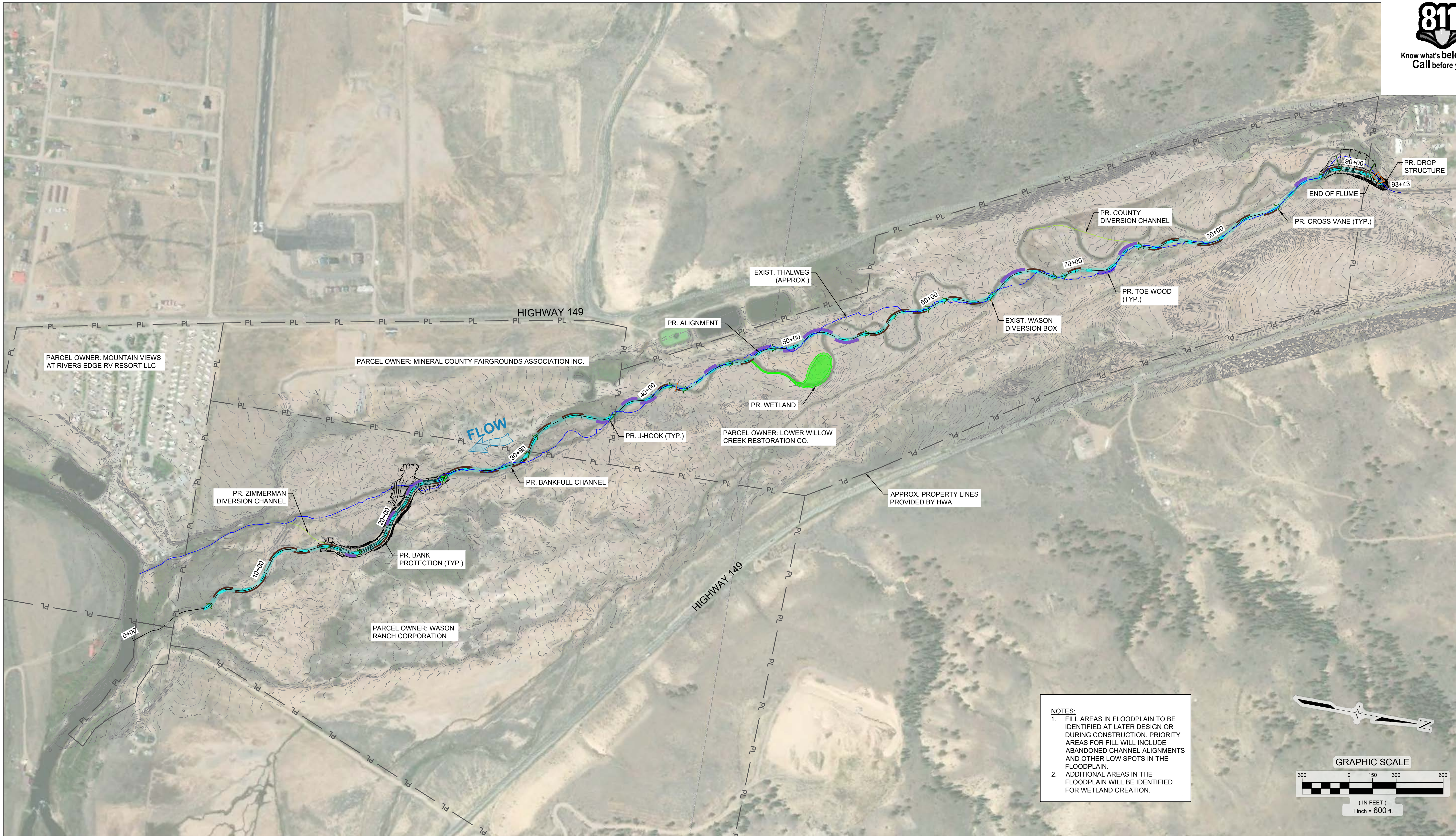
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

HORIZONTAL CONTROL PLAN

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. 1" = 600'
VERT. N/A
DATE ISSUED: August 2021
SHEET 04 OF 25
DRAWING No. HZ01

811 Know what's below. Call before you dig.



NOTES:

1. FILL AREAS IN FLOODPLAIN TO BE IDENTIFIED AT LATER DESIGN OR DURING CONSTRUCTION. PRIORITY AREAS FOR FILL WILL INCLUDE ABANDONED CHANNEL ALIGNMENTS AND OTHER LOW SPOTS IN THE FLOODPLAIN.
2. ADDITIONAL AREAS IN THE FLOODPLAIN WILL BE IDENTIFIED FOR WETLAND CREATION.

REFERENCE DRAWINGS

X-1183-MDG22x34
X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 600'			DR01
CHECKED BY:	AJS	VERT.	N/A	SHEET	05 OF 25	

REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

REVISIONS

No.	DATE	DESCRIPTION	BY

COMPUTER FILE MANAGEMENT

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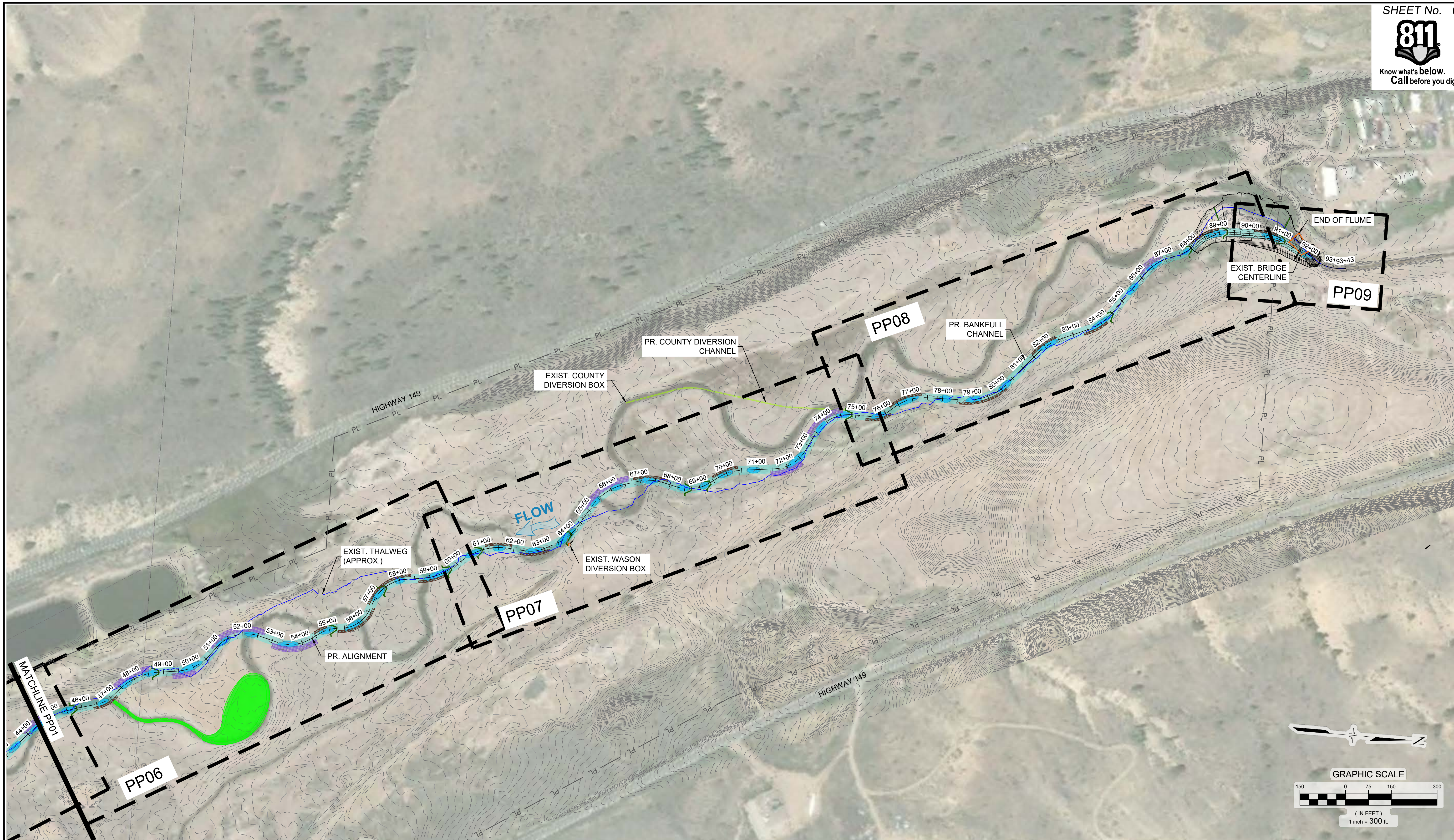
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION 60% DESIGN PLANS

PLAN AND PROFILE OVERVIEW

DESIGNED BY: JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ.	1" = 300'	SHEET	06 OF 25	PP01
CHECKED BY: AJS	VERT.	N/A			



REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210 X-1183-EX-IMAGE X-1183-MDG22x34 X-1183-EX-TOPO X-1183-PR-TOPO X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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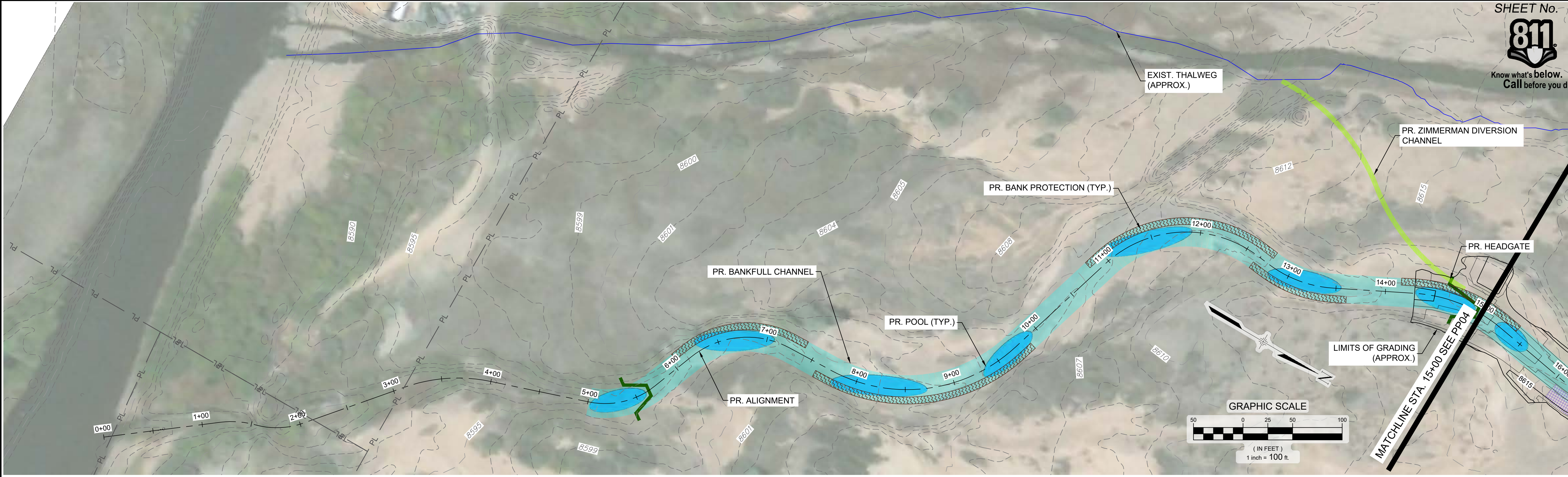
PROJECT No. 20.1183.001

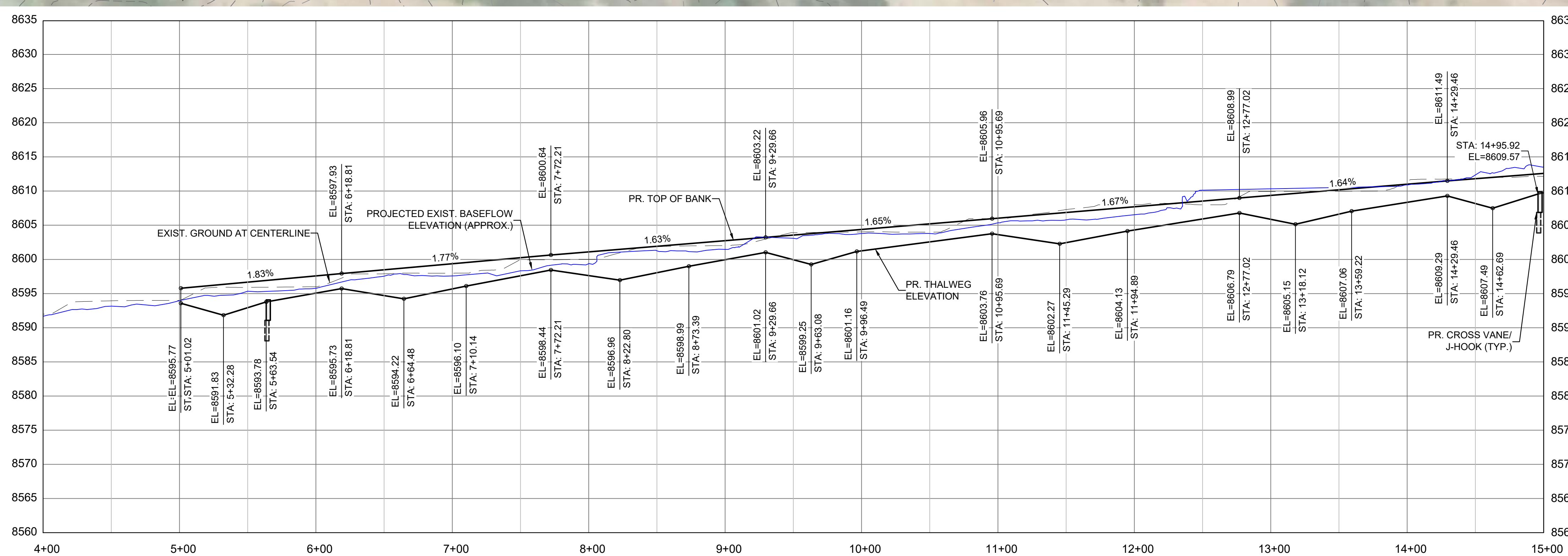
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE OVERVIEW

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. 1" = 300'	SHEET 07 OF 25	PP02
CHECKED BY: AJS	VERT. N/A		





REFERENCE DRAWINGS

Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT

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60% DESIGN PLANS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

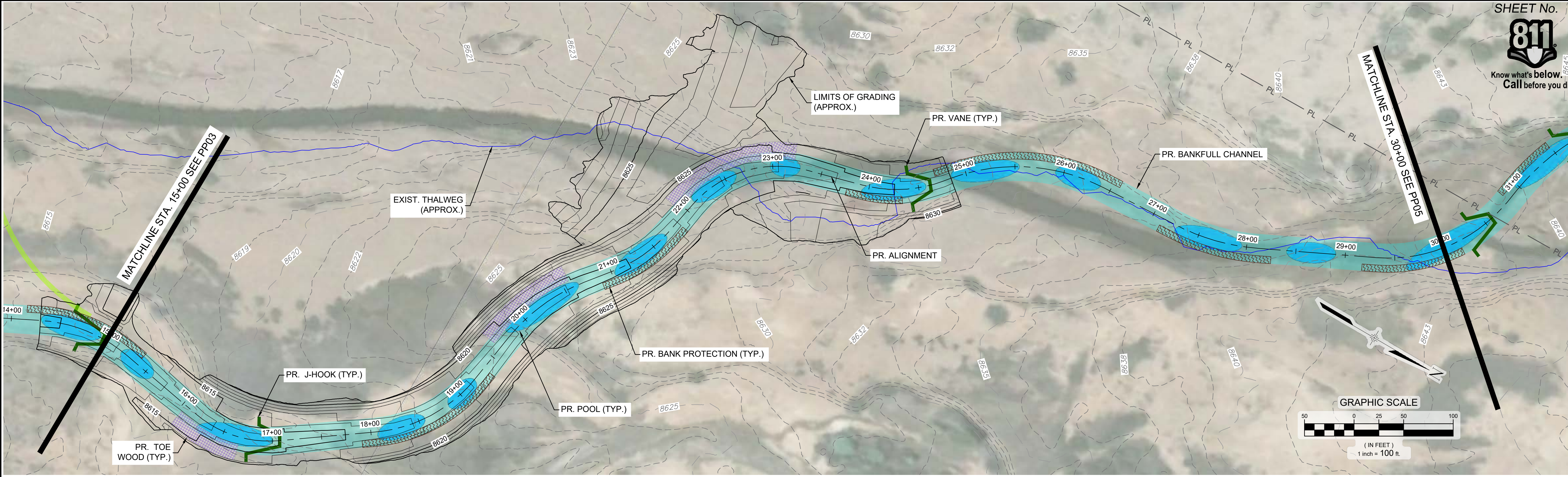
PLAN AND PROFILE
STA. 0+00 - 15+00

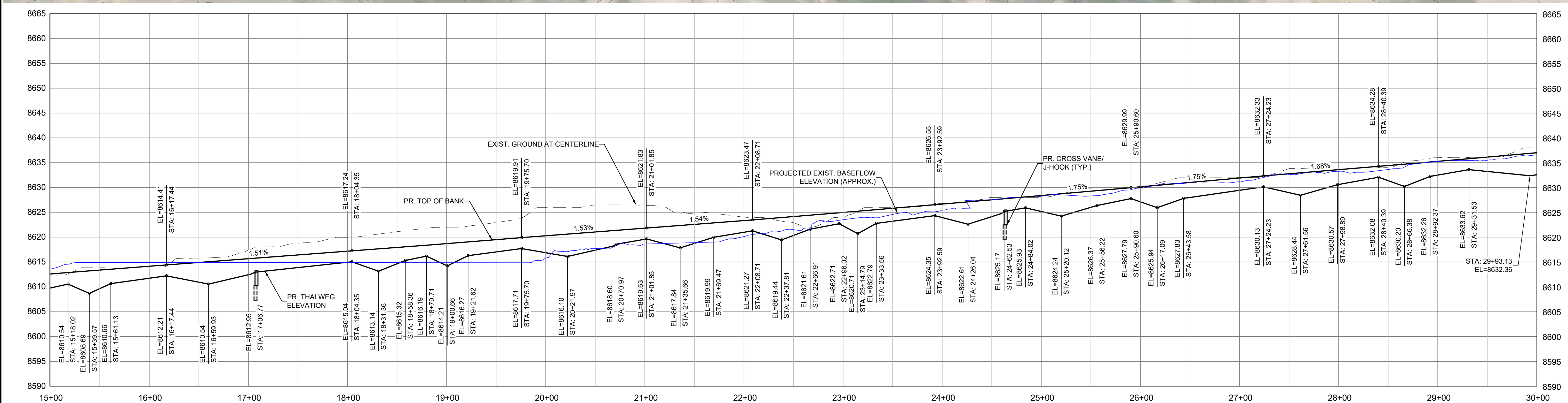
DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS

SCALE
HORIZ. 1" = 100'
VERT. 1" = 20'

DATE ISSUED: August 2021
SHEET 08 OF 25

DRAWING No. PP03





REFERENCE DRAWINGS	No.	DATE	DESCRIPTION	BY
Lower Willow Creek Survey 20201210 X-1183-EX-IMAGE X-1183-MDG22x34 X-1183-EX-TOPO X-1183-PR-TOPO X-1183-PARCELS FROM TU				

REVISIONS

COMPUTER FILE MANAGEMENT
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60% DESIGN PLANS

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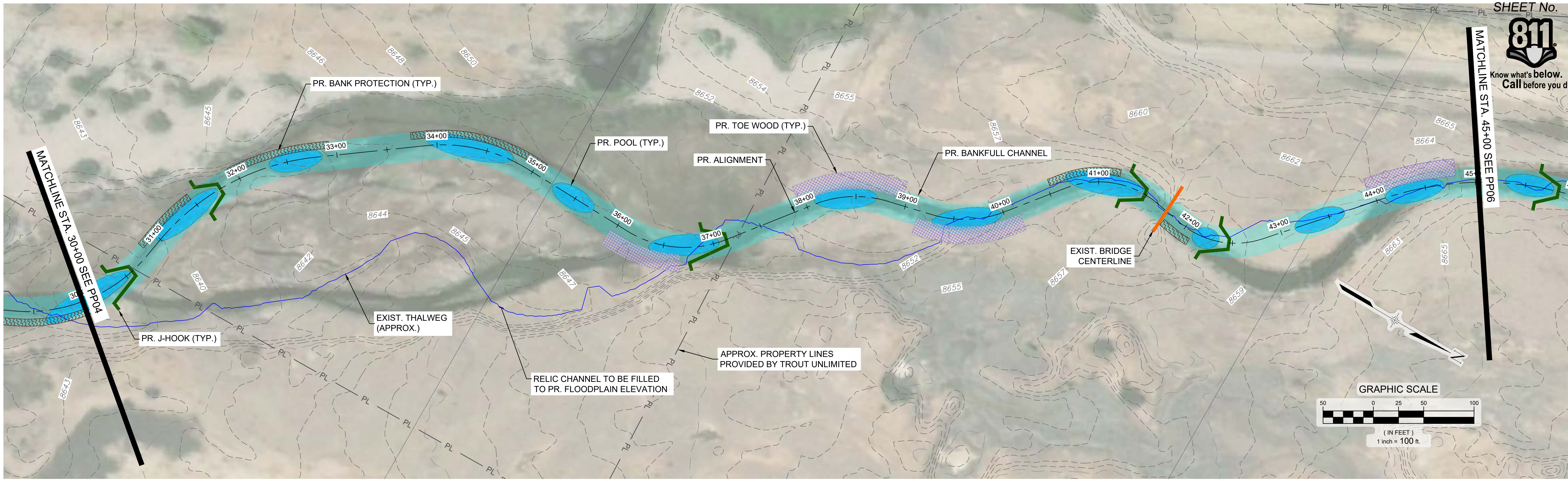
PROJECT No. 20.1183.001

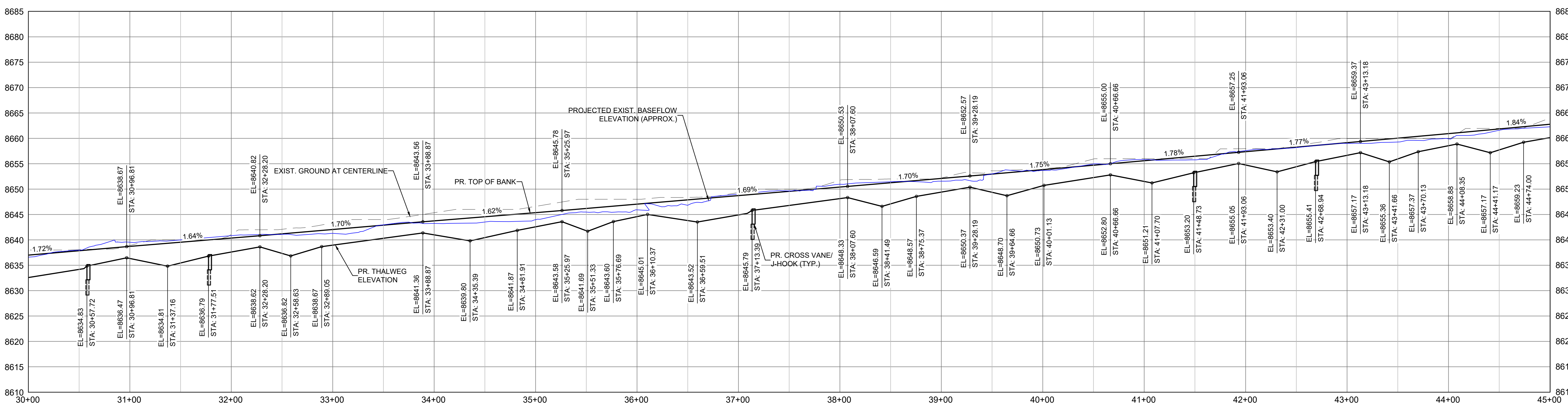
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 15+00 - 30+00

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 100'	SHEET	09 OF 25	PP04
CHECKED BY:	AJS	VERT.	1" = 20'			





REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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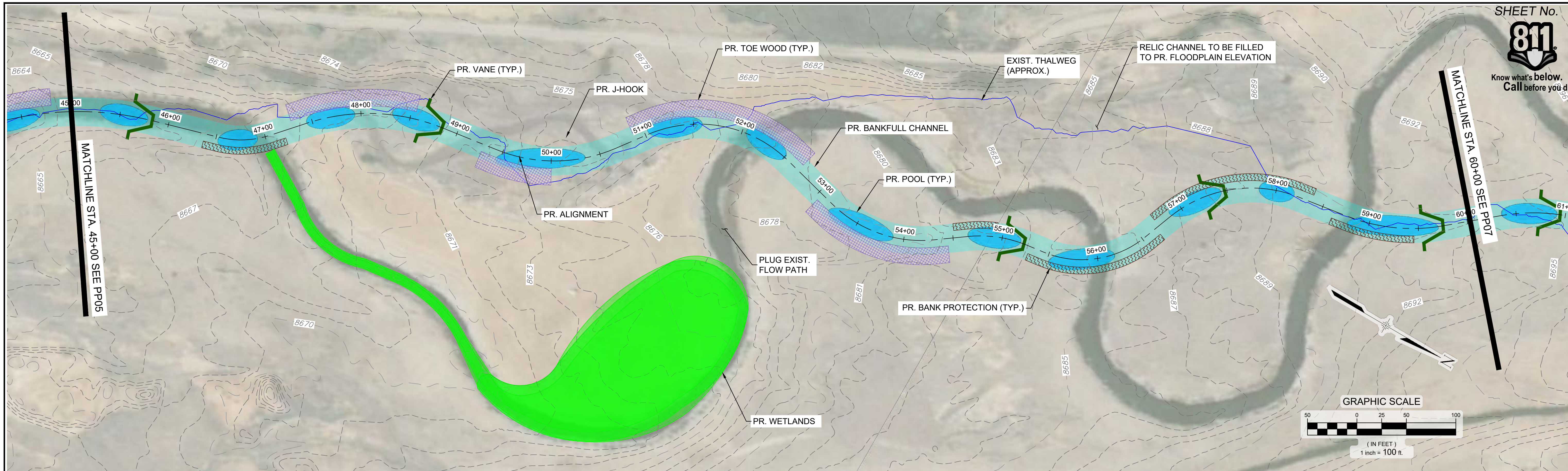
PROJECT No. 20.1183.001

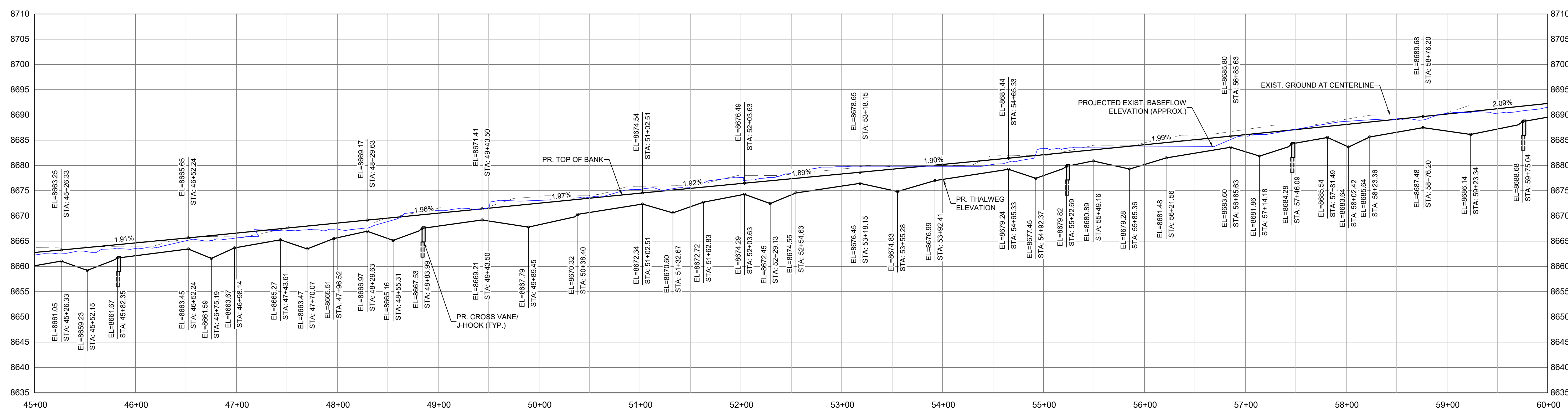
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 30+00 - 45+00

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. 1" = 100'	SHEET 10 OF 25	PP05
CHECKED BY: AJS	VERT. 1" = 20'		





REFERENCE DRAWINGS
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X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 45+00 - 60+00

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 100'	SHEET	11 OF 25	PP06
CHECKED BY:	AJS	VERT.	1" = 20'			

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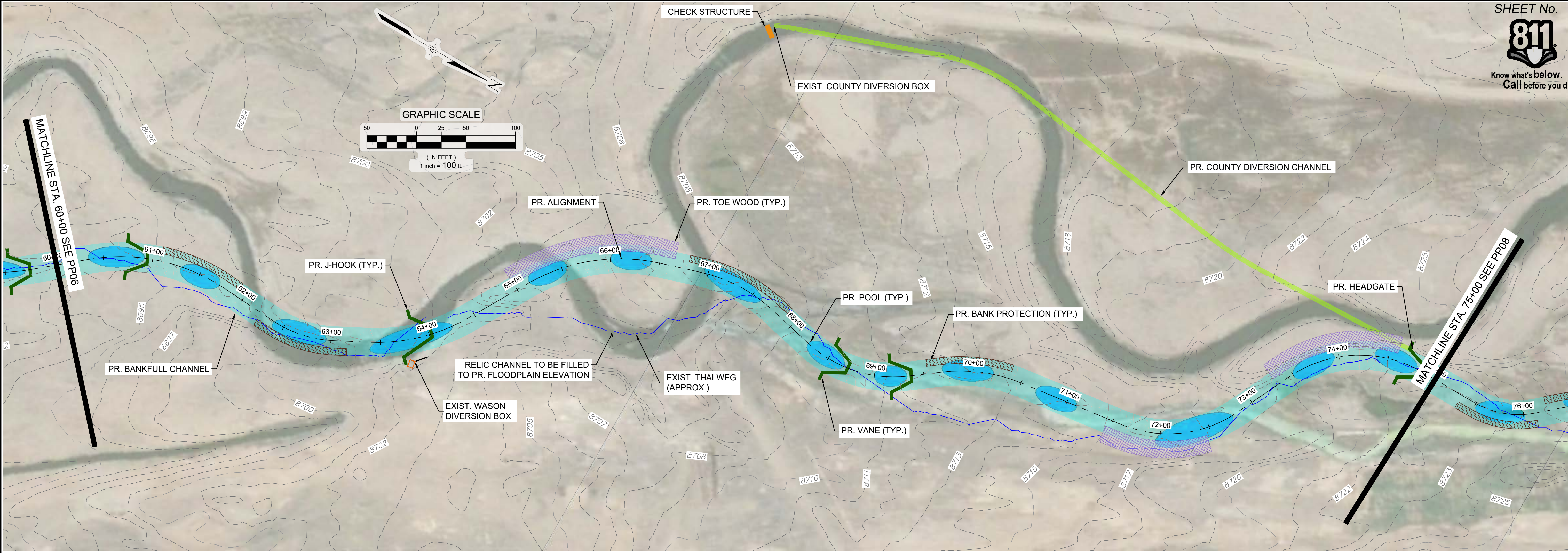

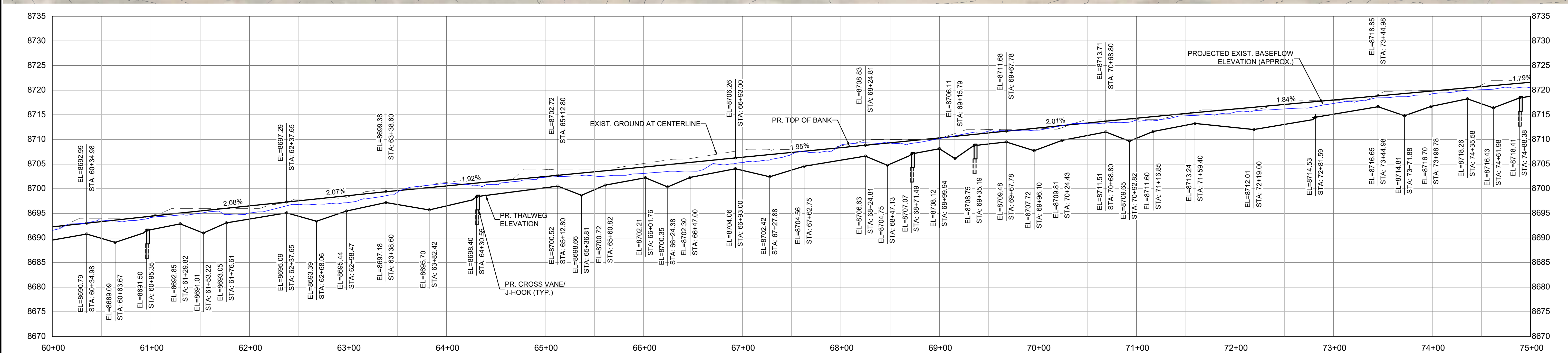

REFERENCE DRAWINGS
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X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\20.1183.001 Lower Willow Creek Floodplain Restoration\Dwg\Design Plans\1183-PP01-XX.dwg
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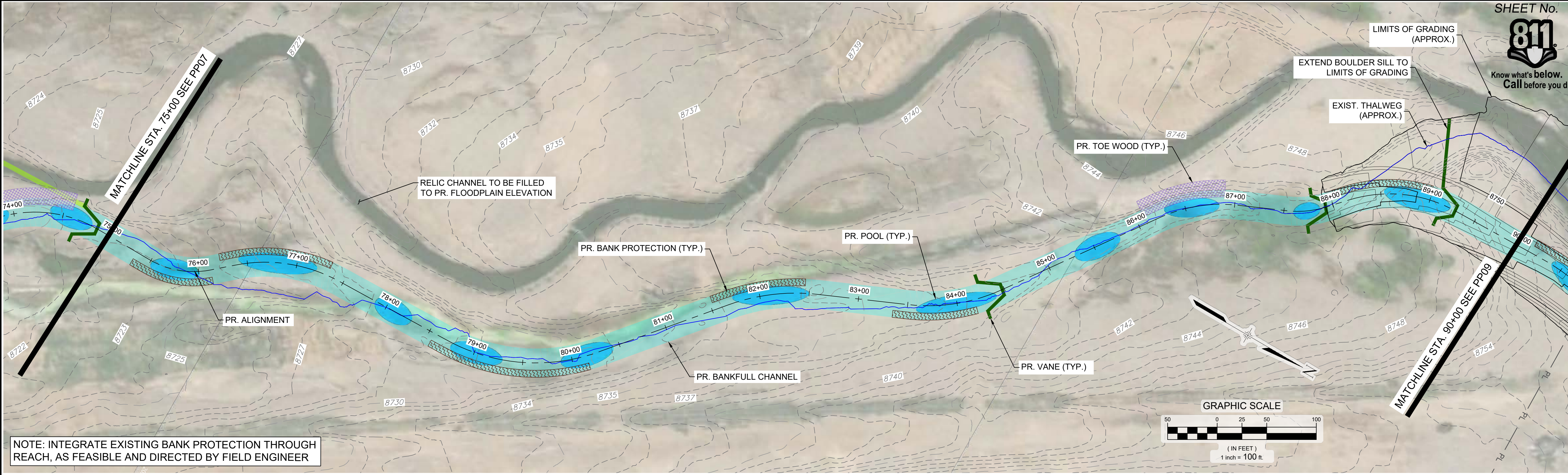
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

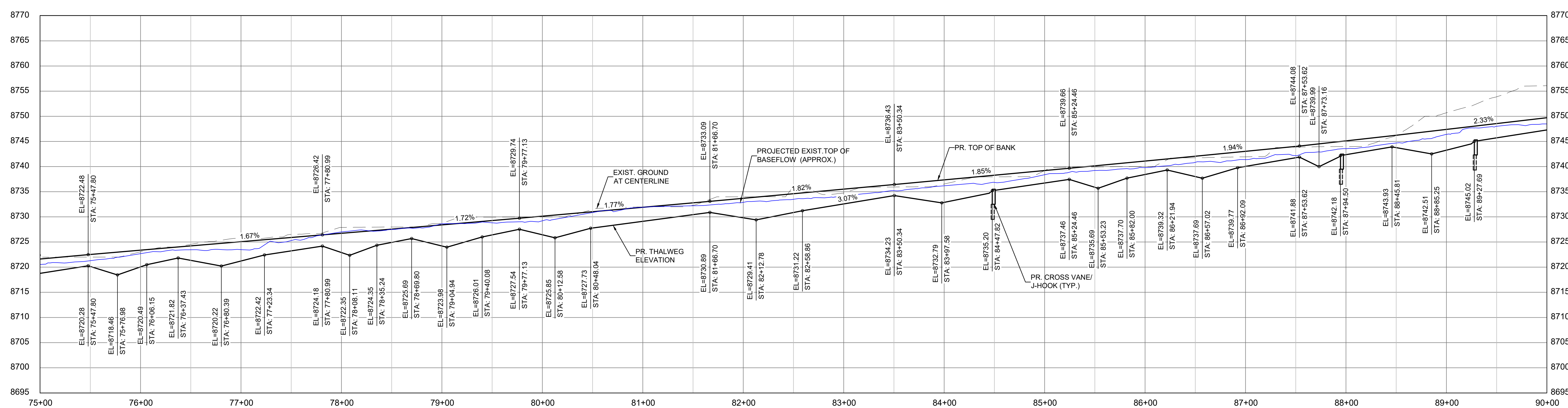
LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 60+00 - 75+00

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. 1" = 100'
VERT. 1" = 20'
DATE ISSUED: August 2021
SHEET 12 OF 25
DRAWING No. PP07



NOTE: INTEGRATE EXISTING BANK PROTECTION THROUGH REACH, AS FEASIBLE AND DIRECTED BY FIELD ENGINEER



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Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 75+00 - 90+00

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. 1" = 100'	SHEET 13 OF 25	PP08
CHECKED BY: AJS	VERT. 1" = 20'		

811
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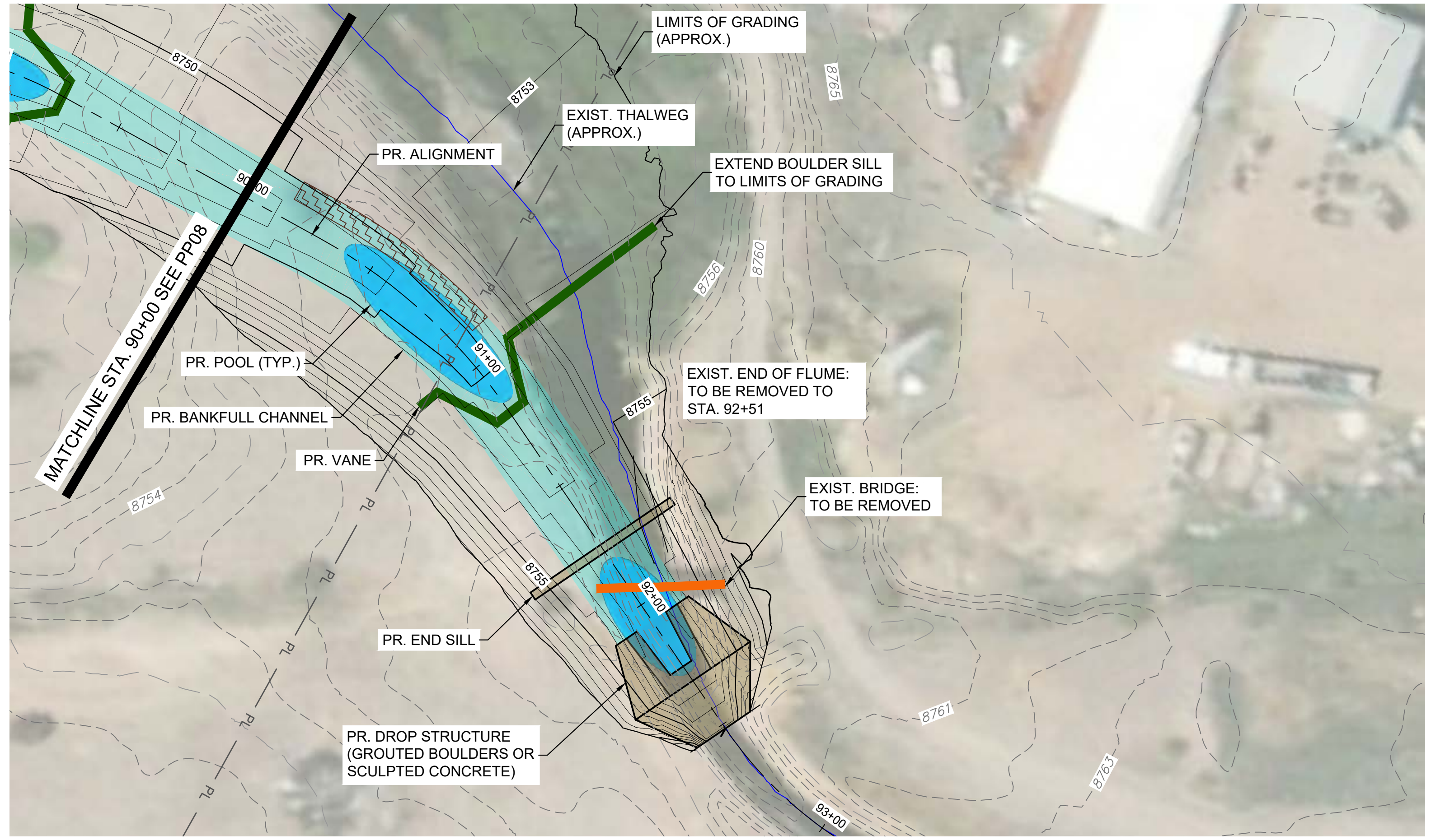
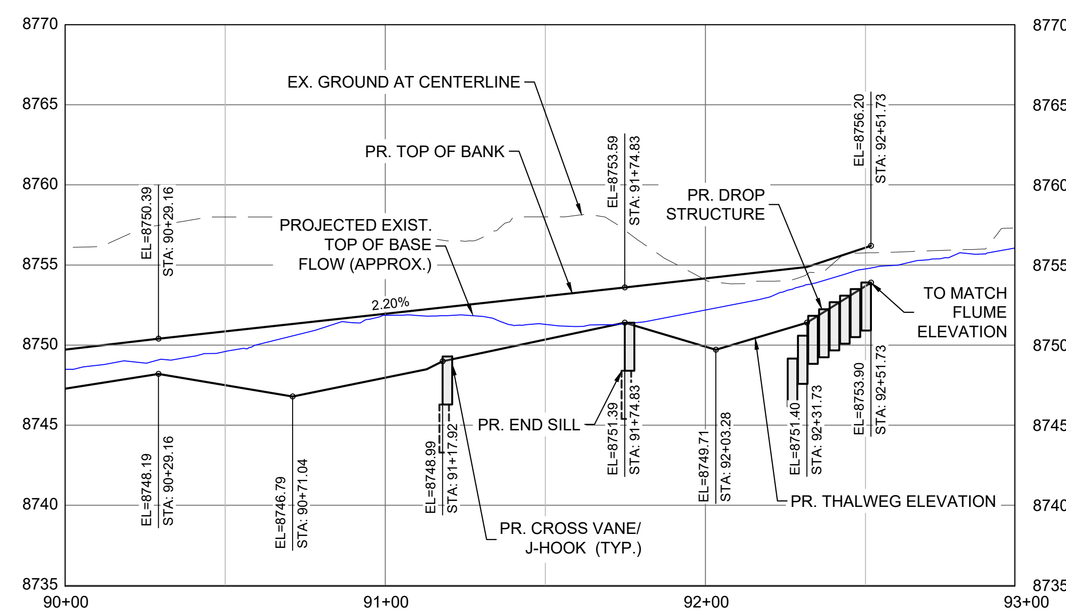


GRAPHIC SCALE

30 0 30 30 30

(IN FEET)
1 inch = 60 ft.



REFERENCE DRAWINGS
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE
X-1183-MDG22x34
X-1183-EX-TOPO
X-1183-PR-TOPO
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

PLAN AND PROFILE
STA. 90+00 - 93+00

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	1" = 60'			
CHECKED BY:	AJS	VERT.	1" = 12'	SHEET	14 OF 25	PP09

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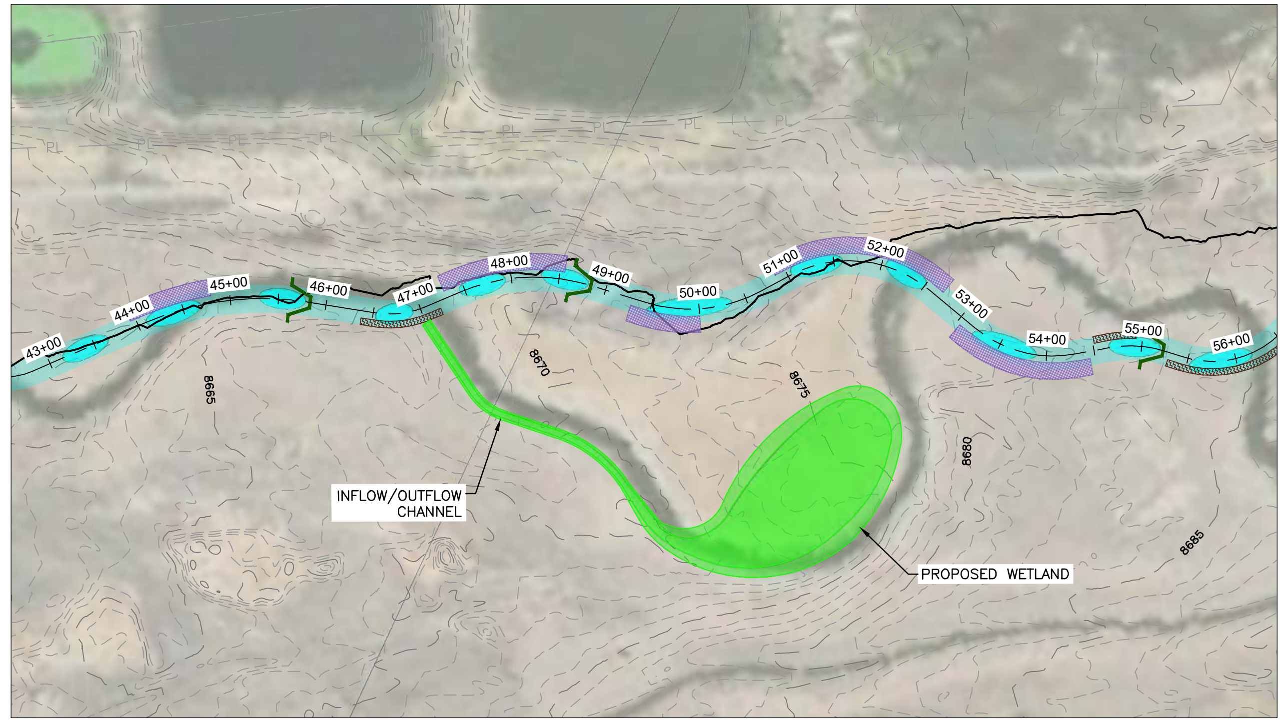
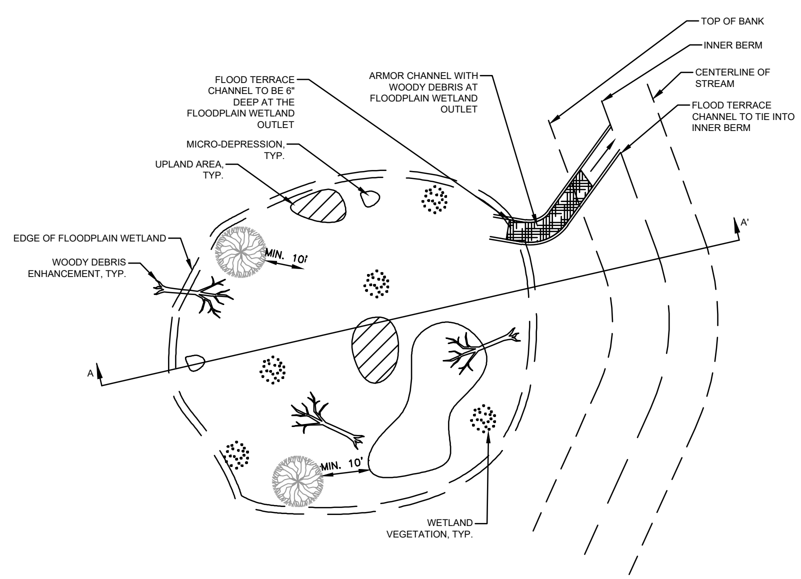


PLAN VIEW

SCALE: 1"=100'



PLAN VIEW

NOTES:

1. MICRO-DEPRESSIONS AND UPLAND AREAS ARE INTENDED TO INCREASE THE VARIABILITY OF WETLAND HABITAT WITHIN THE FLOODPLAIN WETLAND.

2. FLOODPLAIN WETLANDS SHALL BE LOCATED AND SIZED PER THE PROJECT PLAN SHEETS.

3. ALL SIDE SLOPES ASSOCIATED WITH THE FLOODPLAIN WETLAND SHALL BE NO GREATER THAN 4:1.

4. THE BOTTOM OF WETLAND SHALL BE ONE FOOT OFF ESTIMATED GROUNDWATER TABLE ELEVATION.

5. THE FLOODPLAIN WETLANDS ARE TO BE PLANTED PER WETLAND SEED MIX THIS SHEET.

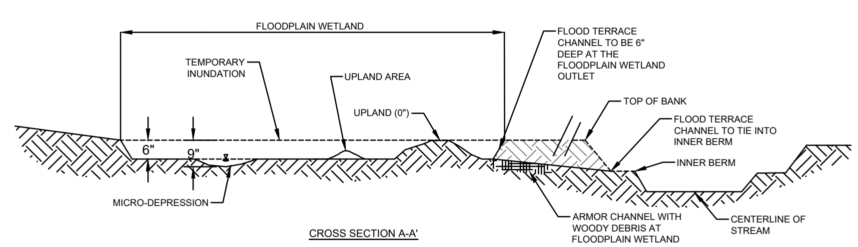
6. MICRO-DEPRESSIONS AND UPLAND AREAS ARE TO BE CREATED THROUGHOUT THE FLOODPLAIN DEPRESSTION IN A RANDOM PATTERN. THERE SHOULD BE NO MICRO-DEPRESSIONS OR FLOOD TERRACE CHANNEL EXCAVATED WITHIN 10' OF THE DRIP LINE OF ANY PLANTED TREES.

WETLAND SEED MIX

Common Name	***Scientific Name***	**Recommended Seed Rate - PLS (lbs / acre)**
Redtop	*Agrostis gigantea*	0.5
Smooth brome - Manchar	*Bromus inermis*	1.0
Water sedge	*Carex aquatilis*	1.5
Common beaked sedge	*Carex utriculata*	1.5
Tufted hairgrass	*Deschampsia cespitosa*	2.0
Streambank wheatgrass - Sodar	*Elymus lanceolatus* ssp. *lanceolatus*	2.0
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
TOTAL		**15.5**

2 WETLAND SEED MIXES

Scale: NTS



CROSS SECTION A-A'

1 DETAIL - FLOODPLAIN WETLAND

NOT TO SCALE

REFERENCE DRAWINGS
X-1183-MDG22x34
X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE-DEN-FILE02
63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU

No.	DATE	DESCRIPTION	BY

REVISIONS

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60% DESIGN PLANS

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HEADWATERS ALLIANCE CREEDE, CO

TROUT UNLIMITED

PREPARED BY:

SWCA ENVIRONMENTAL CONSULTANTS

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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

FLOODPLAIN WETLAND DETAIL

DESIGNED BY: --
DRAWN BY: TS
CHECKED BY: AH

SCALE
HORIZ. N/A
VERT. N/A

DATE ISSUED: August 2021
SHEET 15 OF 25

DRAWING No. RV01

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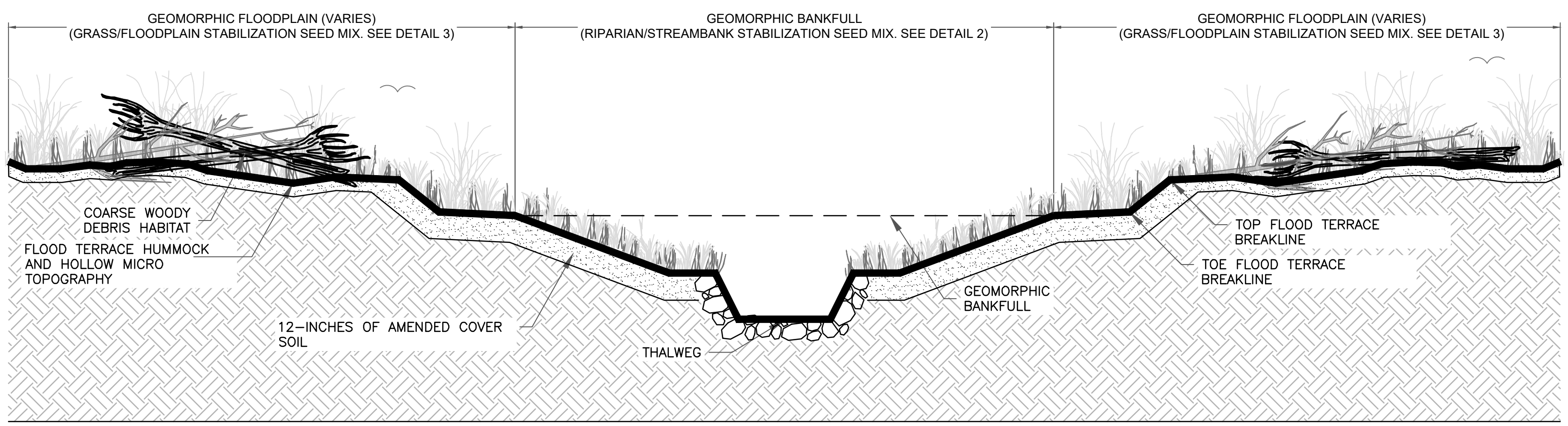


1 TYPICAL SECTION - RIFFLE

Scale: NTS

RIPARIAN/STREAMBANK STABILIZATION SEED MIX

Common Name	*Scientific Name*	Recommended Seed Rate - PLS (lbs / acre)
Redtop	*Agrostis gigantea*	0.5
Smooth brome - Manchar	*Bromus inermis*	1.0
Water sedge	*Carex aquatilis*	1.5
Common beaked sedge	*Carex utriculata*	1.5
Tufted hairgrass	*Deschampsia cespitosa*	2.0
Streambank wheatgrass - Sodar	*Elymus lanceolatus ssp. lanceolatus*	2.0
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
TOTAL		**15.5**

2 RIPARIAN/STREAMBANK STABILIZATION SEED MIXES

Scale: NTS

GRASS/FLOODPLAIN STABILIZATION SEED MIX

Common Name	*Scientific Name*	Recommended Seed Rate - PLS
Indian ricegrass - Nezpar	*Achnatherum hymenoides*	1.0
Redtop	*Agrostis gigantea*	0.1
Smooth brome - Manchar	*Bromus inermis*	1.0
Tufted hairgrass	*Deschampsia cespitosa*	0.5
Streambank wheatgrass - Sodar	*Elymus lanceolatus* ssp. *lanceolatus*	1.0
Slender wheatgrass - San Luis	*Elymus trachycaulus*	1.5
Arizona fescue - Redondo	*Festuca arizonica*	0.5
Hard fescue - Durar	*Festuca ovina*	0.5
Western wheatgrass - Arriba	*Pascopyrum smithii*	2.0
Tall wheatgrass - Jose	*Thinopyrum ponticum*	5.0
Blue flax - Lewis	*Linum lewisii*	0.3
Rocky mountain penstemon	*Penstemon strictus*	0.3
Alsike clover	*Trifolium hybridum*	0.5
	TOTAL	**14.1**

3 GRASS/FLOODPLAIN STABILIZATION SEED MIX

Scale: NTS

COVER SOIL PLACEMENT

- IMPORTED COVER SOIL TO BE FREE OF COARSE FRAGMENTS, IDEALLY LOAMY TEXTURE, PH 6.5-7.5
- AMENDMENTS MIXED IN AT RATES DESCRIBED BELOW
- HETEROGENIC SURFACE DEVELOPED BY POCKMARKING WITH MINI-EX OR EQUIVALENT
- WOODY DEBRIS PLACED RANDOMLY TO PRODUCE 10% COVER ACROSS FLOODPLAIN

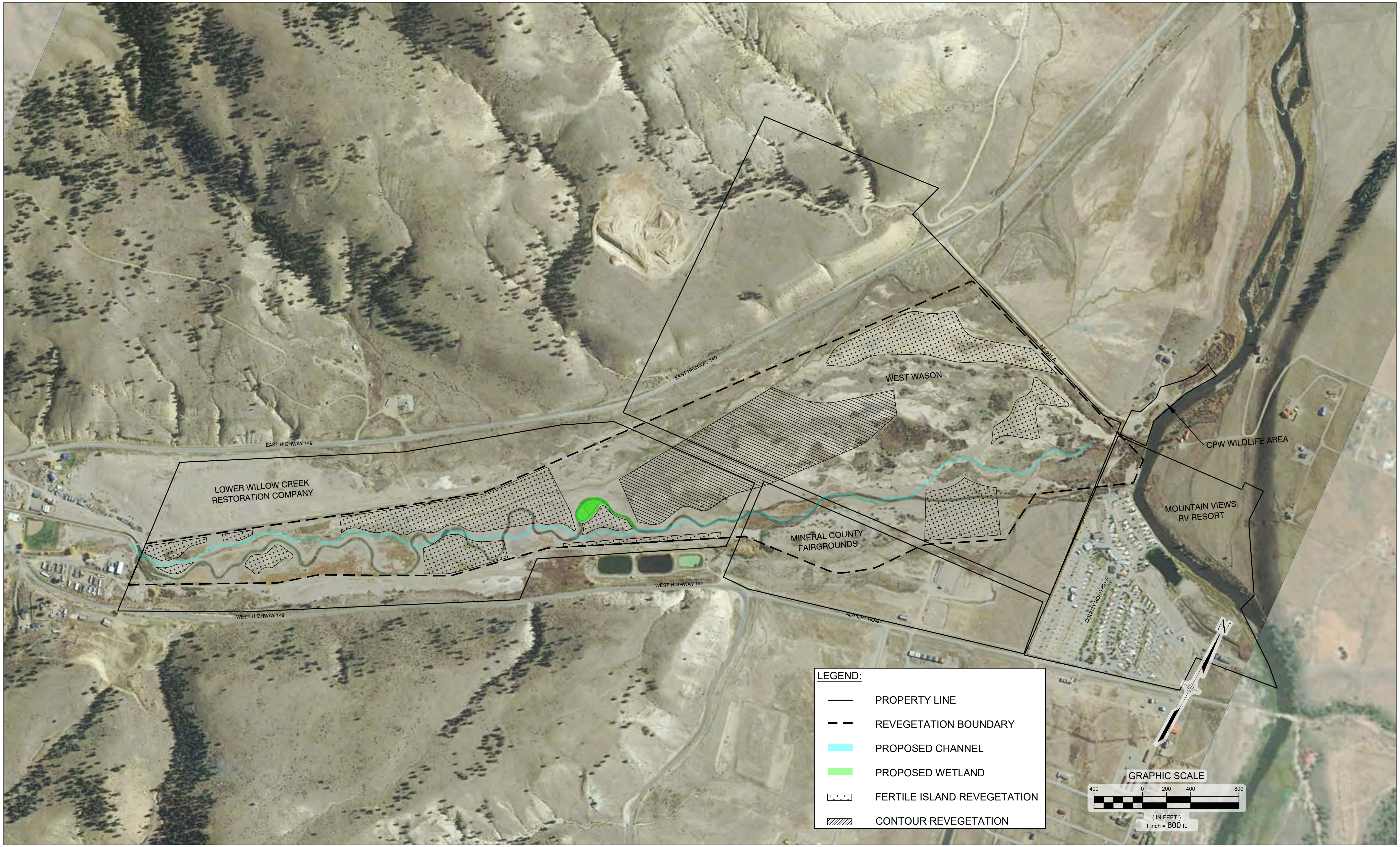
AMENDMENTS

- BIOCHAR MIXED INTO COVER MATERIAL AT 7.5% VOL/VOL
- RICHLAWN 3-6-3 WITH MYCORRHIZAE AND HUMATES 2,000 POUNDS/ACRE

SEEDING GUIDANCE

1. SEED METHODOLOGY: THE FOLLOWING METHODOLOGY PROVIDES SEQUENCING FOR ESTABLISHING THE SEED MIXES PRESCRIBED HEREIN. THIS PROCESS SHOULD BEGIN FOLLOWING FINAL GRADING. THE BEST TIME TO SEED FOR THIS PROJECT IS IN THE FALL AND NO LATER THAN NOVEMBER 30. THE SEEDING SEQUENCE SHOULD BEGIN NO LONGER THAN 48 HOURS AFTER FINAL GRADING. SITE STABILIZATION TECHNIQUES SHOULD BE UTILIZED IN THIS 48-HOUR TIME PERIOD.
2. SEED BED PREPARATION: SEED BED PREPARATION IS THE PROCESS OF LOOSENING THE SOIL SURFACE TO CREATE A LOOSE, FRIABLE, SOIL SURFACE. SOIL PREPARATION SHOULD ONLY OCCUR WHEN WEATHER, SOIL CONDITIONS, AND CONSTRUCTION PHASING ALLOWS FOR NO LONGER THAN 48 HOURS BETWEEN PREPARATION (THE BEGINNING OF THE SEEDING PROCESS) AND HYDROSEEDING. APPROPRIATE SEED RATES FOR EACH PRESCRIBED SEED MIX ARE SPECIFIED ON THE ACCOMPANYING DETAILS.
3. SEEDING: INITIAL DRILL SEEDING WILL OCCUR WITH ONE PASS OF A DRILL SEEDER. THE REMAINING SEED WILL BE INCORPORATED INTO AN HYDRAULIC MULCH (FLEXTERRA OR EQUIVALENT APPLIED AT 3,000 LB/ACRE) AND APPLIED TO ACHIEVE 100% COVER.
4. NATIVE HAY GRASS MULCHING/CRIMPING: NATIVE HAY GRASS MULCH WILL BE APPLIED TO SEEDED/RECLAIMED AREAS IMMEDIATELY FOLLOWING SEEDING APPLICATION TO PROVIDE ADDITIONAL SITE STABILIZATION AND A MORE SUITABLE SEEDBED. ALL NATIVE HAY GRASS MUST BE WEED-FREE CERTIFIED, WITH DOCUMENTED SOURCE AND SPECIES.
5. RESEEDING: AREAS TO BE RESEEDED SHALL FOLLOW THE SAME SEEDING SEQUENCE OUTLINED ABOVE. IT IS EXPECTED THAT SOME SEEDED AREAS MAY NOT GERMINATE, BUT THAT OVER TIME THE PLANTED AREAS SHALL FILL IN THROUGH SEED PROLIFERATION AND GROWTH HABITS. AREAS LARGE ENOUGH TO BE IDENTIFIED THROUGH MONITORING AS BEING DOMINATED BY WEEDS OR OTHER INVASIVE SPECIES THAT HAVE OUT COMPETED THE SPECIFIED SEED MIX OR AREAS DEEMED UNSTABLE DUE TO LOW PLANT GROWTH SHALL BE RESEEDED ACCORDINGLY.
6. PLANT SUCCESSION NOTES: IT IS POSSIBLE THAT OVER TIME SOME SEEDED AREAS MIGHT BECOME DOMINATED BY NATIVE PLANT SPECIES EXISTING IN THE SOIL SEED BANK. ONE EXAMPLE OF THIS IS THE LIKELIHOOD THAT VARIOUS TYPES OF NATIVE SEDGES NOT INCLUDED IN THE SEED MIX COULD EMERGE IN WETLAND AREAS. ESTABLISHED EXISTING NATIVE SPECIES ARE HIGHLY DESIRABLE BECAUSE THEY ARE PROVEN TO EXIST AND THRIVE IN THE IDENTIFIED PLANTING AREAS AND ADD TO LANDSCAPE DIVERSITY. NATIVE SPECIES THAT EMERGE DUE TO BEING IN THE SOIL SEED BANK SHOULD REMAIN. THOROUGH AND REGULAR MONITORING DURING THE MATURATION OF THE ESTABLISHMENT AREAS IS A KEY COMPONENT TO BALANCING AREAS TO BE RESEEDED AND AREAS WHERE SUCCESSIONAL PLANT GROWTH OF NATIVES SHOULD BE ALLOWED TO THRIVE.

811 Know what's below. Call before you dig.



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X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE-DEN-FILE02
63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU
63588-LowerWillow-PlantingPlanSet-07272021
63588-TitleBlock-ANSI-D

No.	DATE	DESCRIPTION	BY

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HEADWATERS ALLIANCE CREEDE, CO

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PREPARED BY:
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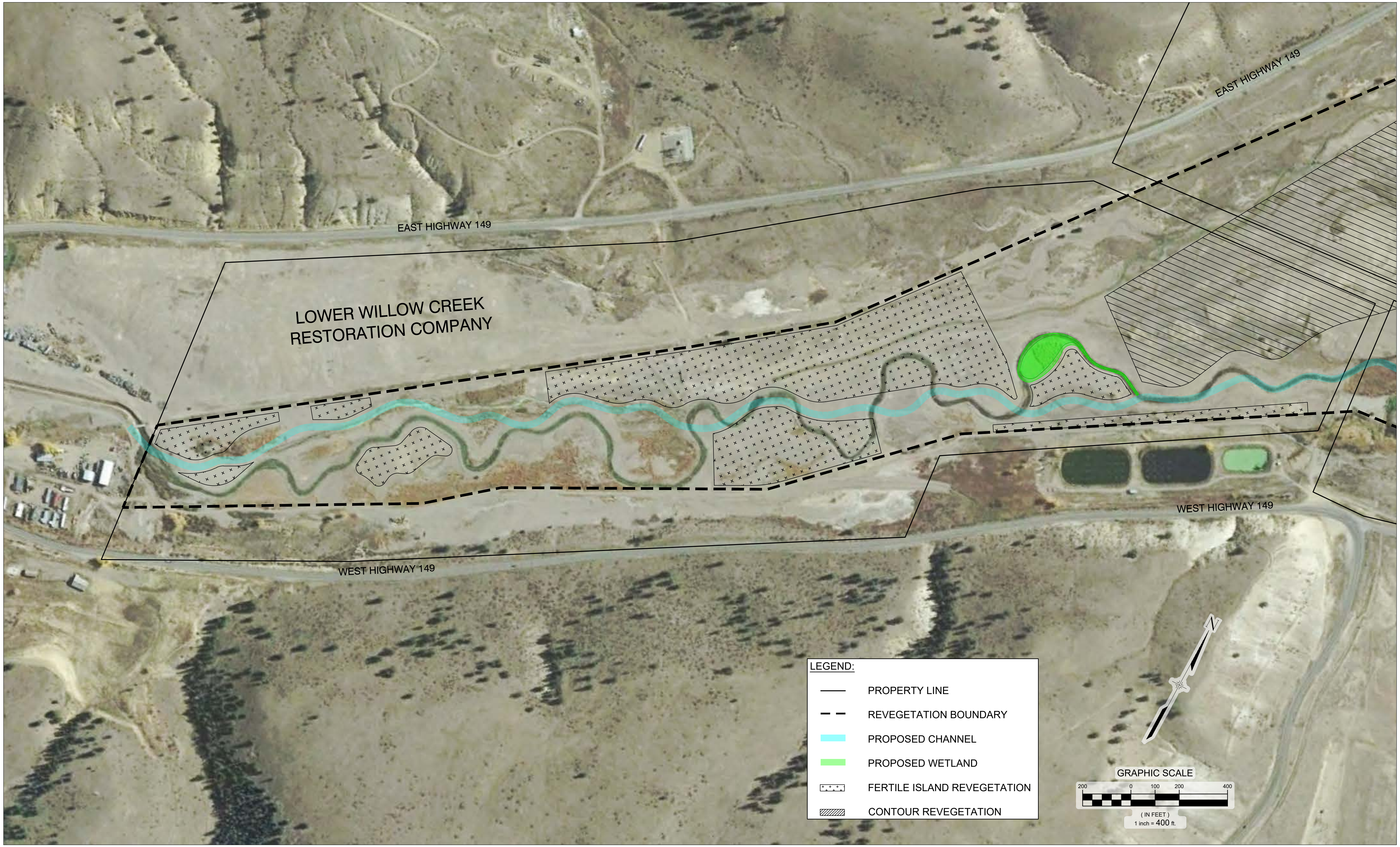
FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

FLOODPLAIN REVEGETATION PLAN - OVERVIEW

DESIGNED BY: --
DRAWN BY: TS
CHECKED BY: AH
SCALE HORIZ. 1" = 800'
VERT. N/A
DATE ISSUED: August 2021
SHEET 17 OF 25
DRAWING No. RV03



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X-1183-EX-TOPO
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X-1183-EX-IMAGE-DEN-FILE02
63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU
63588-LowerWillow-PlantingPlanSet-07272021
63588-TitleBlock-ANSI-D

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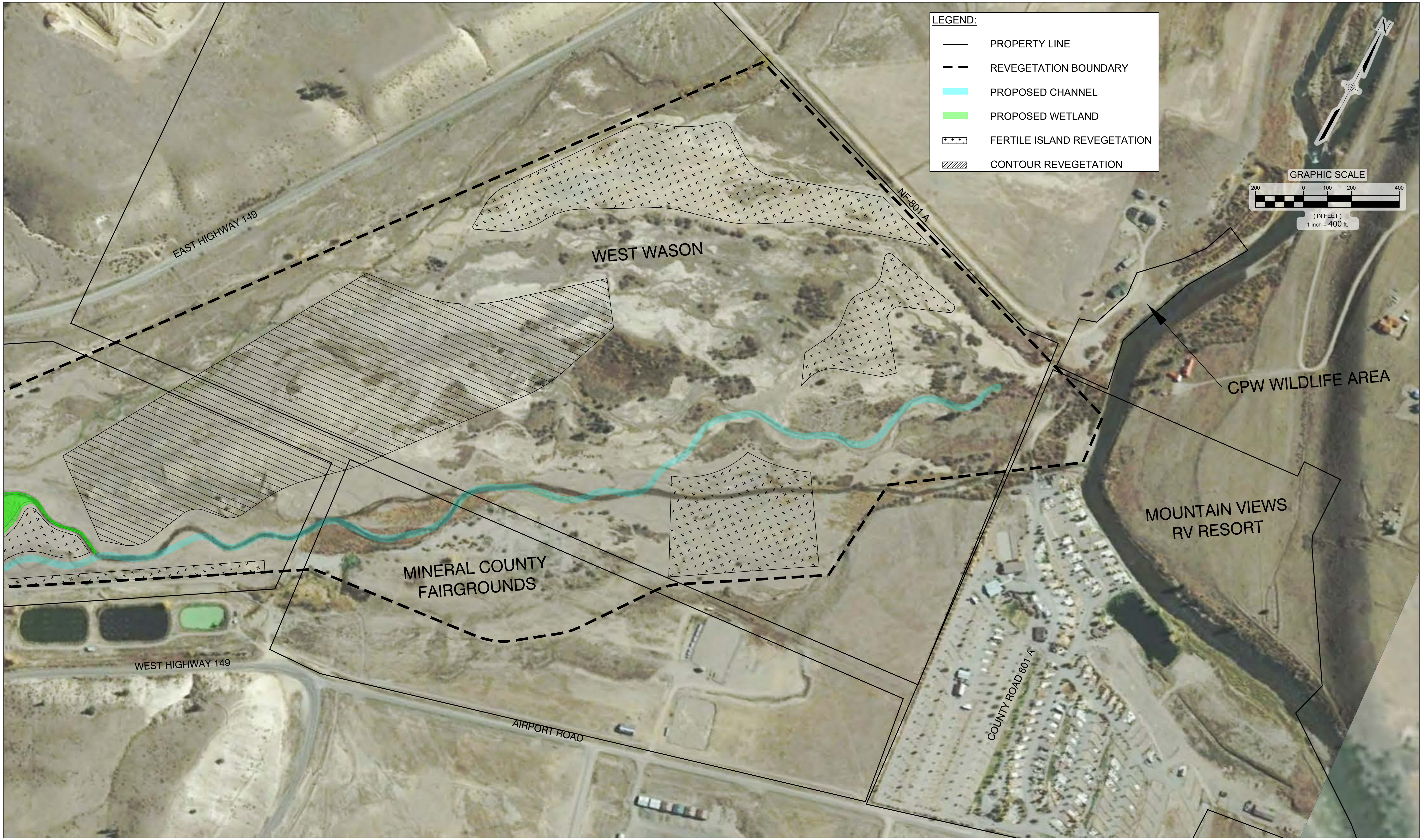
LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

FLOODPLAIN REVEGETATION PLAN - NORTH

DESIGNED BY: --	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: TS	HORIZ. 1" = 400'	SHEET 18 OF 25	RV04
CHECKED BY: AH	VERT. N/A		



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Lower Willow Creek Survey 20201210
X-1183-EX-IMAGE-DEN-FILE02
63588-LowerWillow-WetlandDesign
X-1183-PARCELS FROM TU
63588-LowerWillow-PlantingPlanSet-07272021
63588-TitleBlock-ANSI-D

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PREPARED BY:

SWCA ENVIRONMENTAL CONSULTANTS

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PROJECT No. 20.1183.001

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LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

FLOODPLAIN REVEGETATION PLAN - SOUTH

DESIGNED BY: --	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: TS	HORIZ. 1" = 400'	SHEET 19 OF 25	RV05
CHECKED BY: AH	VERT. N/A		

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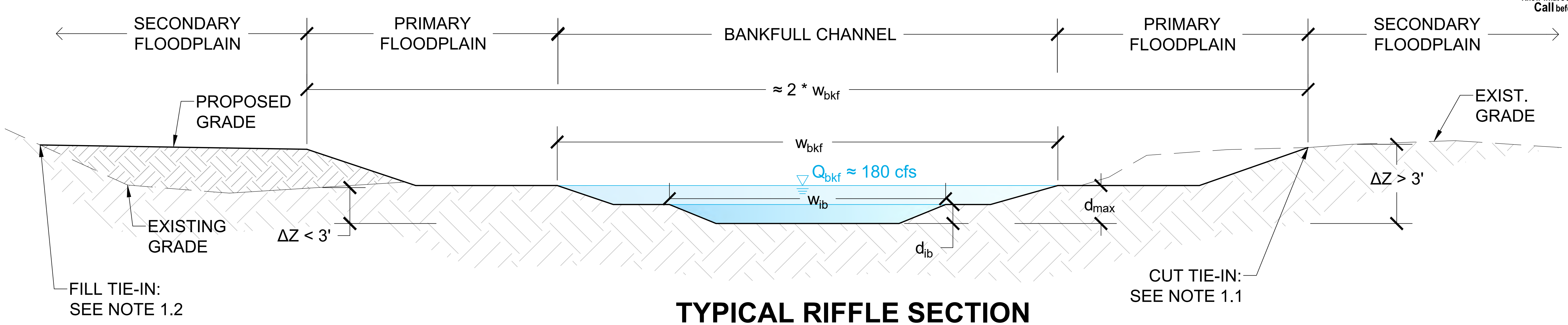

TYPICAL RIFFLE SECTION

NOT TO SCALE

NOTES ON BANKFULL CHANNEL GRADING:

1. THE TYPICAL RIFFLE SECTION REPRESENTS THE CHANNEL CROSS SECTION AT THE HEAD OF THE RIFFLE FACET. THE LOCATIONS FOR THE HEAD OF RIFFLE ARE SHOWN IN THE PROFILE SHEET, CORRESPONDING TO THE TOP OF BANK STA./ELEV. CALLOUT.
2. SEE TABLE BELOW FOR TYPICAL VALUES FOR BANKFULL DIMENSIONS.
3. CREATE SMOOTH TRANSITIONS BETWEEN TYPICAL RIFFLE AND POOL SECTIONS.
4. BED MATERIAL PLACED IN THE CHANNEL BOTTOM SHOULD BE CONSISTENT WITH BED MATERIAL FOUND ONSITE (CONSISTING PRIMARILY OF COARSE GRAVEL/SMALL COBBLE).

DIMENSIONS FOR TYPICAL RIFFLE SECTION

		MINIMUM	TYPICAL	MAXIMUM
BANKFULL TOP WIDTH	w_{bkf}	27	29	31
BANKFULL MAX DEPTH	d_{max}	2.1	2.2	2.3
INNER BERM WIDTH	w_{ib}	14	16	22
INNER BERM MAX DEPTH	d_{ib}	1.0	1.1	1.2

NOTES ON FLOODPLAIN GRADING:

1. THE FLOODPLAIN GRADING DEPENDS UPON THE RELATIVE ELEVATION OF THE EXISTING FLOODPLAIN
   ΔZ = HEIGHT OF EXISTING ABOVE PROPOSED THALWEG ELEVATION
   THE FLOODPLAIN SHALL CONFORM TO THE FOLLOWING:
   1.1. CUT TIE-IN (ΔZ > 3'): TIE INTO EXISTING FLOODPLAIN AT APPROXIMATELY TWICE BANKFULL WIDTH (AS SHOWN ON THE RIGHT IN TYPICAL DETAIL).
   1.2. FILL TIE-IN (ΔZ < 3'): FILL WILL BE REQUIRED IN THE FLOODPLAIN OUTSIDE OF TWICE BANKFULL WIDTH (AS SHOWN ON LEFT IN TYPICAL DETAIL). FILL TO ACHIEVE A RELATIVE ELEVATION OF AT LEAST 3', WITH 4' BEING PREFERABLE. DO NOT CREATE A BERM IN THE FLOODPLAIN.
2. BY CONSTRUCTING FLOODPLAIN WIDTHS AND DEPTHS AT EACH RIFFLE SECTION PER THESE NOTES, SMOOTH TRANSITIONS CAN BE MADE IN THE FLOODPLAIN BETWEEN RIFFLE SECTIONS. IT SHOULD NOT BE THE CASE THAT THE FLOODPLAIN MEANDERS IDENTICALLY WITH THE CHANNEL. IN GENERAL, FLOODPLAIN WILL BE ORIENTED DOWN VALLEY, WITH MEANDERS MORE GRADUAL THAN THAT OF THE BANKFULL CHANNEL.
3. FLOODPLAIN GRADING WILL VARY BASED ON EXISTING CONDITIONS, AND THE ABOVE IS GENERAL GUIDANCE. FINAL TIE-IN GRADING TO BE VERIFIED BY ENGINEER.
4. SLOPES IN FLOODPLAIN SHOULD BE 3:1 OR FLATTER.
5. GRADING SHOULD HAVE NATURAL VARIABILITY TO AVOID UNIFORM APPEARANCE: E.G. AVOID IDENTICAL 3:1 SIDE SLOPES AND IDENTICAL FLOODPLAIN WIDTH.
6. PROPOSED GRADING COUNTOURS ARE SHOWN FROM STA. 14+30 TO 24+84 AND FROM STA. 87+92 TO 92+52. THESE TWO AREAS HAVE SIGNIFICANT CUT AND FILL FOR CONSTRUCTING THE PROPOSED CHANNEL AND FILLING THE EXISTING CHANNEL. THE PROPOSED CONTOURS SHOULD BE CONSIDERED APPROXIMATE. SPECIFICALLY:
   6.1. THE PROPOSED CONTOURS DO NOT SHOW VARYING SECTIONS WITHIN THE BANKFULL CHANNEL.
   6.2. THE PROPOSED FLOODPLAIN GRADING IS MOSTLY UNIFORM. FINAL FLOODPLAIN GRADING SHOULD MEET THE GUIDANCE OF THE PREVIOUS NOTE.

REFERENCE DRAWINGS
X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

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PREPARED BY:
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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

TYPICAL RIFFLE CROSS SECTION

DESIGNED BY: JAB | DRAWN BY: EAL | CHECKED BY: AJS
SCALE: HORIZ. N/A | VERT. N/A
DATE ISSUED: August 2021
SHEET 20 OF 25
DRAWING No. DT01

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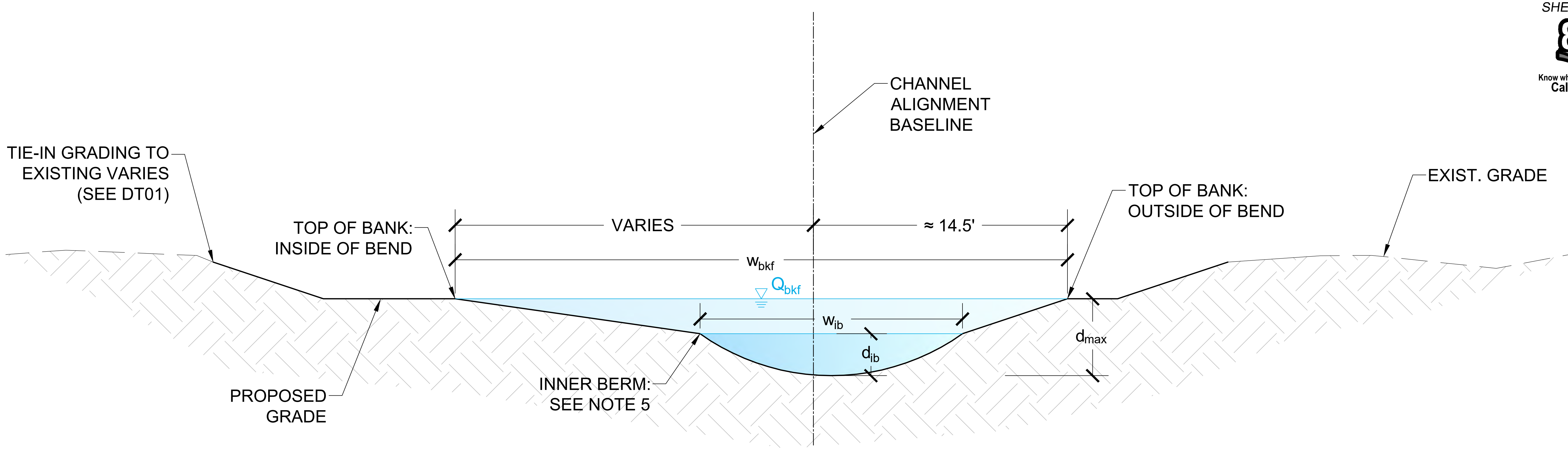

TYPICAL POOL SECTION

NOT TO SCALE

NOTES:

1. LOCATION OF POOL SECTIONS ARE SHOWN ON THE PROFILE SHEETS.
2. VARIATION IN BANKFULL WIDTH SHOULD PRIMARILY OCCUR ALONG THE INSIDE OF A BEND. THE OUTSIDE TOP OF BANK SHOULD MAINTAIN AN OFFSET OF APPROXIMATELY 14.5' FROM THE CENTERLINE ALIGNMENT, AS SHOWN ABOVE.
3. THE THALWEG POOL ELEVATION SHOWN IN THE PROFILE CORRESPONDS TO A MAX POOL DEPTH OF 4.5'. HOWEVER, VARIABILITY IN POOL DEPTH IS PREFERRED, WITH RANGES GIVEN IN THE TABLE AND GENERAL GUIDANCE AS FOLLOWS:
   - 3.1. EXCAVATE DEEPER POOLS IN TIGHTER/LONGER BENDS.
   - 3.2. EXCAVATE DEEPER POOLS THAT ARE DOWNSTREAM OF LONGER/STEEPER RIFFLES.
4. IN GENERAL, IT IS PREFERRED THAT POOLS ARE CONSTRUCTED DEEPER THAN SHALLOWER.
5. THE ELEVATION OF THE INNER BERM SHOULD BE SLIGHTLY HIGHER (APPROX. 0.1') THAN THE ELEVATION OF THE INNER BERM OF THE DOWNSTREAM RIFFLE.
6. FLOODPLAIN GRADING SHOULD FOLLOW THE GUIDANCE PROVIDED ON DT01 FOR THE TYPICAL RIFFLE SECTION. FLOODPLAIN GRADING ADJACENT TO THE POOL SECTIONS WILL BE ACCOMPLISHED BY SMOOTH TRANSITIONS IN FLOODPLAIN BETWEEN RIFFLE SECTIONS. GENERALLY, THERE WILL BE MORE FLOODPLAIN WIDTH ON THE INSIDE OF THE BEND, AS SHOWN ABOVE, PARTICULARLY AROUND LONGER/TIGHTER BENDS.
7. BED MATERIAL PLACED IN THE CHANNEL BOTTOM SHOULD BE CONSISTENT WITH BED MATERIAL FOUND ONSITE (CONSISTING PRIMARILY OF COARSE GRAVEL/SMALL COBBLE).

DIMENSIONS FOR TYPICAL POOL SECTION

		MINIMUM	TYPICAL	MAXIMUM
BANKFULL TOP WIDTH	w_{bkf}	29	35	42
BANKFULL MAX DEPTH	d_{max}	3.6	4.5	5.1
INNER BERM WIDTH	w_{ib}	11	15	18
INNER BERM MAX DEPTH	d_{ib}	2.7	3.0	3.2

REFERENCE DRAWINGS
X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

REVISIONS

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HEADWATERS ALLIANCE CREEDE, CO

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PREPARED BY:
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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

TYPICAL POOL CROSS SECTION

DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS
SCALE HORIZ. N/A VERT. N/A
DATE ISSUED: August 2021
SHEET 21 OF 25
DRAWING No. DT02

Know what's below. Call before you dig.

MONUMENT CREEK IN COLORADO SPRINGS

MONUMENT CREEK IN COLORADO SPRINGS

DROP STRUCTURE EXAMPLES

MONUMENT CREEK IN COLORADO SPRINGS

CLEAR CREEK IN GOLDEN (BY OTHERS)

NOTE; DETAILS TO BE ADDED BASED ON STRUCTURE TYPE (SCULPTED CONCRETE OR GROUTED BOULDERS) AND FURTHER DESIGN.

SCULPTED CONCRETE

GROUTED BOULDERS

REFERENCE DRAWINGS
X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\20.1183.001 Lower Willow Creek Floodplain Restoration\Dwg\Design Plans\1183-DT01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 8/12/2021 5:00 PM
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60% DESIGN PLANS

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HEADWATERS ALLIANCE CREEDE, CO

TROUT UNLIMITED

PREPARED BY:
Matrix
Excellence by Design

SEAL
PRELIMINARY
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FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

DROP STRUCTURE DETAILS

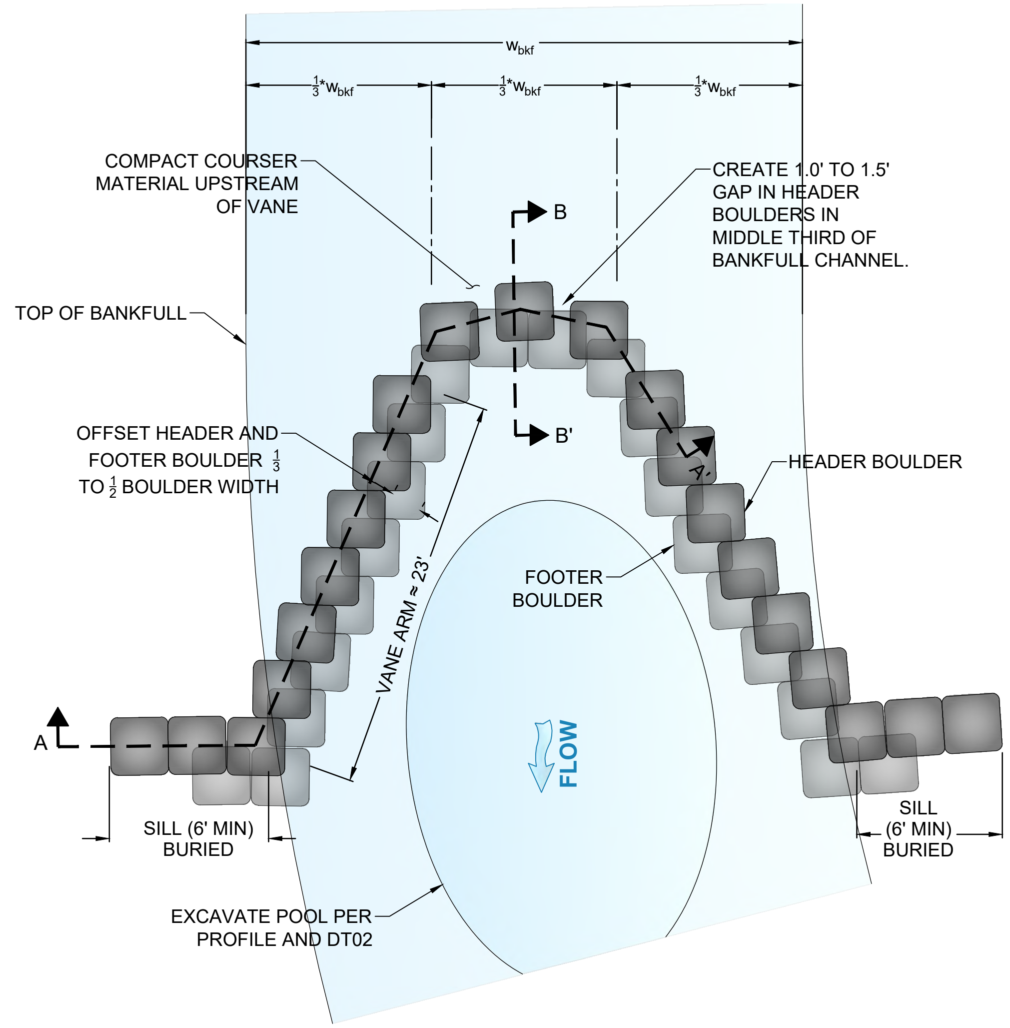
DESIGNED BY: JAB
DRAWN BY: EAL
CHECKED BY: AJS

SCALE
HORIZ. N/A
VERT. N/A

DATE ISSUED: August 2021
SHEET 22 OF 25

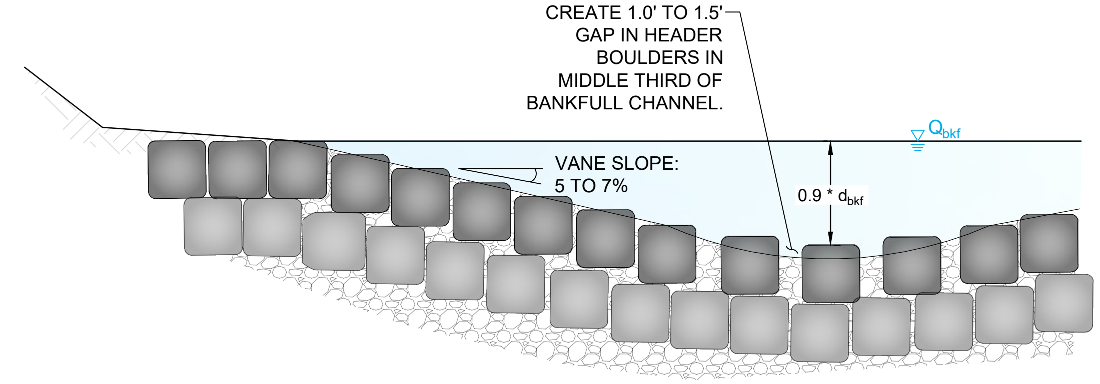
DRAWING No. DT03

811 Know what's below. Call before you dig.



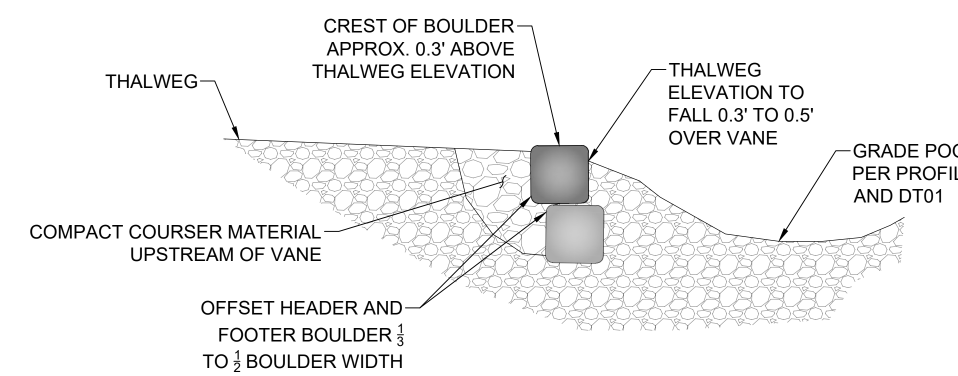
PLAN VIEW

NTS



CROSS VANE SECTION A-A'

LOOKING UPSTREAM NTS



CROSS VANE PROFILE B-B'

NTS

NOTES:

1. BOULDERS SHALL HAVE 3' NOMINAL DIAMETER OR LARGER.
2. GEOTEXTILE FABRIC SHALL BE MIRAFI FW 300 (OR APPROVED EQUAL).
3. FOR J-HOOKS, FOLLOW SAME DETAILS TO CONSTRUCT J-HOOK STRUCTURES. THE INSIDE OF BEND ARM WILL BE SHORTER, AS SHOWN IN PLAN VIEW ON THE PLAN AND PROFILE SHEETS. THE SILL ON THE INSIDE BEND WILL TIE-IN APPROXIMATELY 0.5' BELOW TOP OF BANKFULL.
4. LOGS MAY BE USED IN PLACE OF BOULDERS TO CONSTRUCT VANE ARMS, BASED ON AVAILABILITY OF MATERIALS. IF DESIRED, DETAILS FOR LOG VANES CAN BE PROVIDED.

TYPICAL ROCK CROSS VANE DETAILS

NOT TO SCALE

REFERENCE DRAWINGS

X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT

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60% DESIGN PLANS

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PREPARED BY:
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PROJECT No. 20.1183.001

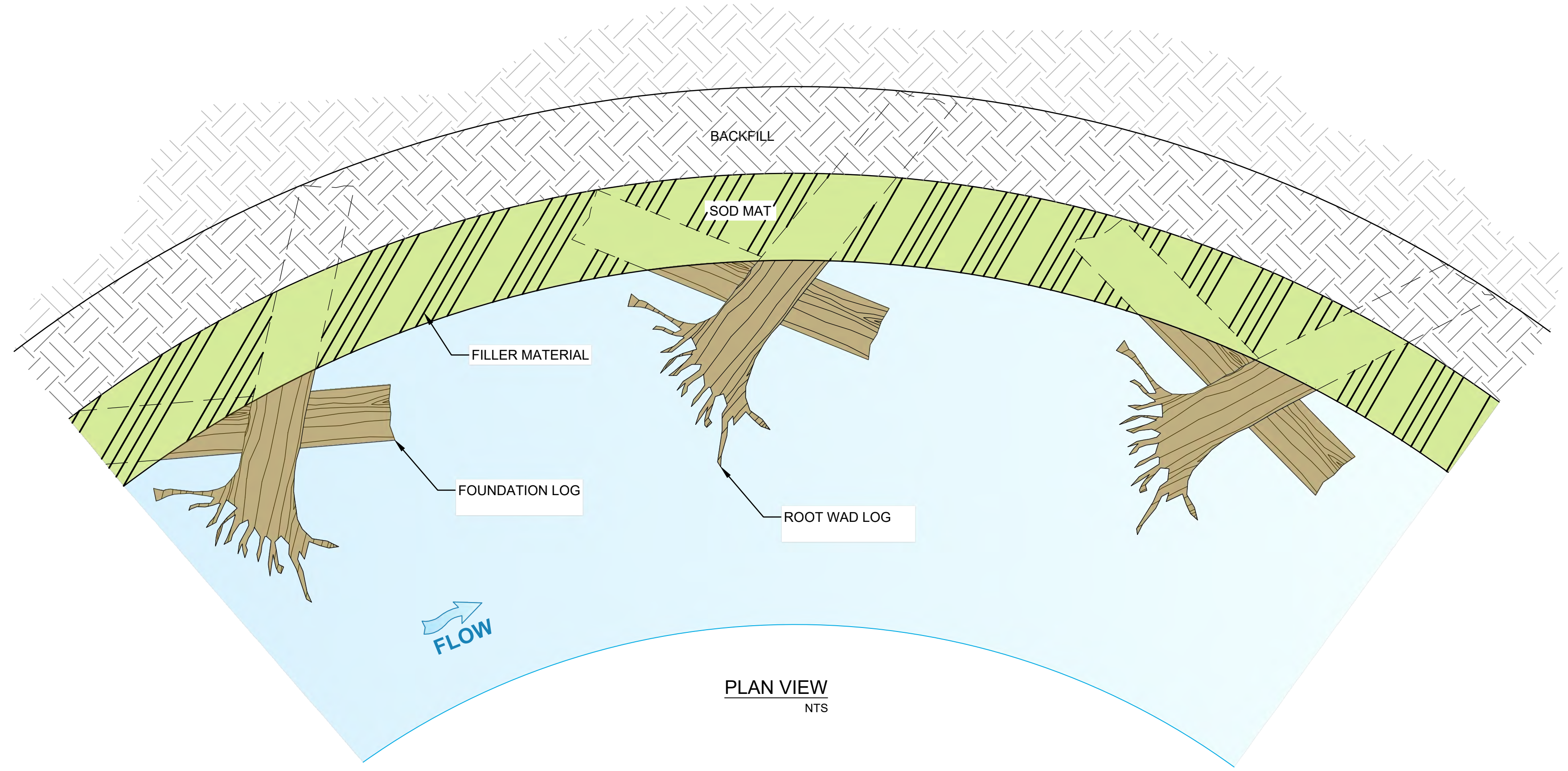
HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

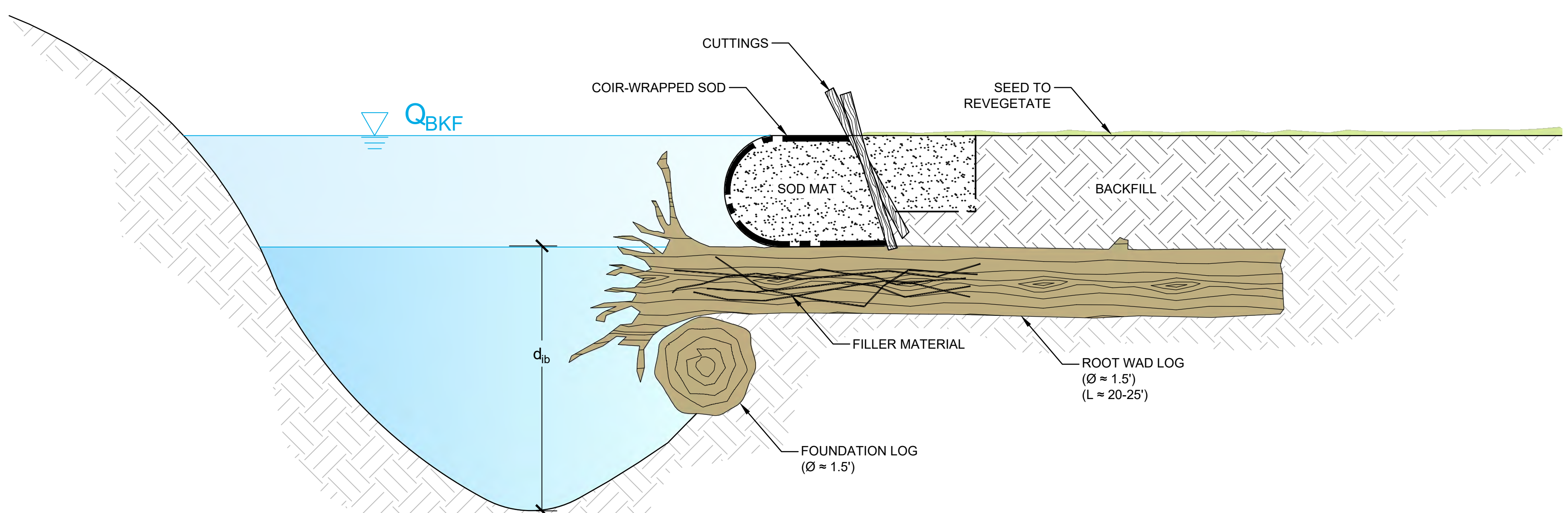
TYPICAL VANE/J-HOOK DETAIL

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	N/A			
CHECKED BY:	AJS	VERT.	N/A	SHEET	23 OF 25	DT04

Know what's **below.** **Call** before you dig.



PLAN VIEW
NTS



CROSS SECTION
NTS

NOTES:
1. DIAMETER OF LOGS SHALL BE MIN. 1.5'. LENGTH OF ROOTWARD LOGS SHALL BE 20' TO 25'. LENGTH OF FOUNDTATION LOGS WILL DEPEND UPON ROOTWAD SPACING AND AVAILABILITY.
2. APPROXIMATELY 80% OF THE LENGTH OF FOUNDATION LOGS AND ROOTWAD LOGS SHALL BE BURIED BENEATH THE OUTSIDE BANK.
3. ROOTWAD DIAMATERS SHALL BE MIN. 6'.
4. SPACING OF ROOTWADS SHOULD BE APPROX. 12'.
5. THE TOP OF LOG ELEVATION SHOULD MATCH THE INNER BERM ELEVATION OF CHANNEL.
6. AFTER PLACEMENT OF FOUNDATION LOGS AND ROOTWADS:
   - 6.1. FILL SPACE BETWEEN ROOTWADS WITH LOGS OF DIAMETERS OF 6" TO 18")
   - 6.2. PLACE SLASH MATERIAL AS AVAILABLE OVER LOGS
   - 6.3. PLACE NATIVE SOIL MATERIAL OVER LOGS/SLASH TO ESTABLISH PROPER SUBGRADE ELEVATION FOR SODMAT SODMAT
   - 6.4. PLACE SODMAT AND COIR WRAP TO ESTABLISH TOP OF BANK. STAKE AS DIRECTED BY ENGINEER.
7. PLACE SILL LOGS AT BEGINNING AND END OF TOE WOOD PROTECTION.
8. ANCHORING OF TOE WOOD (SUCH AS WITH BOULDERS) MAY BE REQUIRED. FURTHER STRUCTURAL ANALYSIS REQUIRED BEFORE CONSTRUCTION OF TOE WOOD.

TYPICAL TOE WOOD DETAILS

NOT TO SCALE

REFERENCE DRAWINGS	No.	DATE	DESCRIPTION	BY
X-1183-MDG22x34				

REVISIONS

COMPUTER FILE MANAGEMENT
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60% DESIGN PLANS

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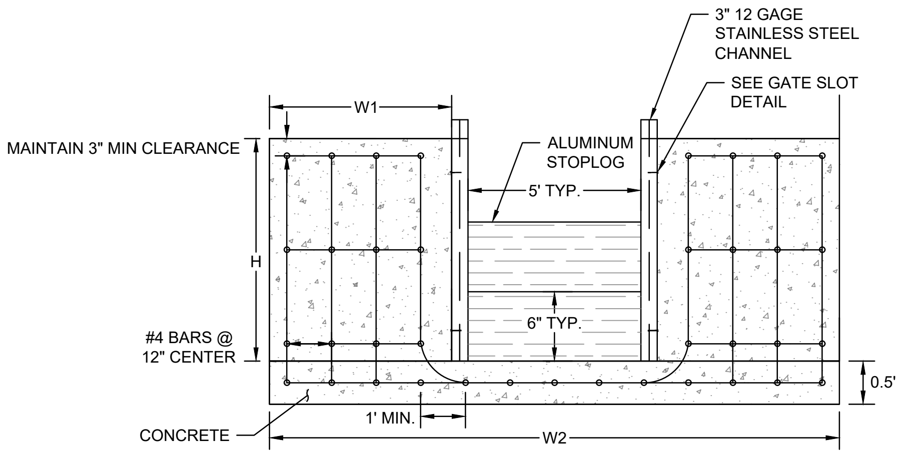
PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

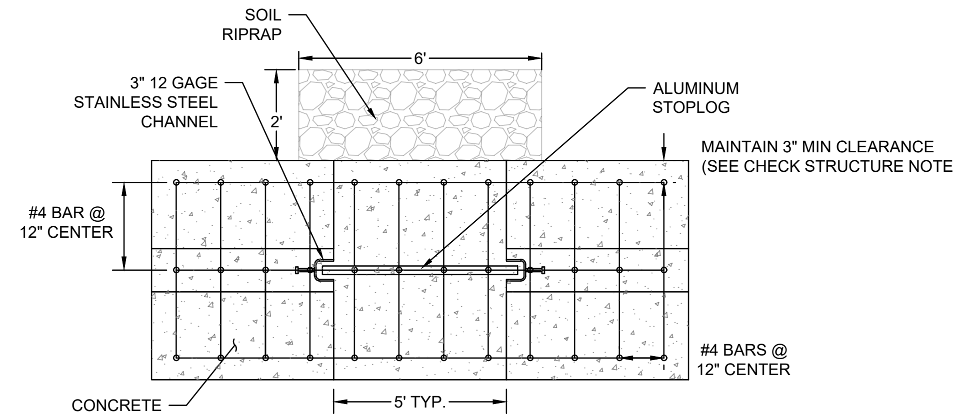
TYPICAL TOE WOOD DETAIL

DESIGNED BY:	JAB	SCALE		DATE ISSUED:	August 2021	DRAWING No.
DRAWN BY:	EAL	HORIZ.	N/A			DT05
CHECKED BY:	AJS	VERT.	N/A	SHEET	24 OF 25	



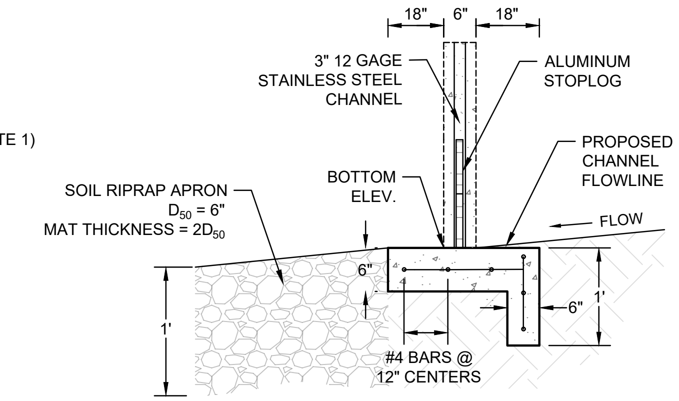
CHECK STRUCTURE

NOT TO SCALE



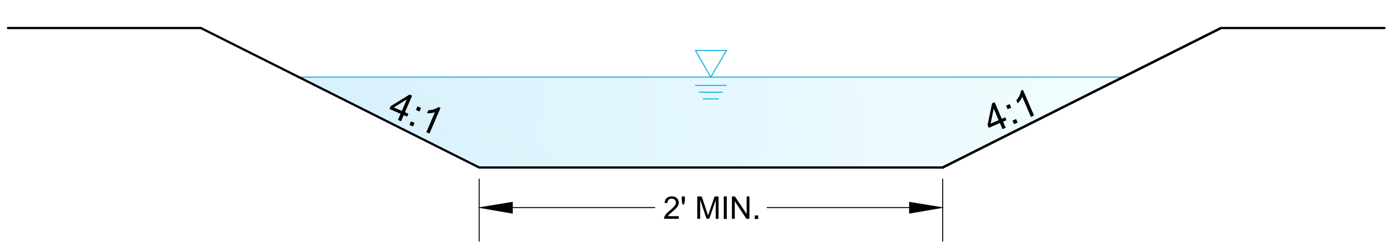
CHECK STRUCTURE TOP VIEW

NOT TO SCALE



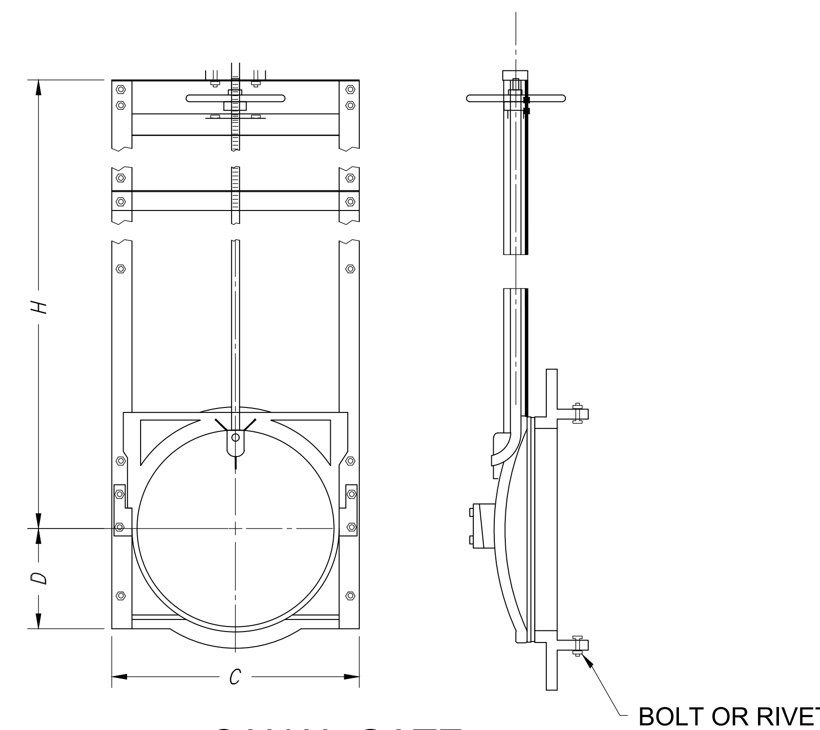
CHECK STRUCTURE PROFILE

NOT TO SCALE



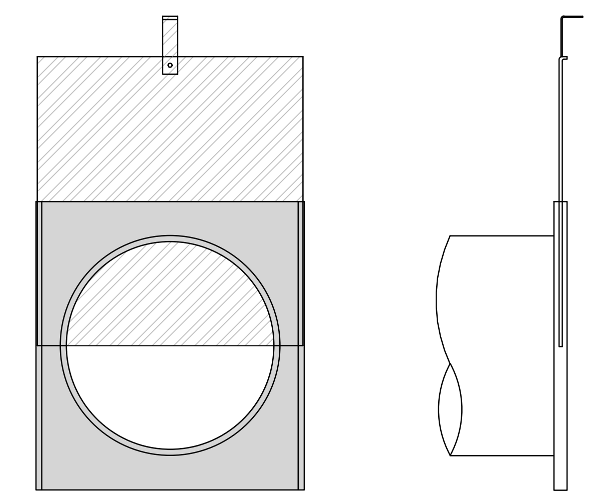
DIVERSION CHANNEL DETAIL

NOT TO SCALE



CANAL GATE

NOT TO SCALE



SLIDE GATE

NOT TO SCALE

CANAL GATE NOTES:

1. SHALL BE WATERMAN CANAL GATE MODEL NO. C-10 OR APPROVED EQUAL.
2. REFER TO WATERMAN STANDARD DRAWINGS AND MANUFACTURERS SPECIFICATIONS FOR ALL DIMENSION VALUES.
3. CONSULT MANUFACTURER FOR PIPE ADAPTER SPECIFICATIONS AND INSTALLATION.

SIDE GATE NOTES:

1. SHALL BE WATERMAN C-2 SLIDE GATE OR APPROVED EQUAL.

REFERENCE DRAWINGS

X-1183-MDG22x34

No.	DATE	DESCRIPTION	BY

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PROJECT No. 20.1183.001

HEADWATERS ALLIANCE & TROUT UNLIMITED

LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

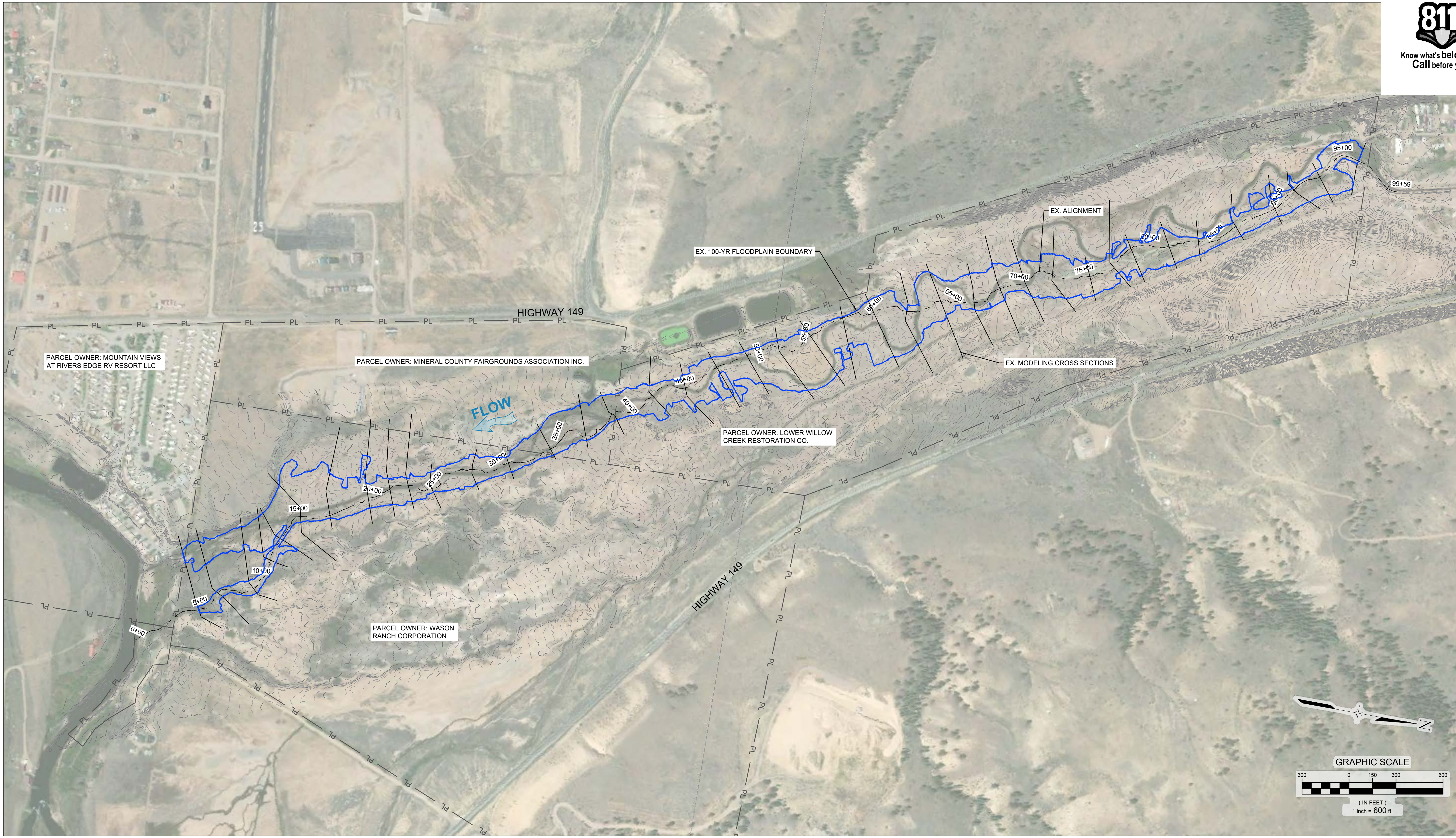
DIVERSION DETAILS

DESIGNED BY: JAB	SCALE	DATE ISSUED: August 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. N/A	SHEET 25 OF 25	DT06
CHECKED BY: AJS	VERT. N/A		

APPENDIX B

HEC-RAS Existing Conditions Modeling

Know what's below. Call before you dig.



REFERENCE DRAWINGS
X-1183-MDG22x34
X-1183-EX-IMAGE
X-1183-EX-TOPO
Lower Willow Creek Survey 20201210
X-1183-PR-TOPO
X-1183-PARCELS FROM TU
1183-PP01-XX_JDH RAS_EX

REVISIONS

No.	DATE	DESCRIPTION	BY

COMPUTER FILE MANAGEMENT

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CTB FILE: Matrix(black).ctb
PLOT DATE: 8/12/2021 4:03 PM
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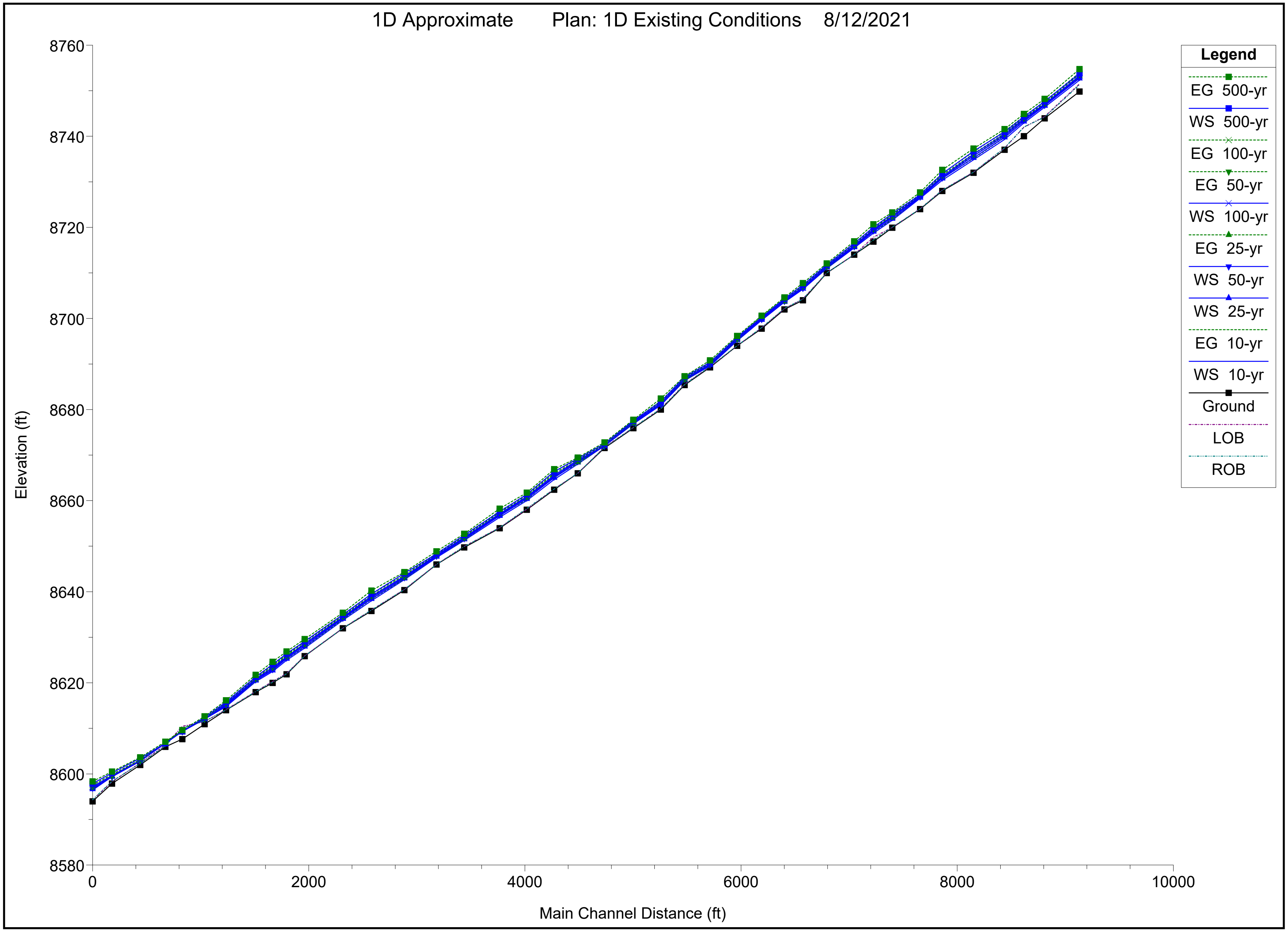
HEADWATERS ALLIANCE & TROUT UNLIMITED

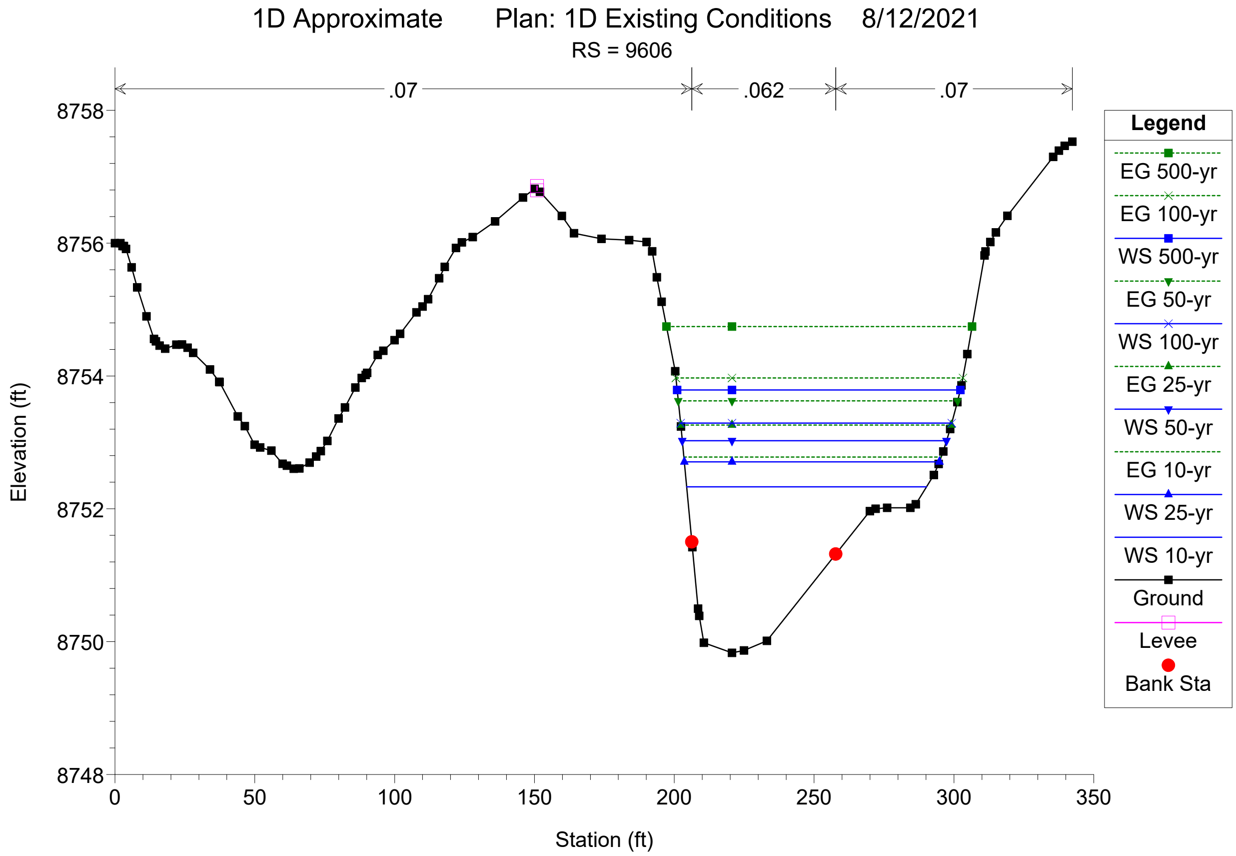
LOWER WILLOW CREEK FLOODPLAIN RESTORATION
60% DESIGN PLANS

HEC-RAS WORKMAP
EXISTING CONDITIONS

DESIGNED BY: JAB	SCALE	DATE ISSUED: AUGUST 2021	DRAWING No.
DRAWN BY: EAL	HORIZ. 1" = 600'	SHEET 1 OF 1	HEC
CHECKED BY: AJS	VERT. N/A		



1D Approximate Plan: 1D Existing Conditions 8/12/2021
Elevation (ft)
Main Channel Distance (ft)
8760
8740
8720
8700
8680
8660
8640
8620
8600
8580
0
2000
4000
6000
8000
10000
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
LOB
ROB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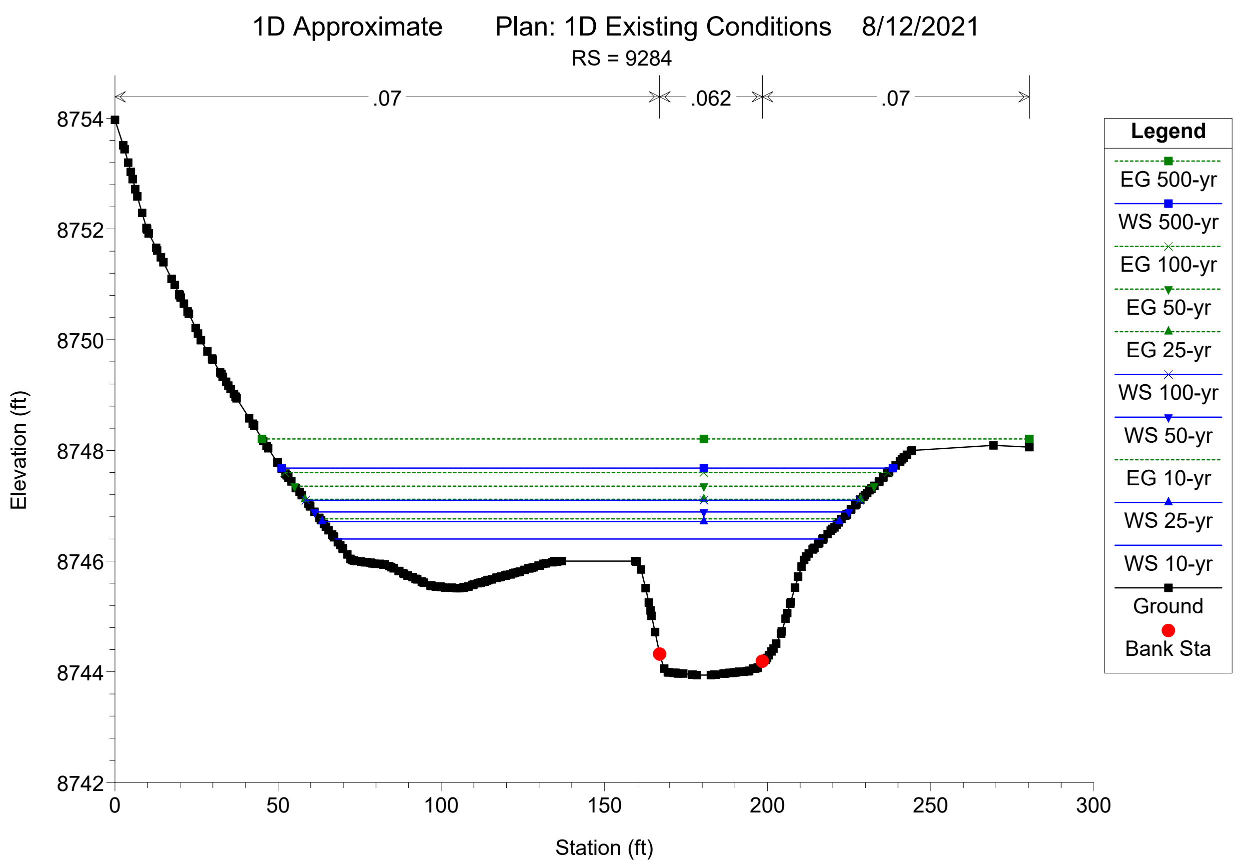
RS = 9606
.07
.062
.07
Legend
EG 500-yr
EG 100-yr
WS 500-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta
Elevation (ft)
8758
8756
8754
8752
8750
8748
0
50
100
150
200
250
300
350
Station (ft)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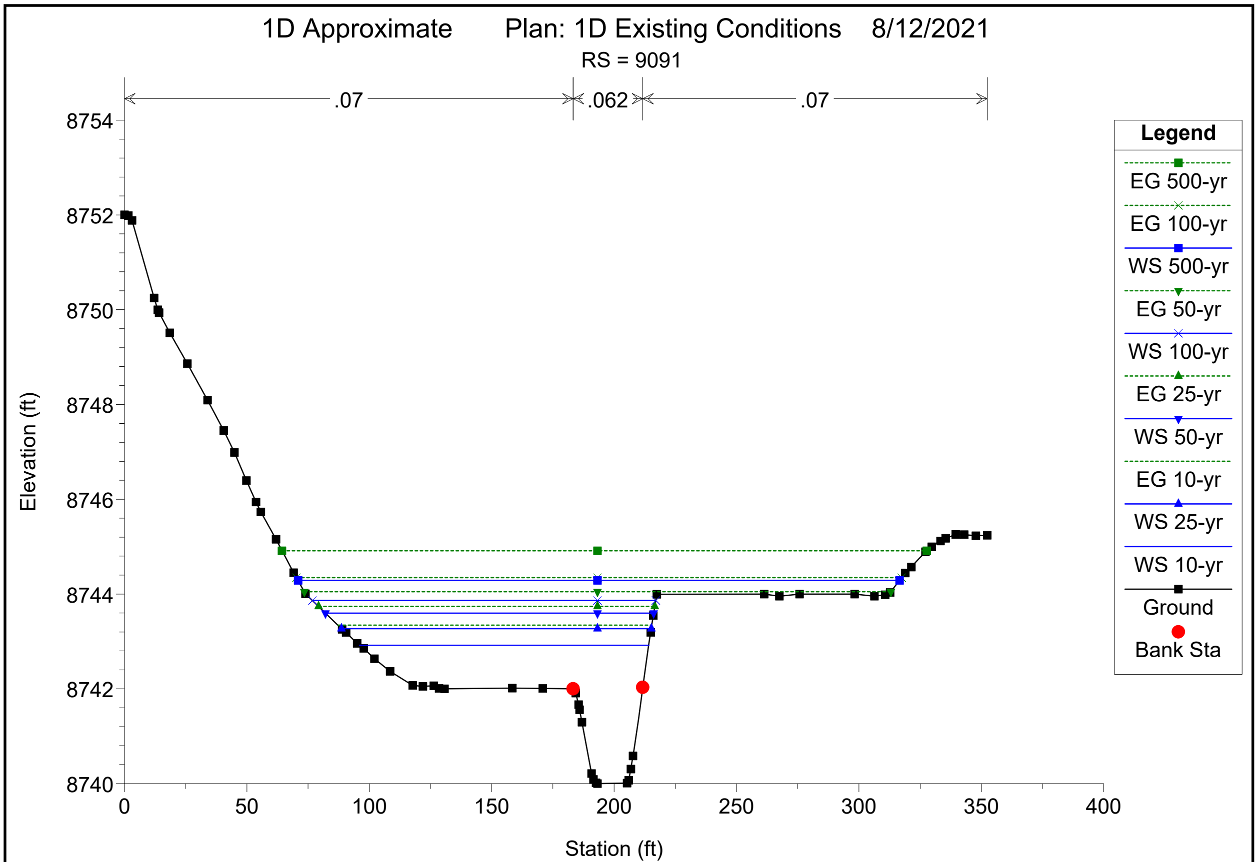
.07
.062
.07
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
EG 25-yr
WS 100-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Bank Sta
Elevation (ft)
8754
8752
8750
8748
8746
8744
8742
0
50
100
150
200
250
300
Station (ft)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.07
.062
.07
Elevation (ft)
Station (ft)
Legend
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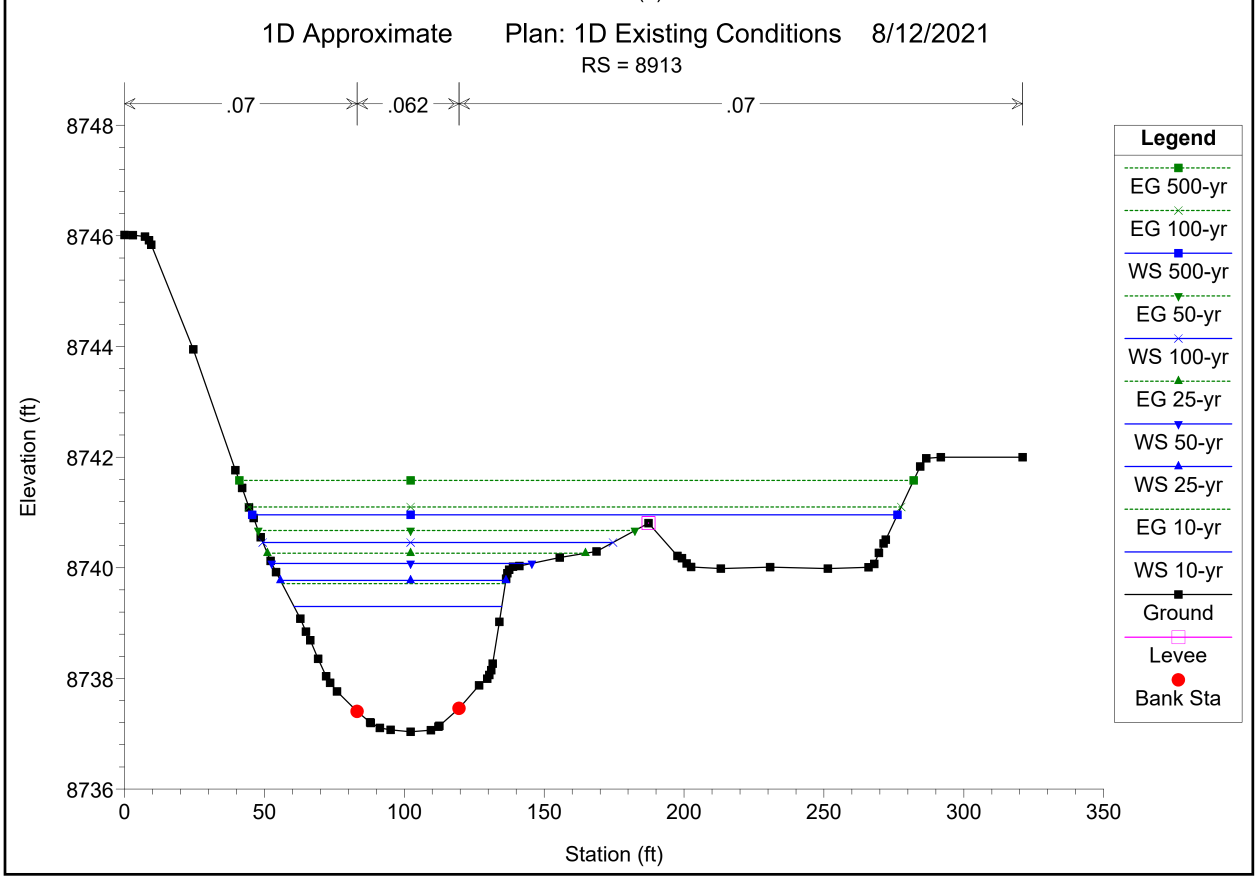
EG 100-yr
WS 500-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Bank Sta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.07
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Station (ft)
Legend
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EG 100-yr
WS 500-yr
EG 50-yr
WS 100-yr
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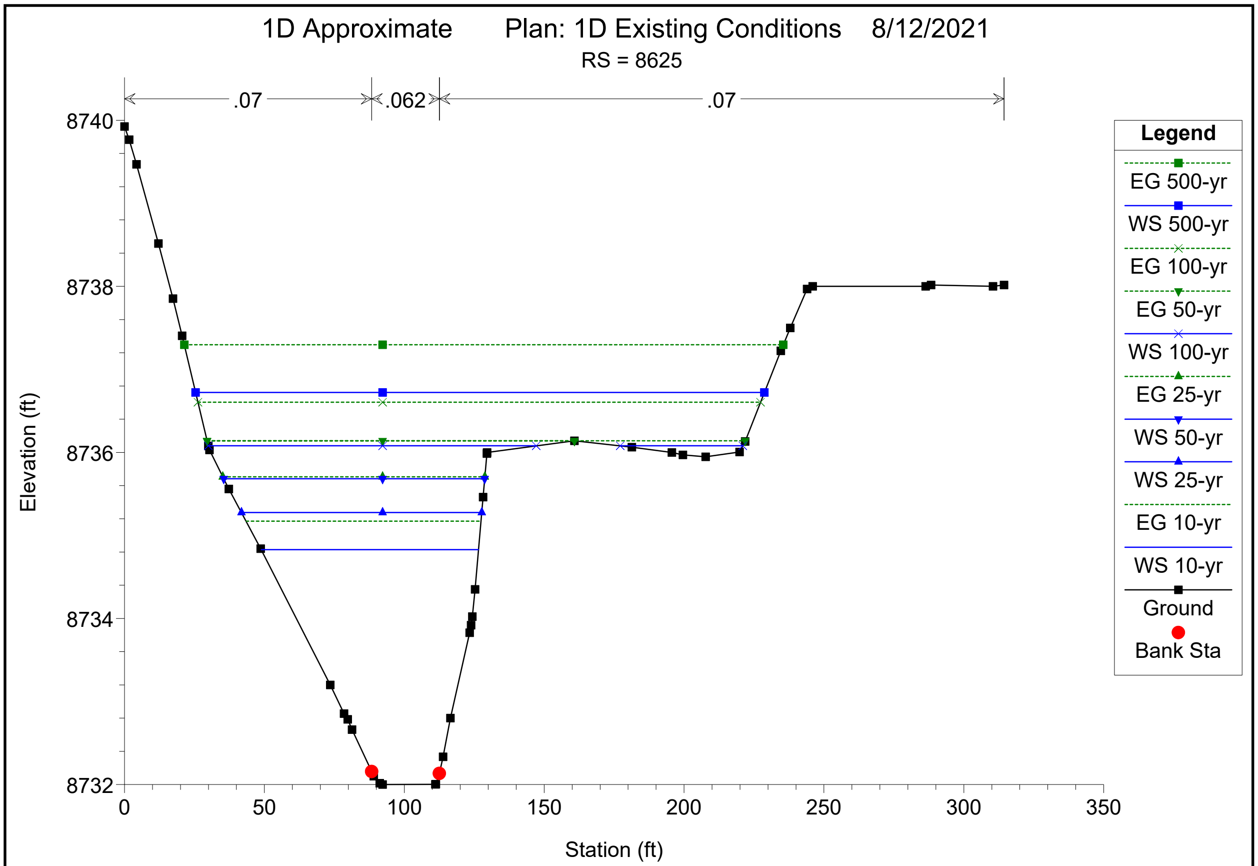
EG 10-yr
WS 10-yr
Ground
Levee
Bank Sta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Station (ft)
Legend
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EG 100-yr
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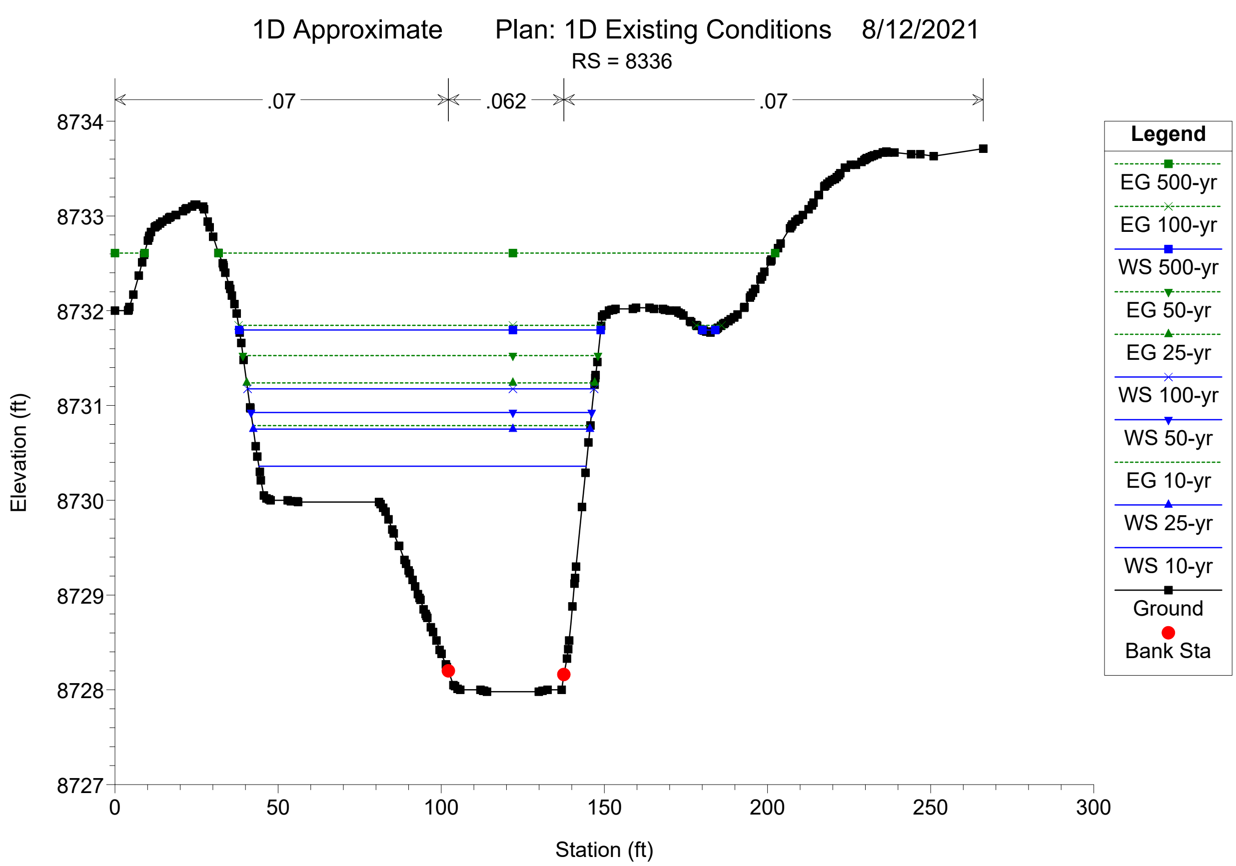
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta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.062
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Elevation (ft)
Station (ft)
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WS 500-yr
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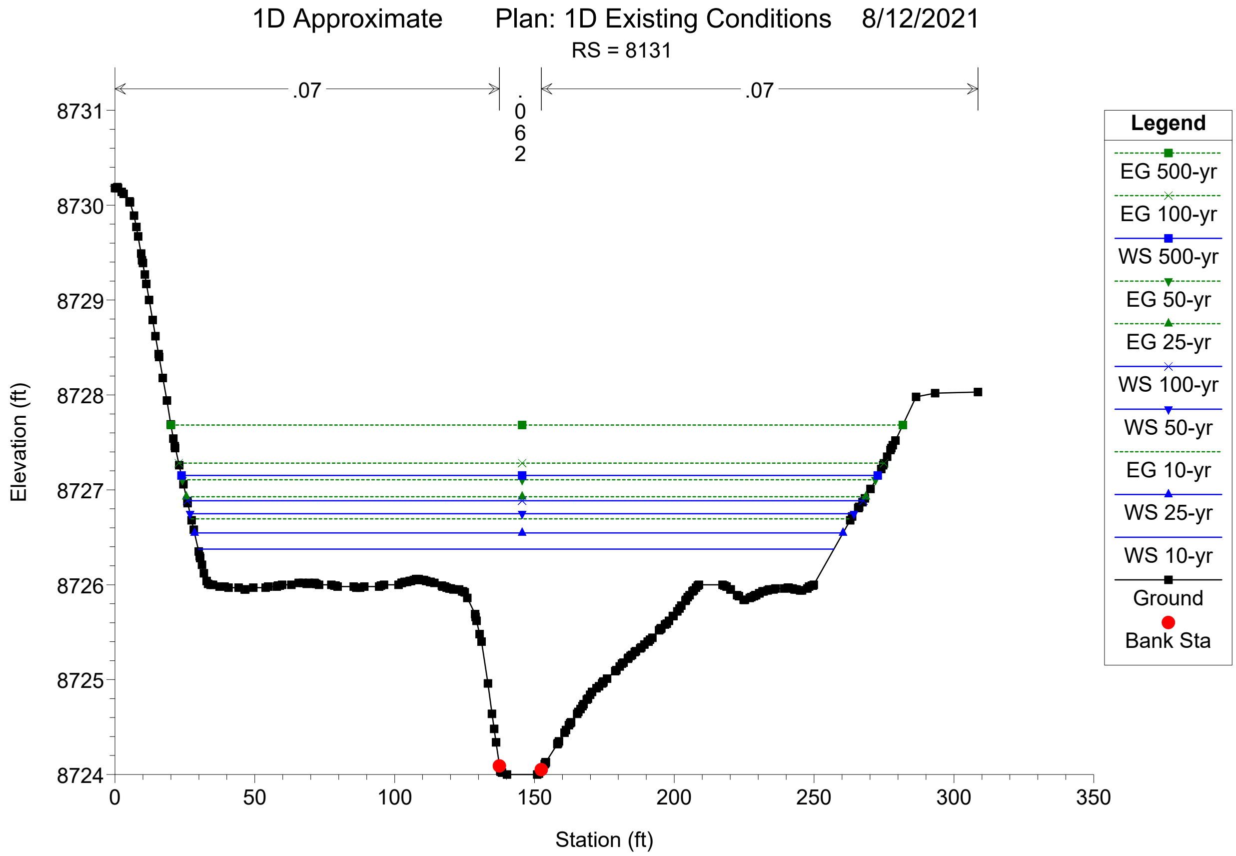
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Bank Sta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.062
.07
Legend
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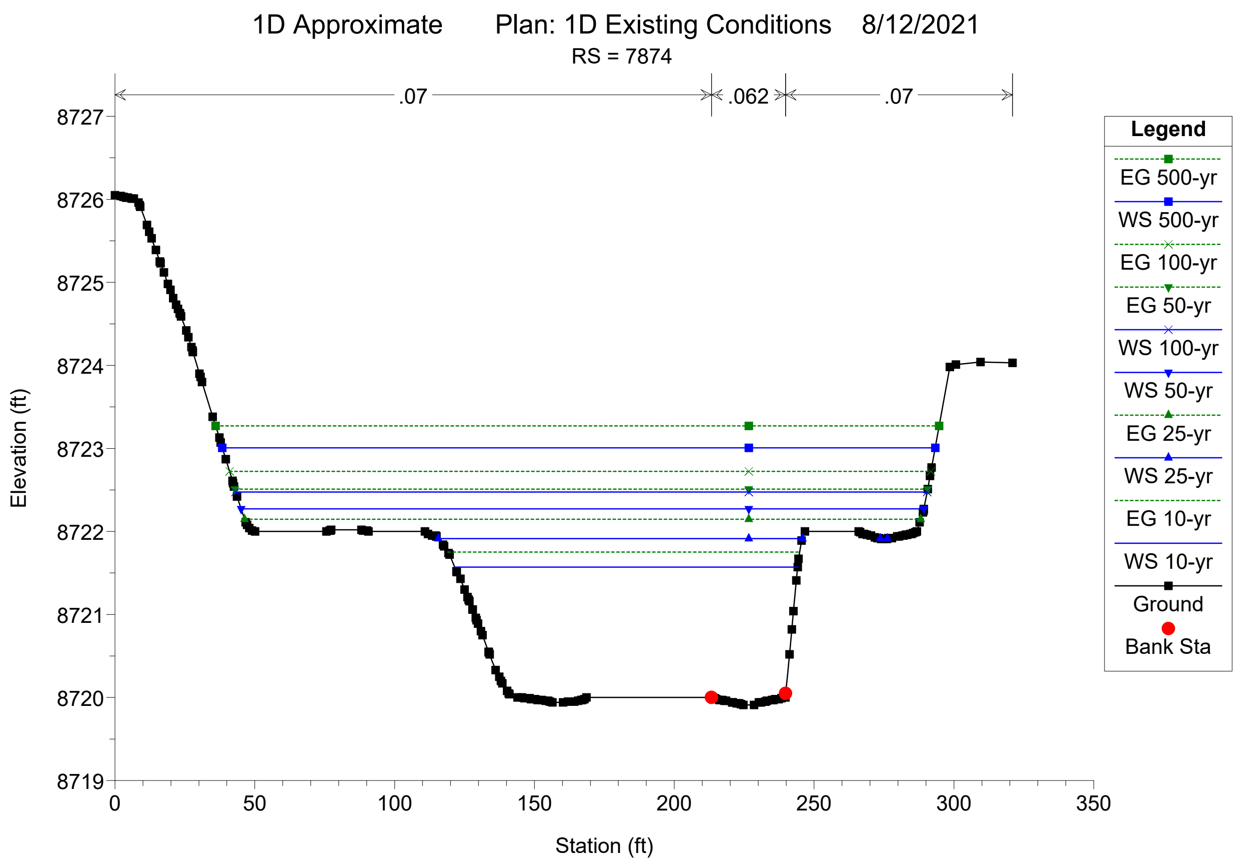
EG 100-yr
WS 500-yr
EG 50-yr
EG 25-yr
WS 100-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Bank Sta
Elevation (ft)
8731
8730
8729
8728
8727
8726
8725
8724
0
50
100
150
200
250
300
350
Station (ft)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.062
.07
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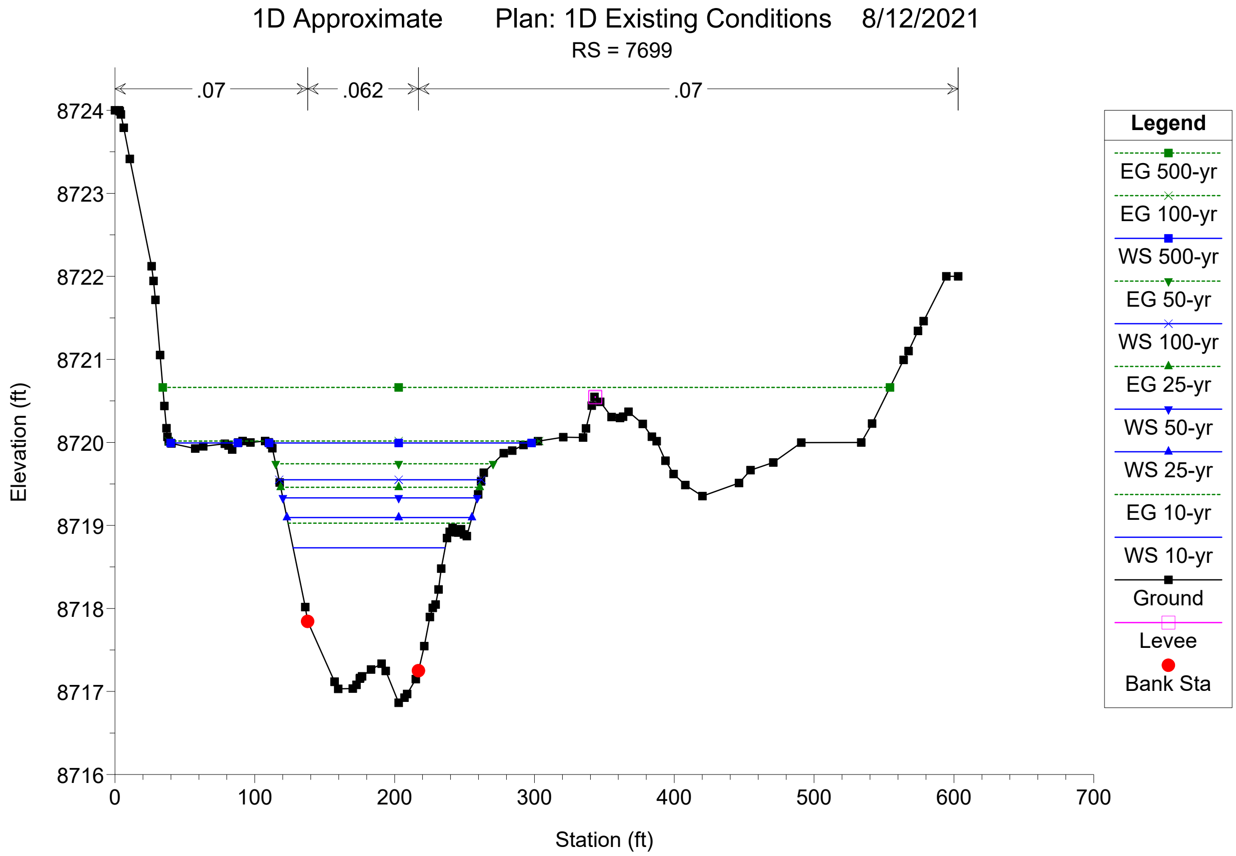
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta
Elevation (ft)
8727
8726
8725
8724
8723
8722
8721
8720
8719
0
50
100
150
200
250
300
350
Station (ft)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.07
.062
.07
Elevation (ft)
Station (ft)
Legend
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EG 100-yr
WS 500-yr
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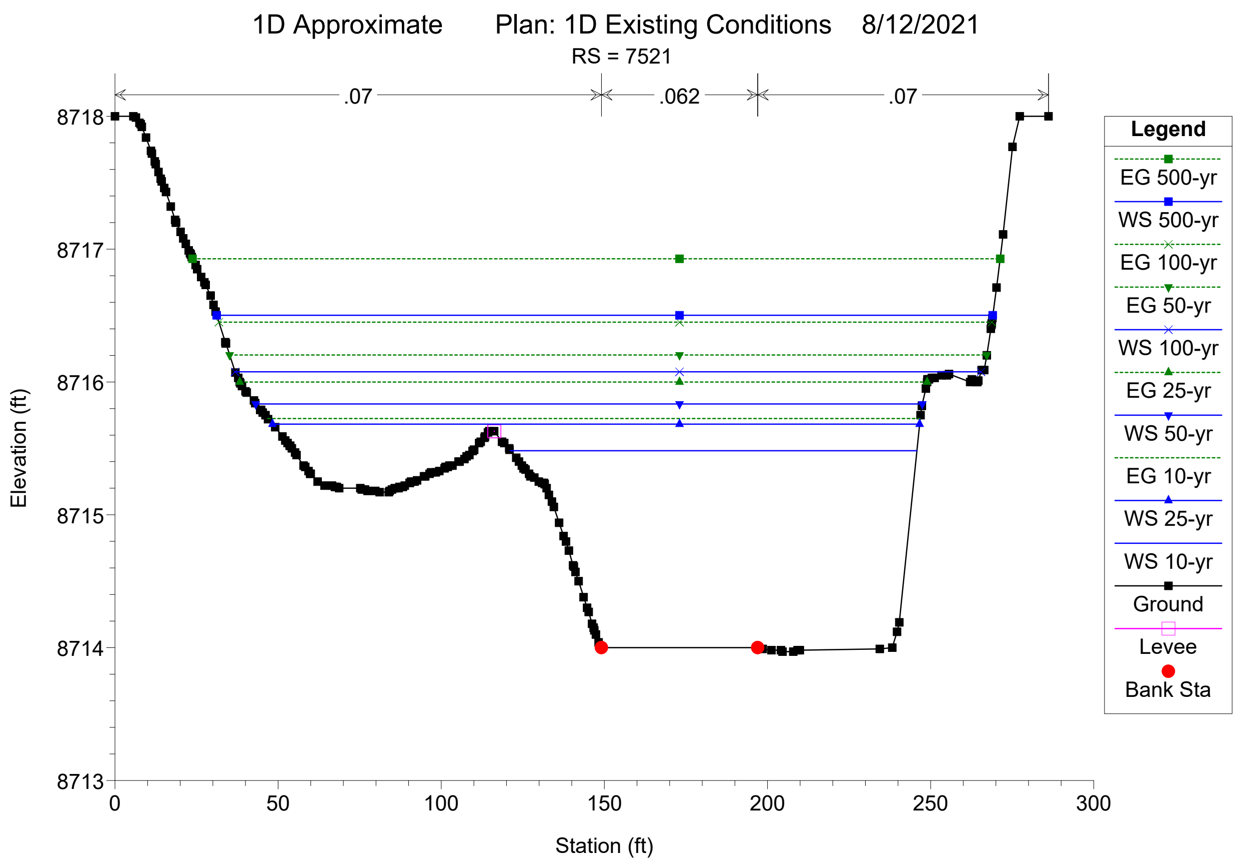
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Levee
Bank Sta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.07
.062
.07
Elevation (ft)
Station (ft)
Legend
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WS 500-yr
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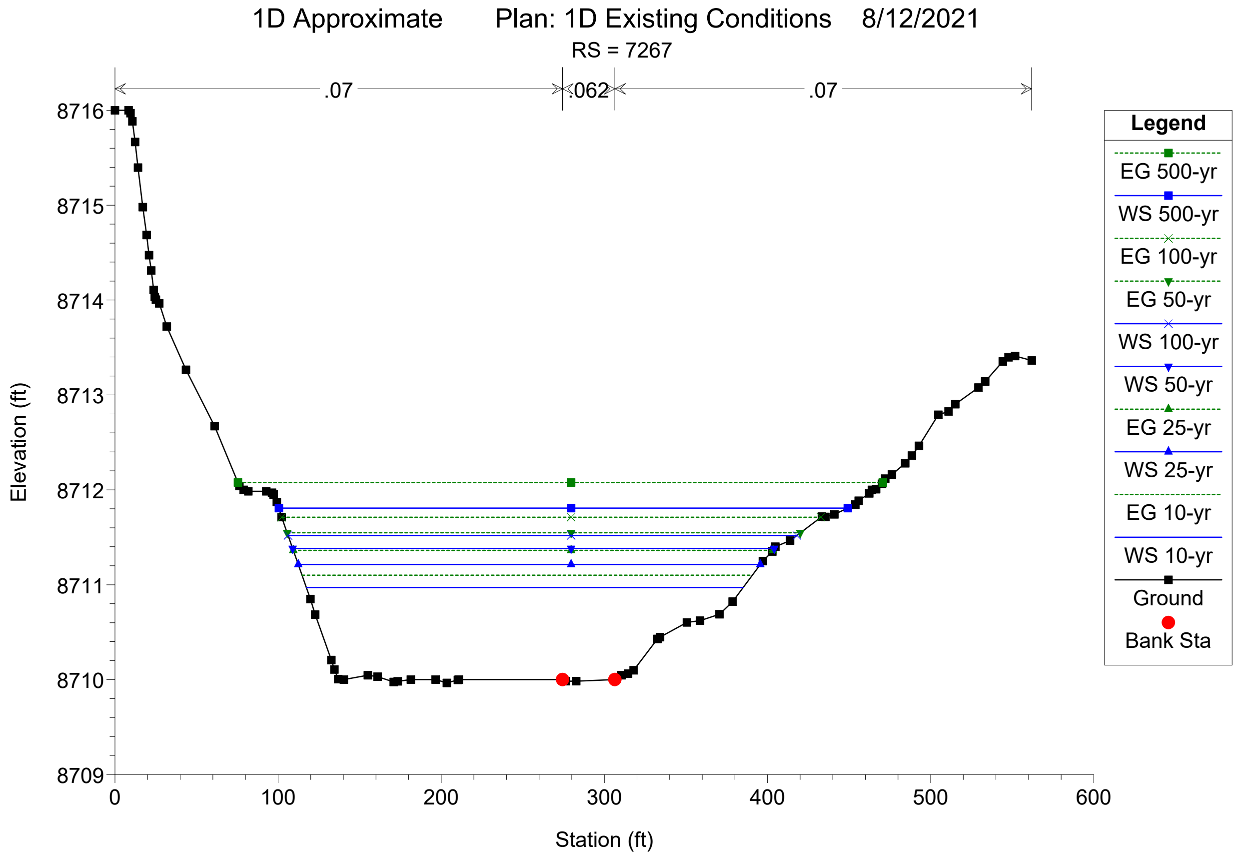
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta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Elevation (ft)
Station (ft)
Legend
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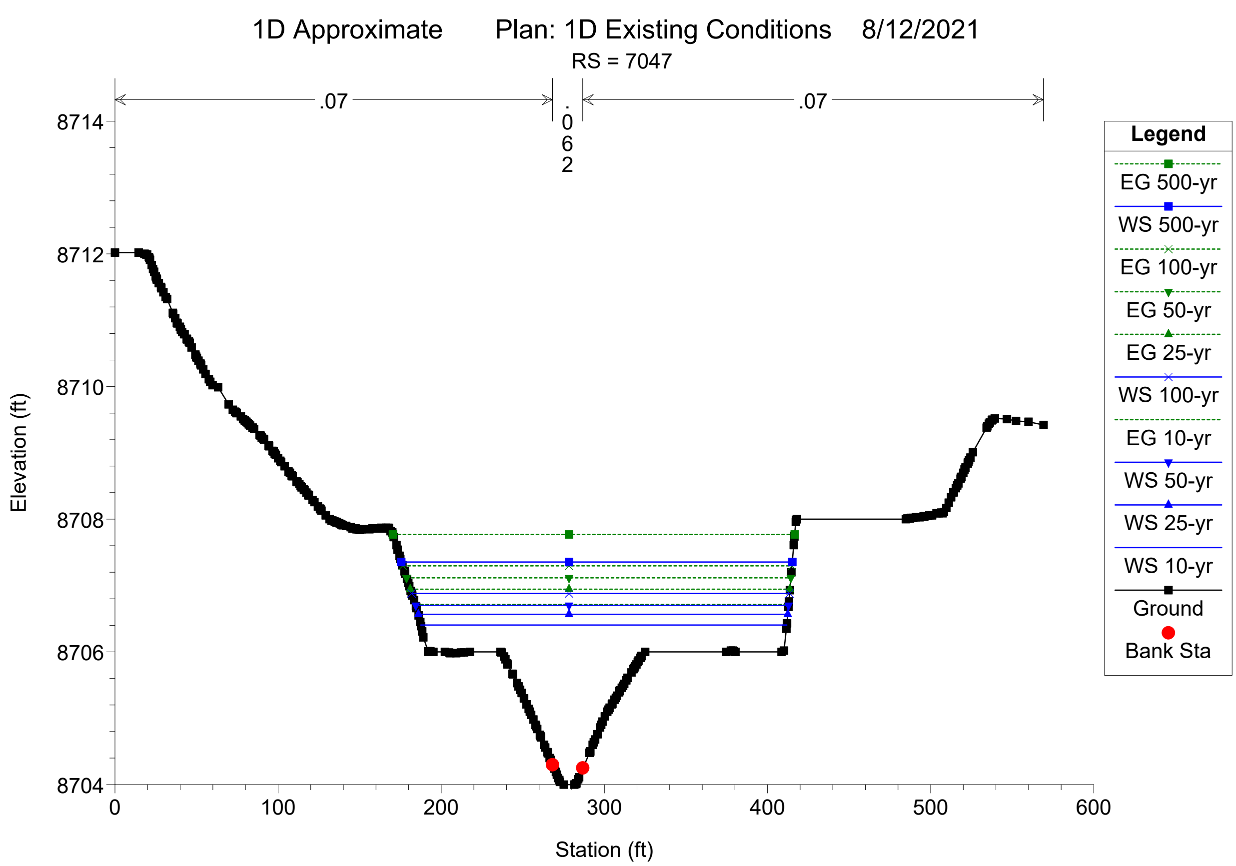
EG 10-yr
WS 10-yr
Ground
Bank Sta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.062
.07
Elevation (ft)
Station (ft)
Legend
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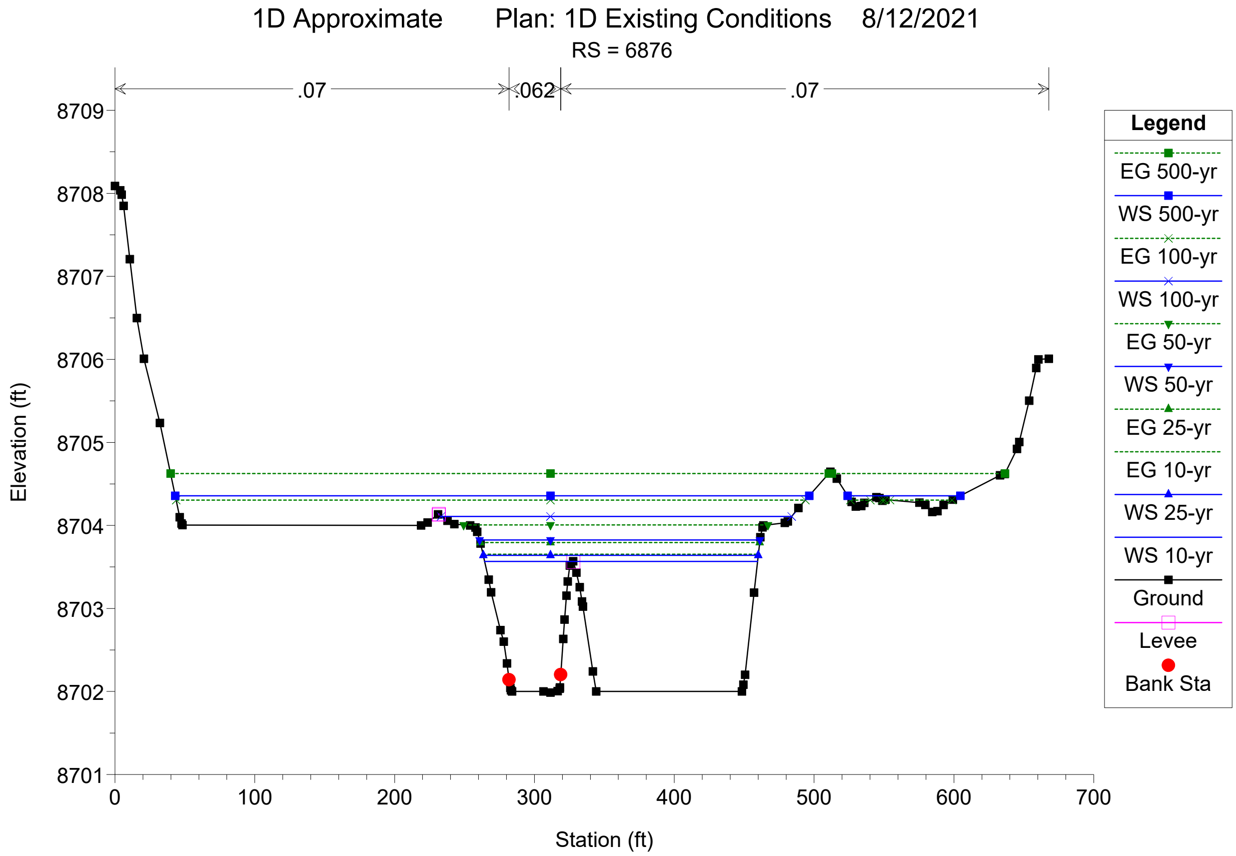
WS 500-yr
EG 100-yr
EG 50-yr
EG 25-yr
WS 100-yr
EG 10-yr
WS 50-yr
WS 25-yr
WS 10-yr
Ground
Bank Sta



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.07
.062
.07
Elevation (ft)
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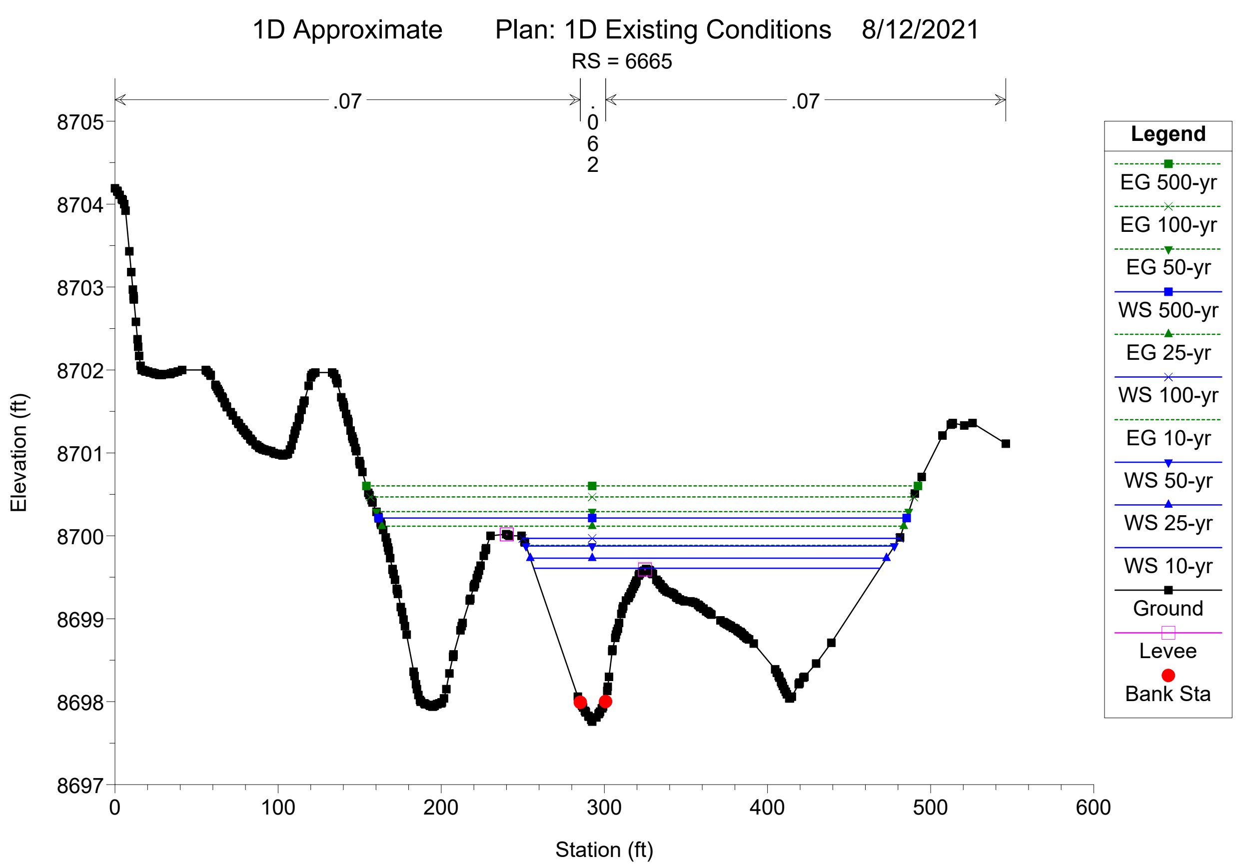
8708
8707
8706
8705
8704
8703
8702
8701
0
100
200
300
400
500
600
700
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
WS 50-yr
EG 25-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta



1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 6665
.07
.062
.07
Elevation (ft)
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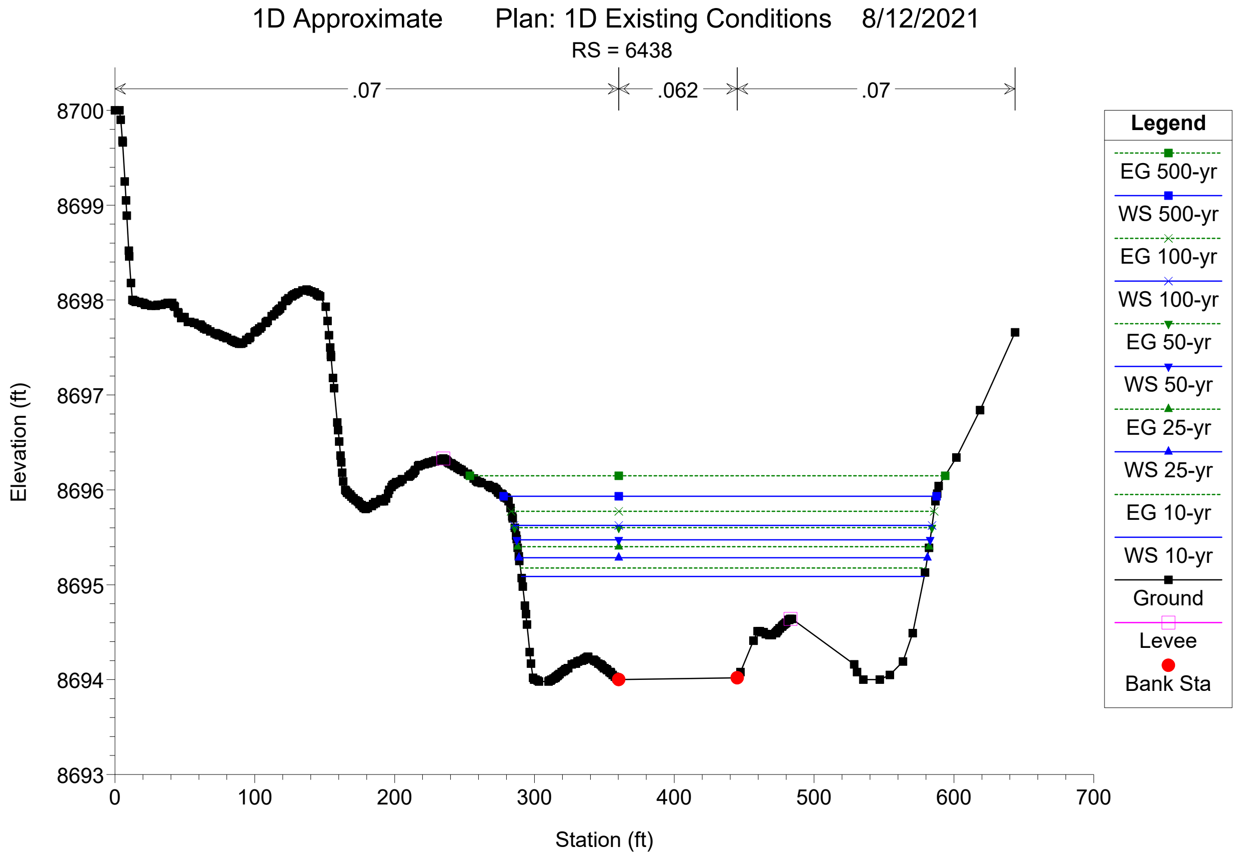
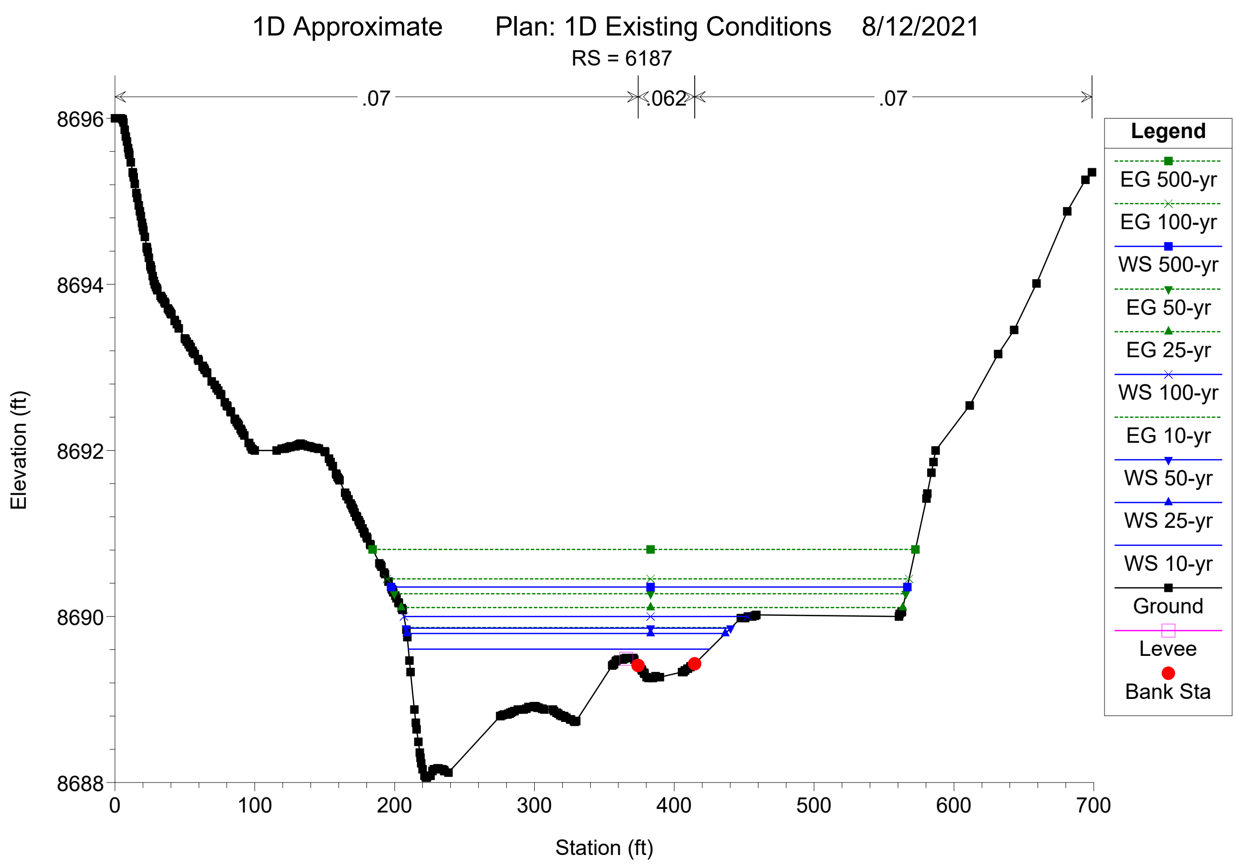
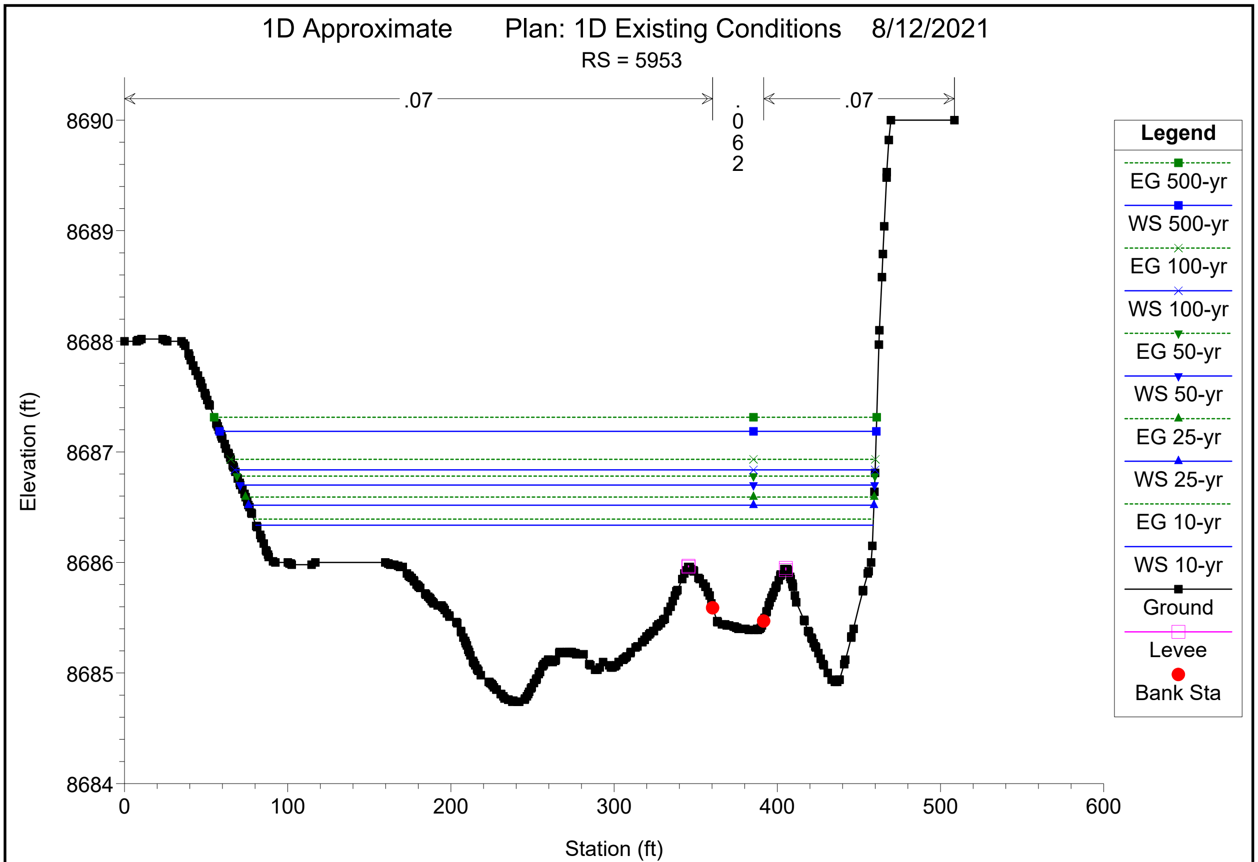
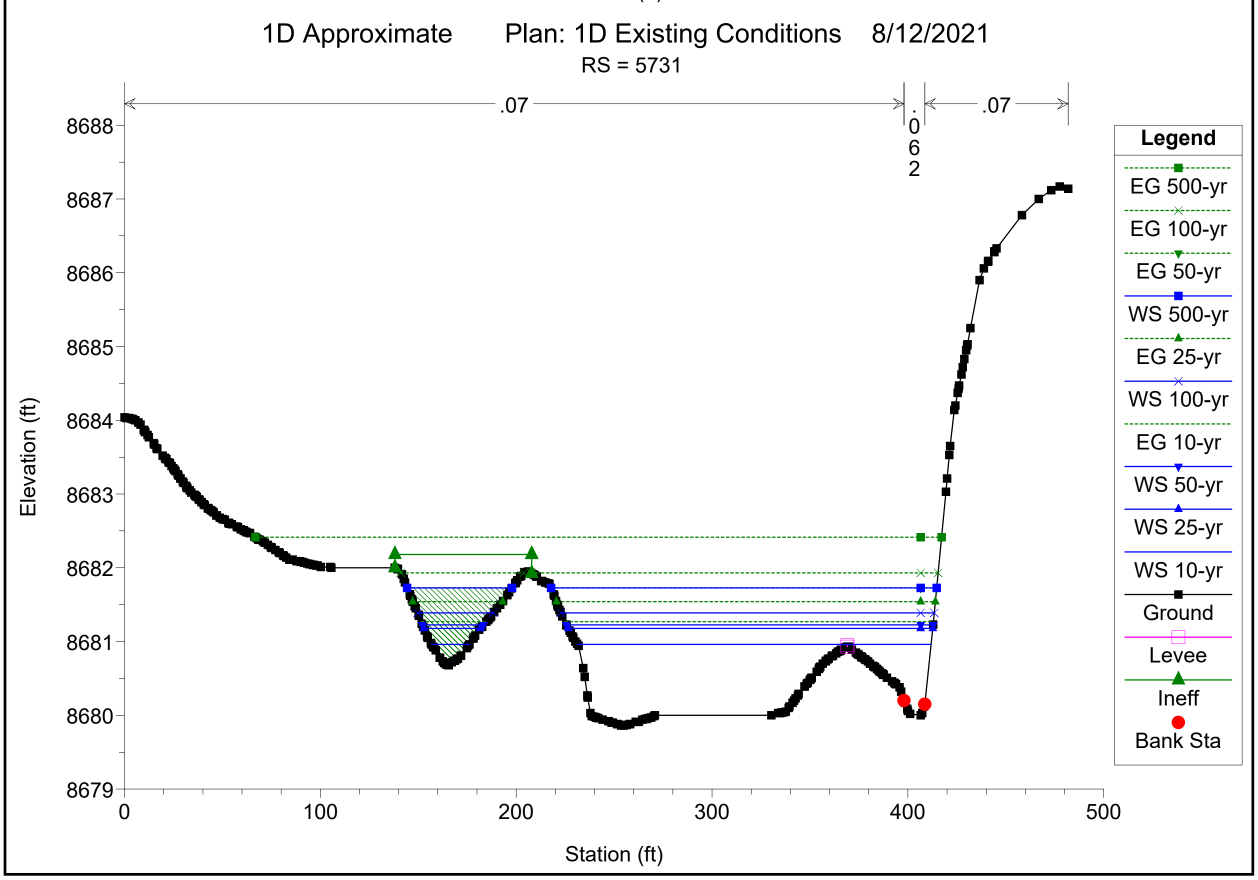
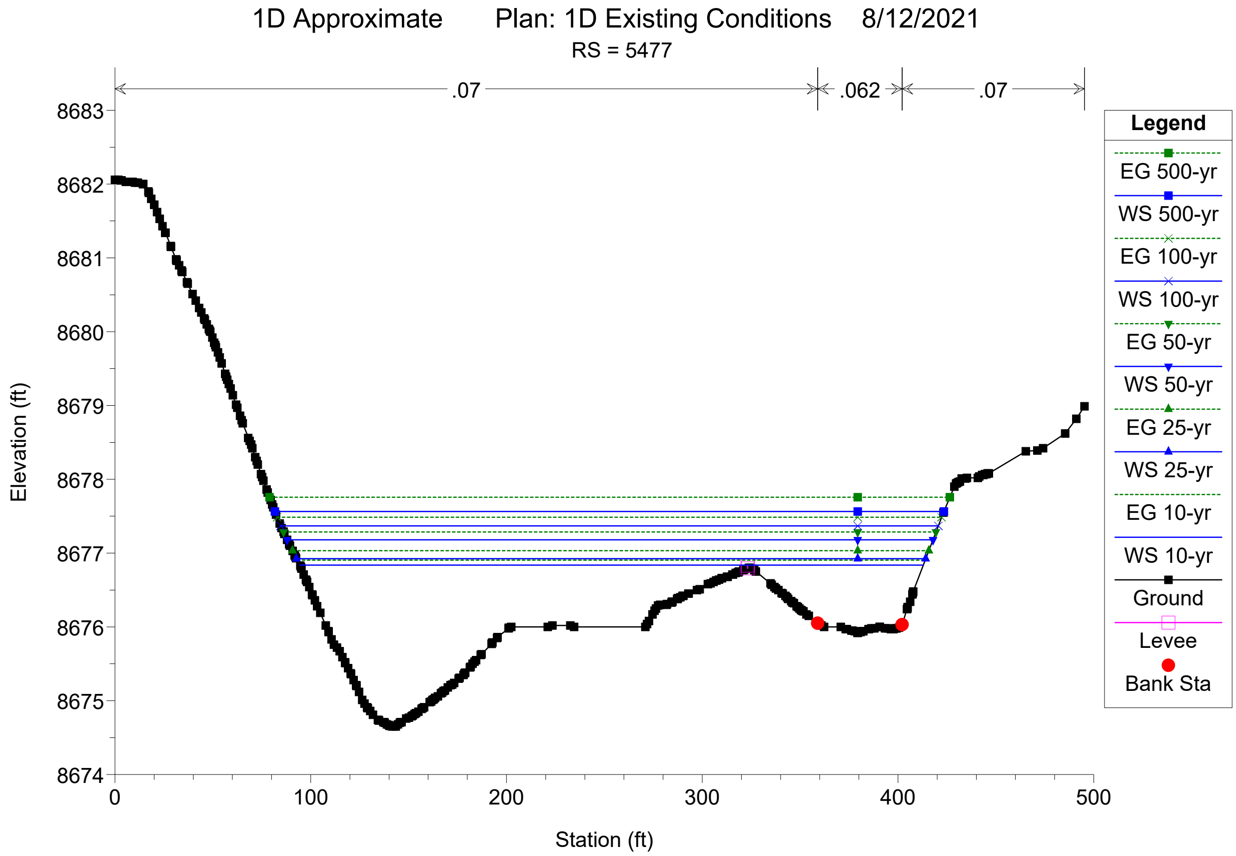
8704
8703
8702
8701
8700
8699
8698
8697
0
100
200
300
400
500
600
Station (ft)
Legend
EG 500-yr
EG 100-yr
EG 50-yr
WS 500-yr
EG 25-yr
WS 100-yr
EG 10-yr
WS 50-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta

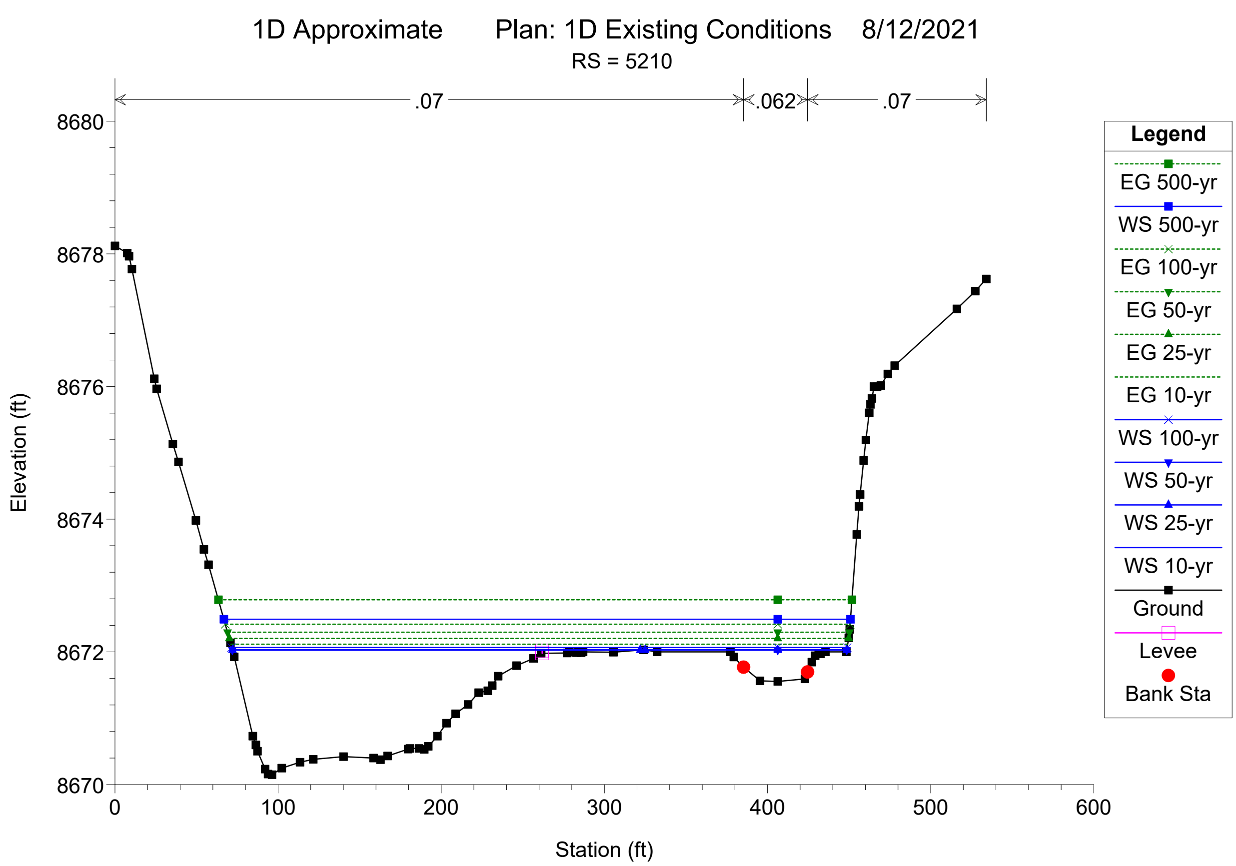

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 6438
.07
.062
.07
Elevation (ft)
Station (ft)
8700
8699
8698
8697
8696
8695
8694
8693
0
100
200
300
400
500
600
700
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Levee
Bank Sta

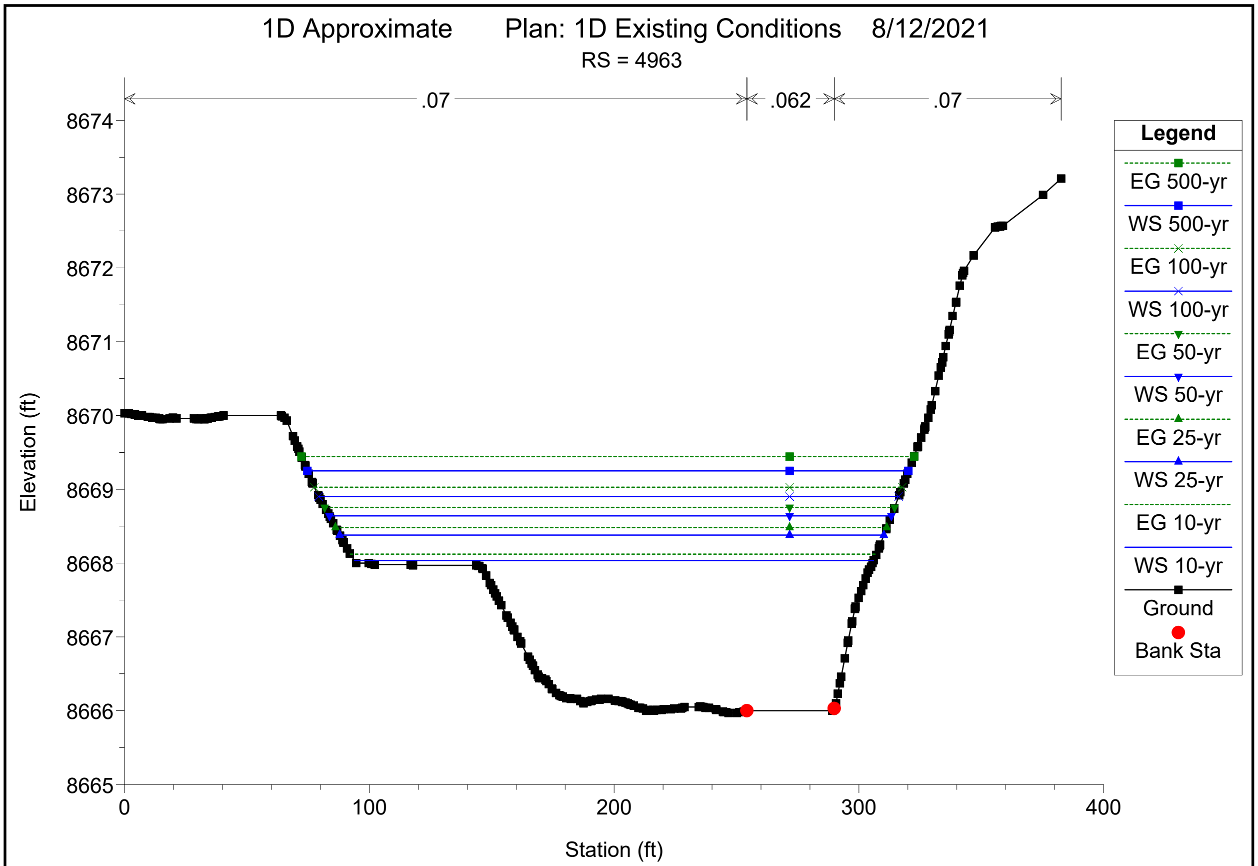

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 6187
.07
.062
.07
Elevation (ft)
Station (ft)
8696
8694
8692
8690
8688
0
100
200
300
400
500
600
700
Legend
EG 500-yr
EG 100-yr
WS 500-yr
EG 50-yr
EG 25-yr
WS 100-yr
EG 10-yr
WS 50-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta

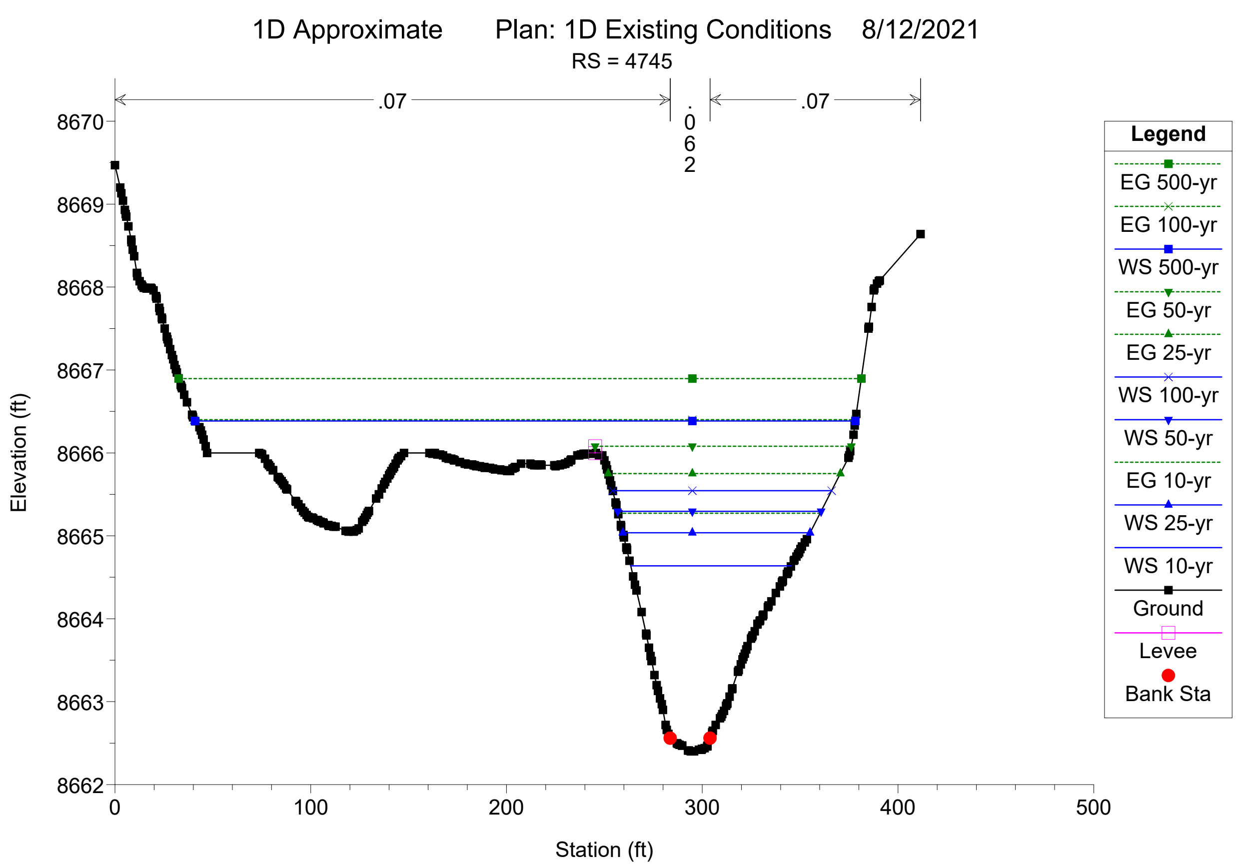

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 5953
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Levee
Bank Sta

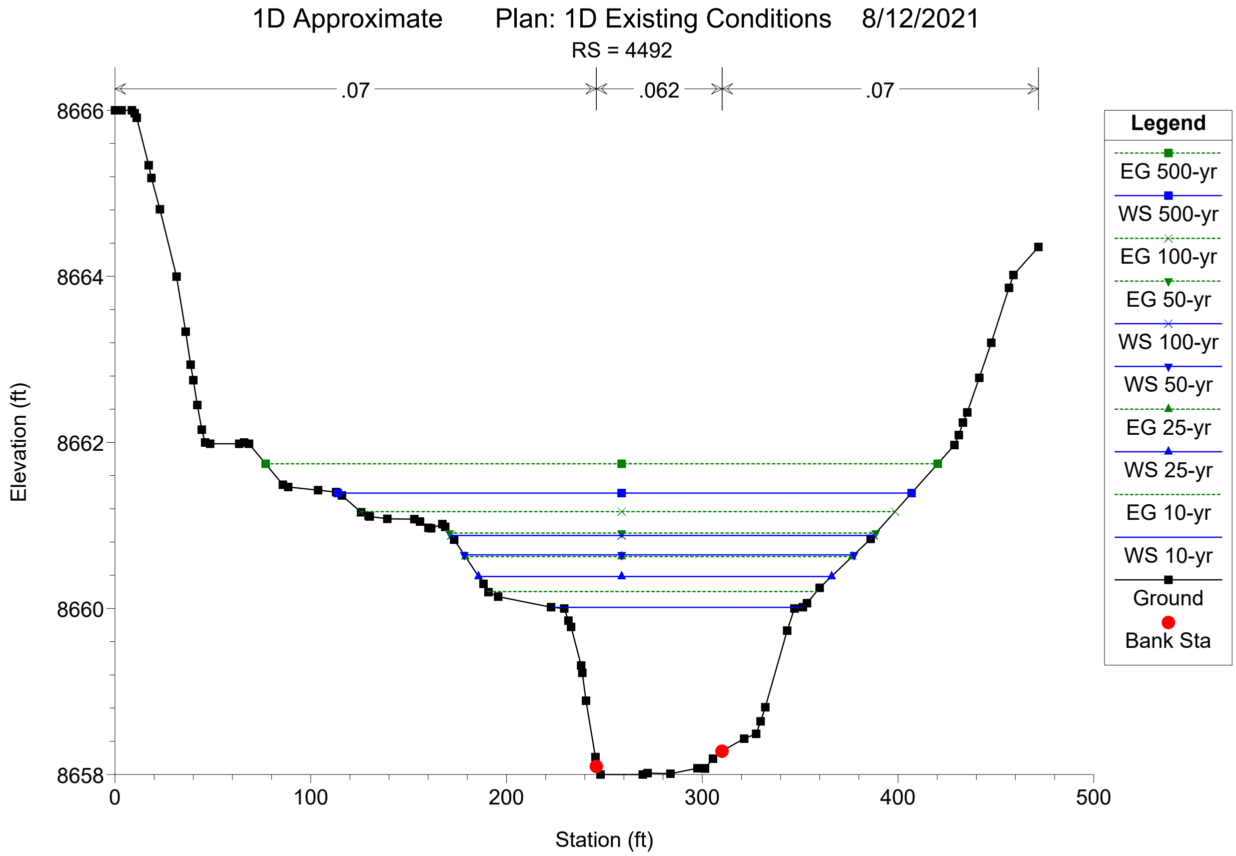

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 5731
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
EG 100-yr
EG 50-yr
WS 500-yr
EG 25-yr
WS 100-yr
EG 10-yr
WS 50-yr
WS 25-yr
WS 10-yr
Ground
Levee
Ineff
Bank Sta


1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 5477
.07
.062
.07
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Levee
Bank Sta
Elevation (ft)
8674
8675
8676
8677
8678
8679
8680
8681
8682
8683
Station (ft)
0
100
200
300
400
500

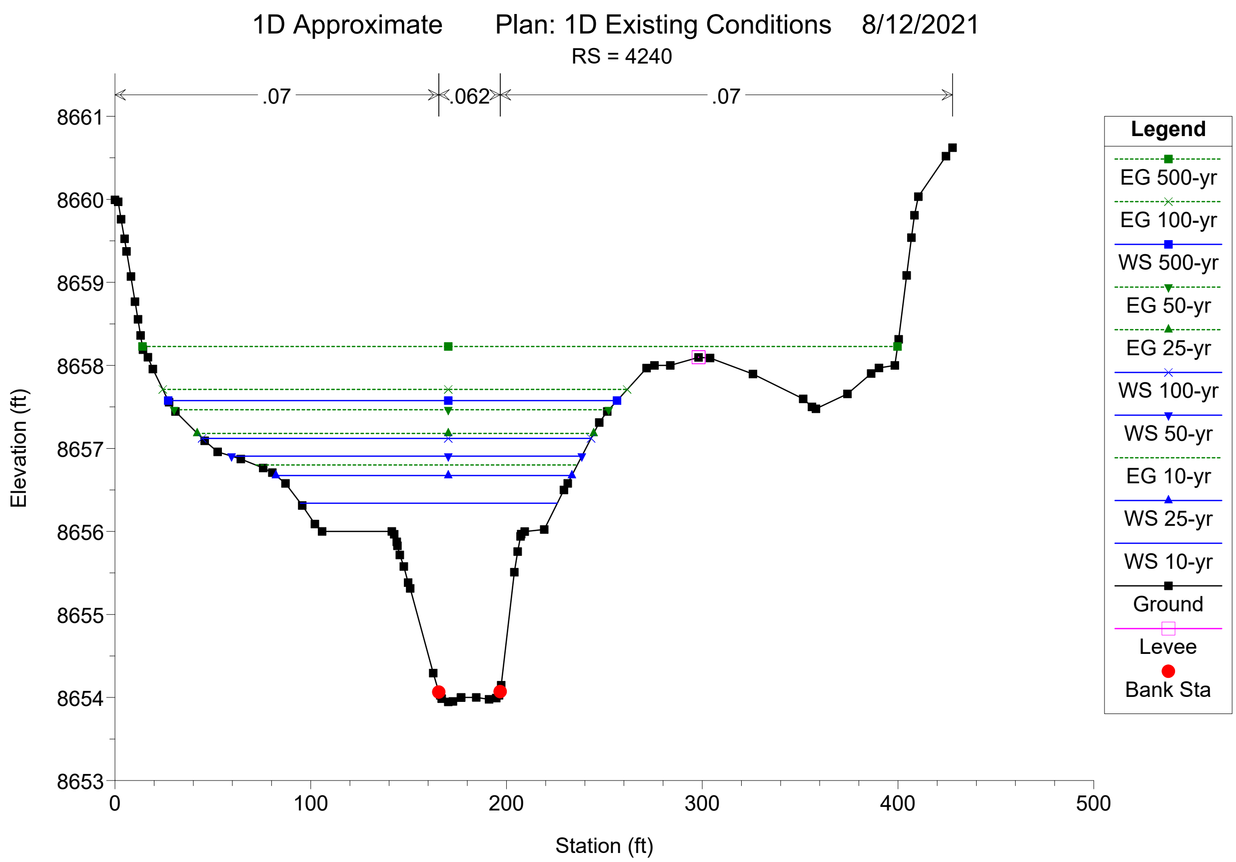

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 5210
.07
.062
.07
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
EG 25-yr
EG 10-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta
Elevation (ft)
8670
8672
8674
8676
8678
8680
Station (ft)
0
100
200
300
400
500
600


1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 4963
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta

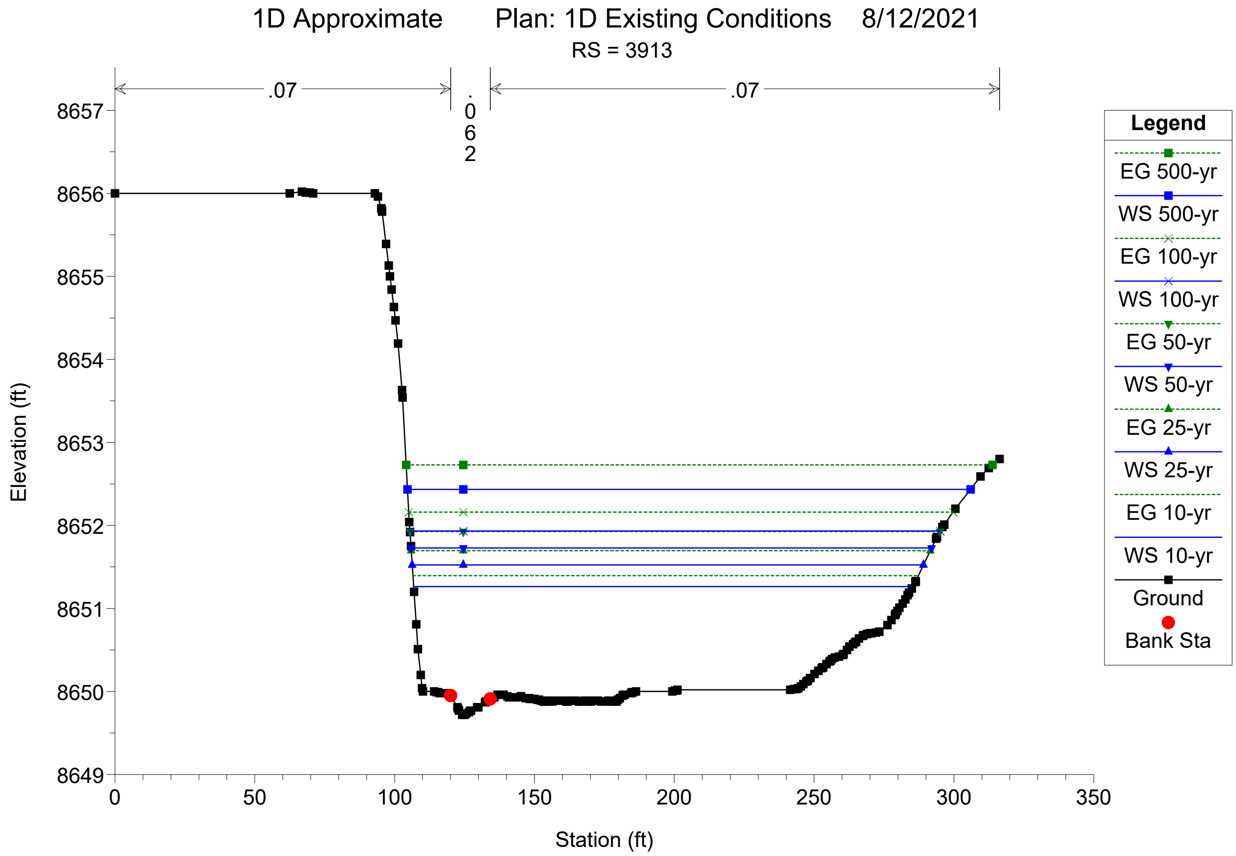

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 4745
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
EG 100-yr
WS 500-yr
EG 50-yr
EG 25-yr
WS 100-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta

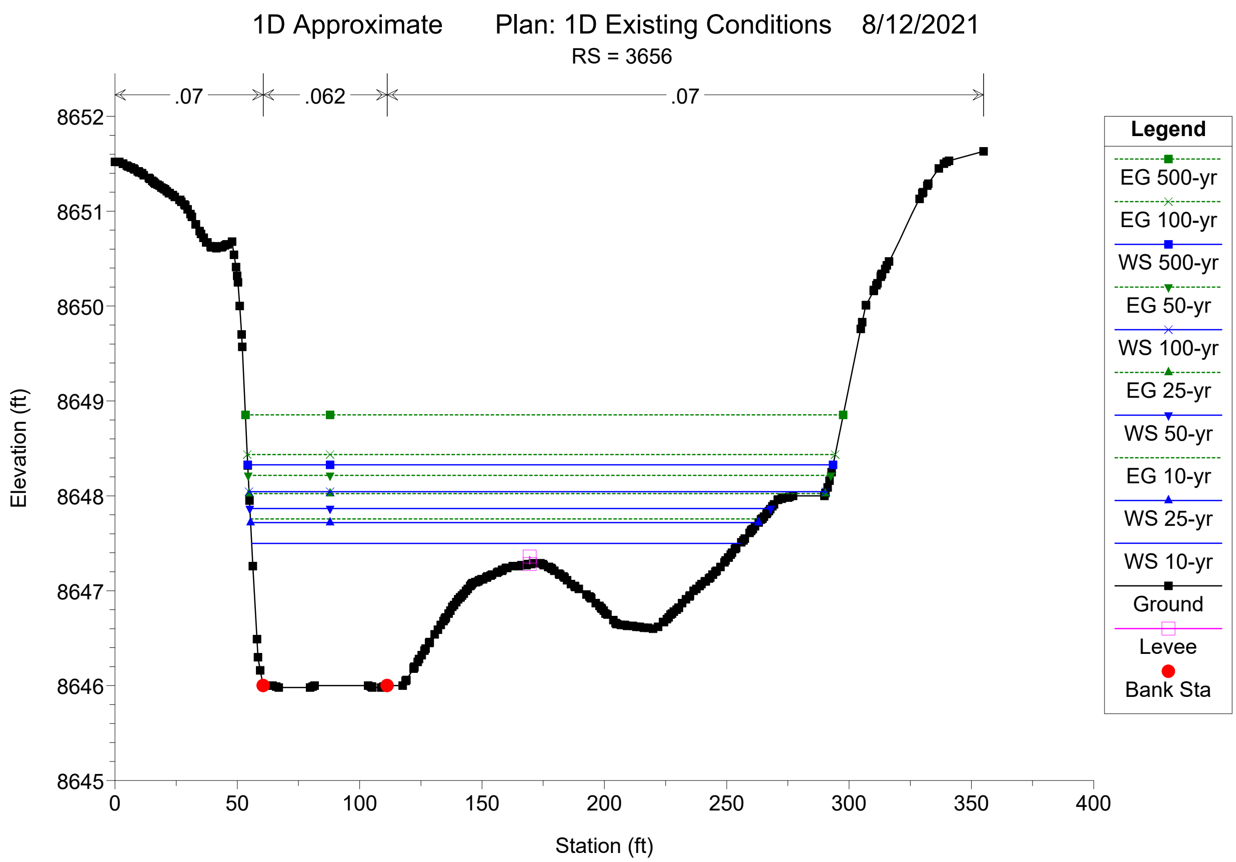


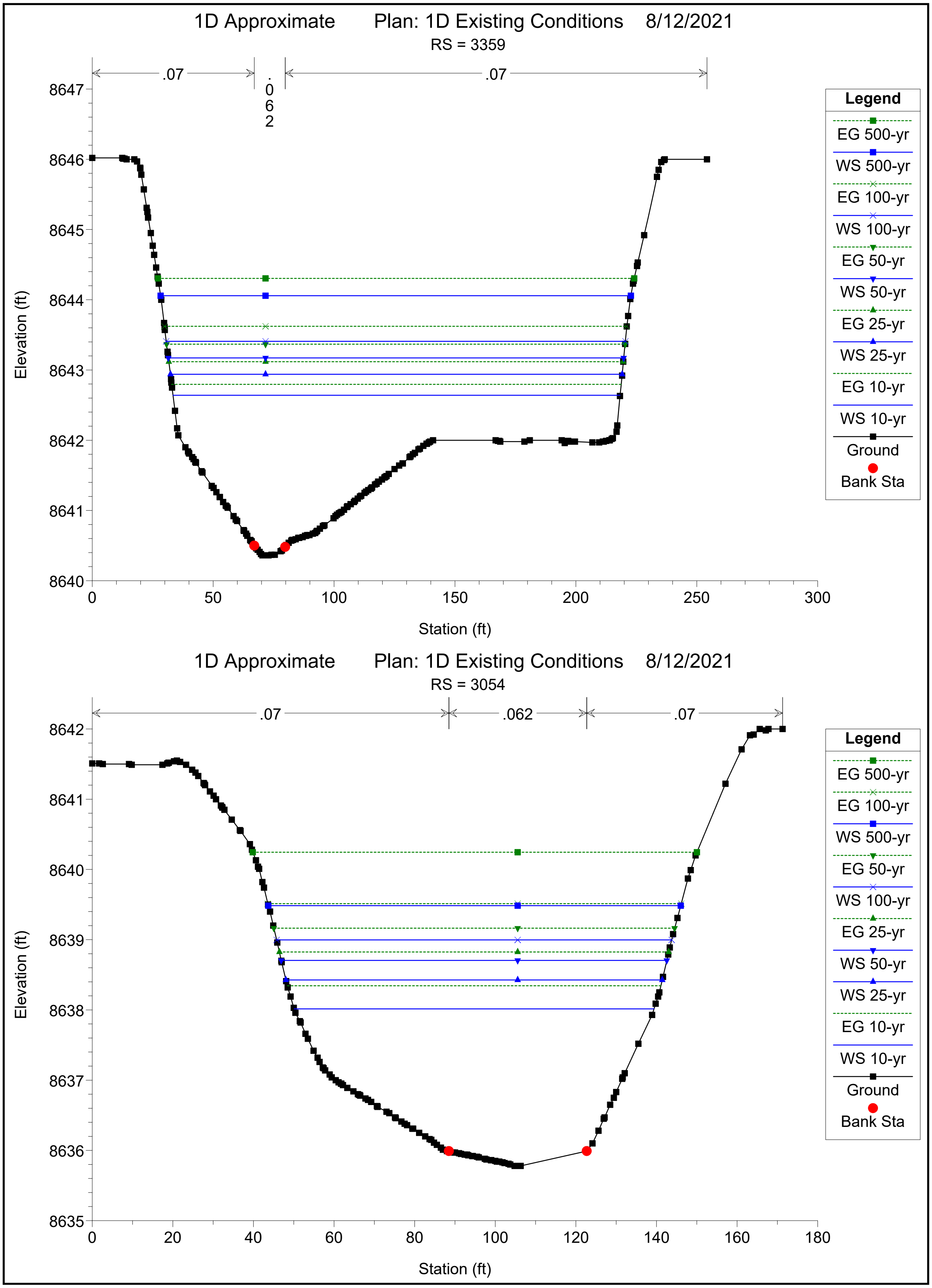
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 4492
.07
.062
.07
Elevation (ft)
8666
8664
8662
8660
8658
0
100
200
300
400
500
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta



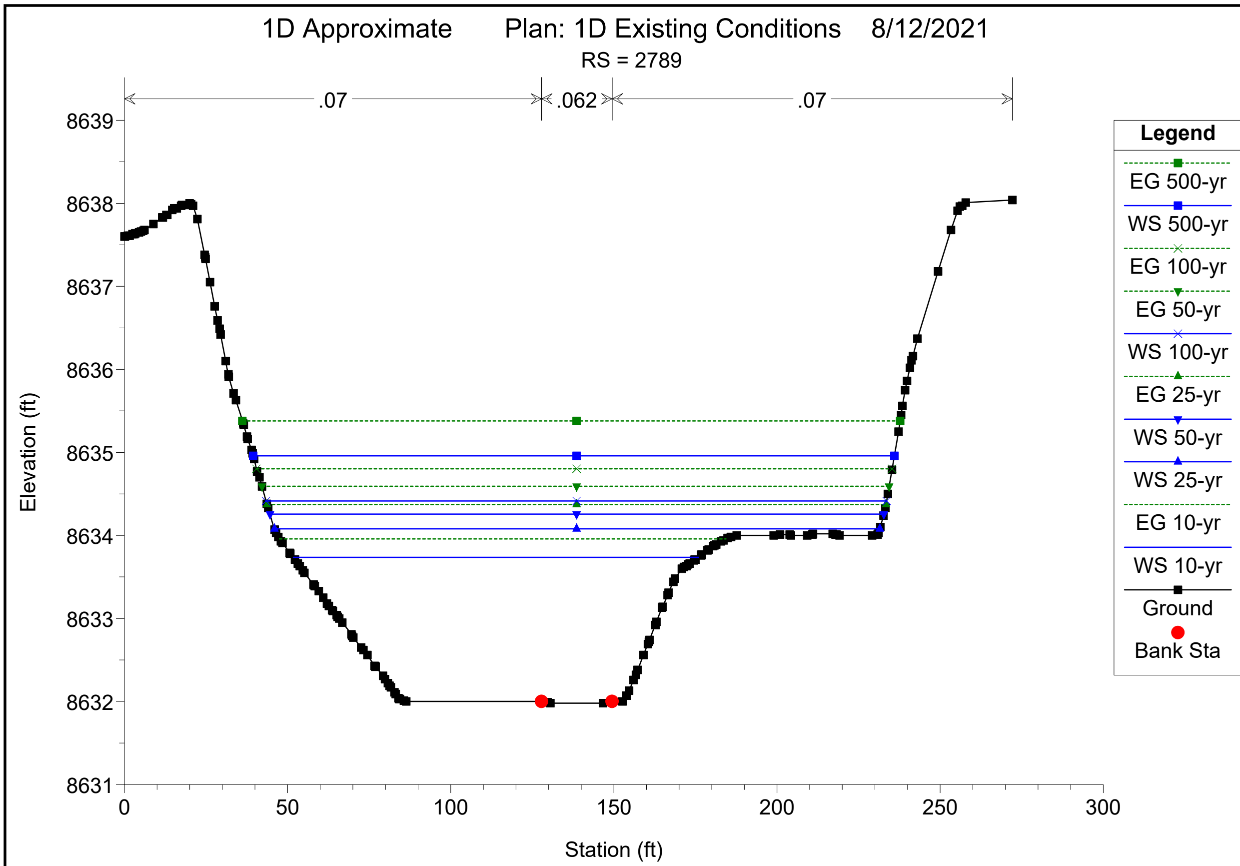
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 4240
.07
.062
.07
Elevation (ft)
8661
8660
8659
8658
8657
8656
8655
8654
8653
0
100
200
300
400
500
Station (ft)
Legend
EG 500-yr
EG 100-yr
WS 500-yr
EG 50-yr
EG 25-yr
WS 100-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta


1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 3913
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta

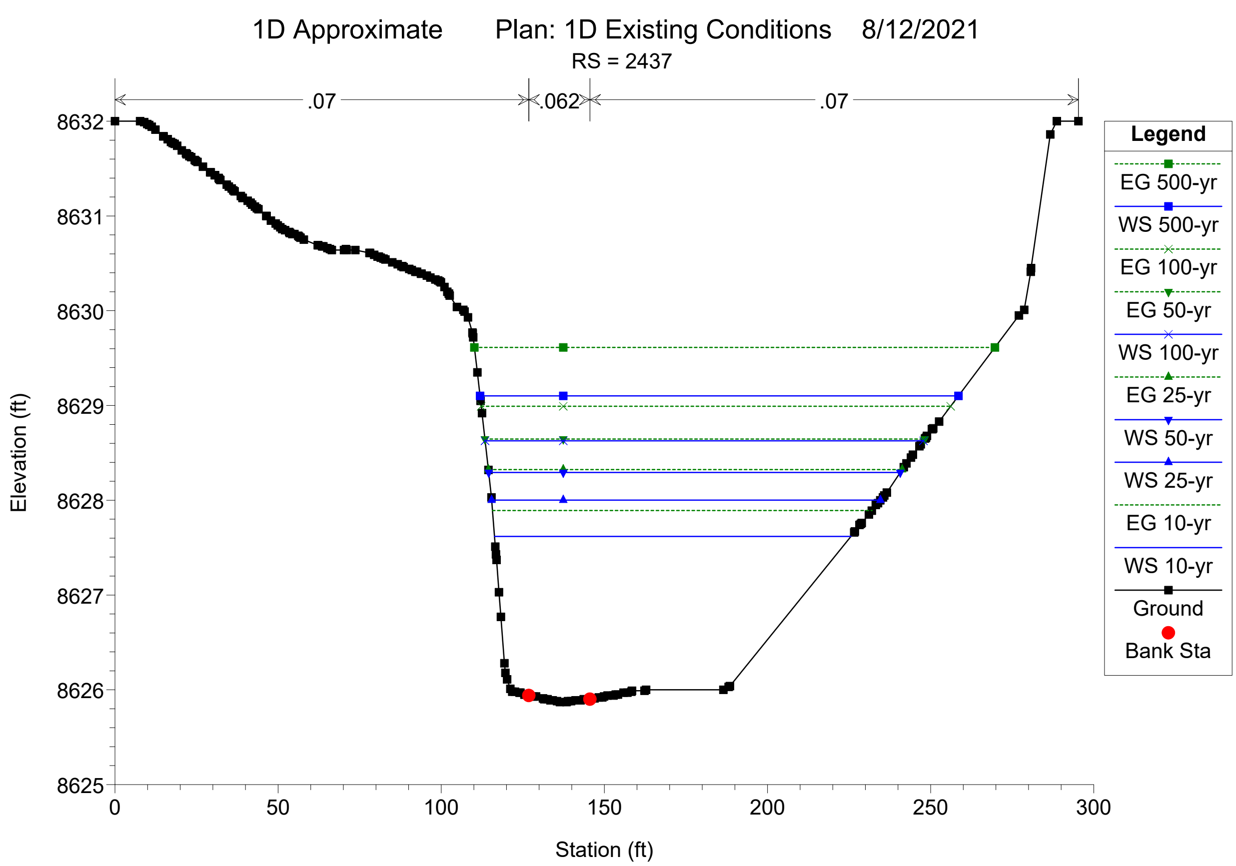

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 3656
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
EG 100-yr
WS 500-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Levee
Bank Sta



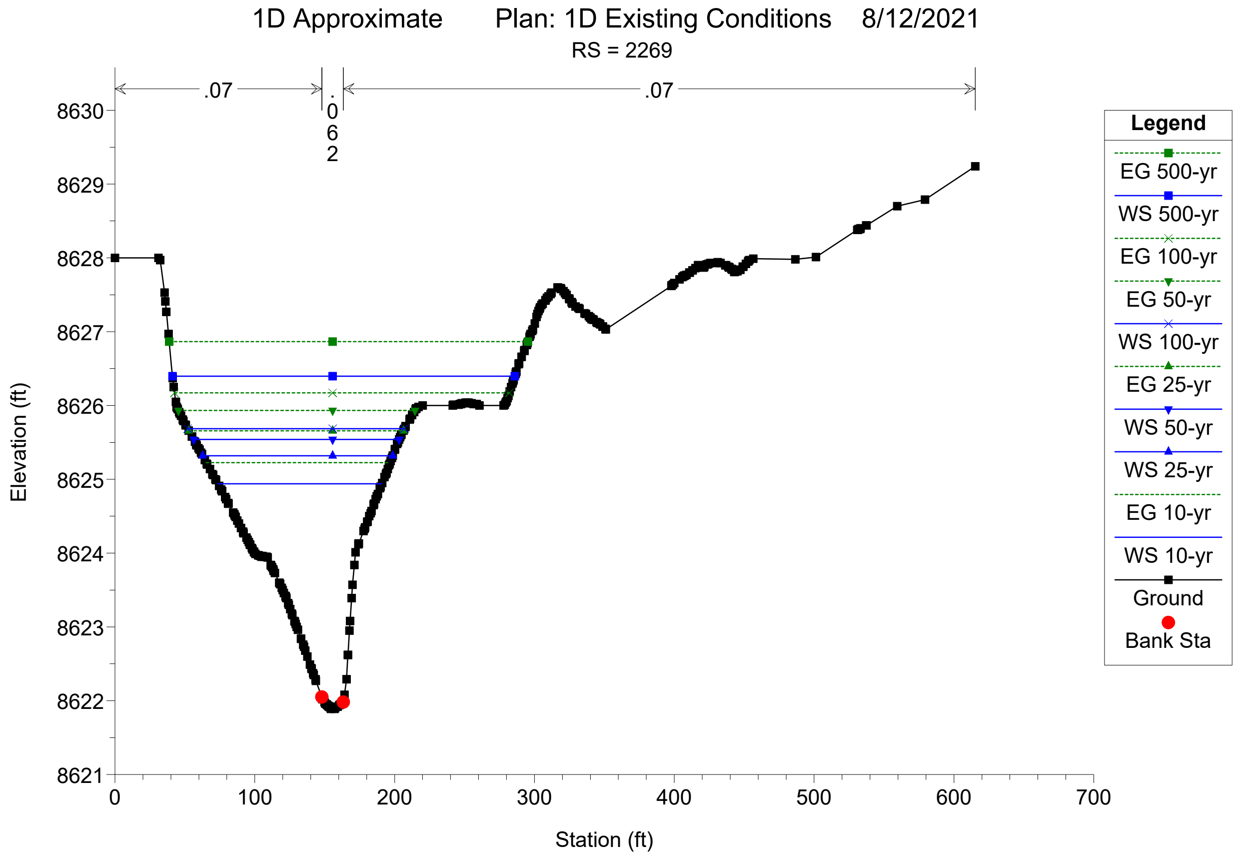
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 3359
.07
.062
.07
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
WS 50-yr
EG 25-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
8640
8641
8642
8643
8644
8645
8646
8647
0
50
100
150
200
250
300
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 3054
.07
.062
.07
Legend
EG 500-yr
EG 100-yr
WS 500-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
8635
8636
8637
8638
8639
8640
8641
8642
0
20
40
60
80
100
120
140
160
180

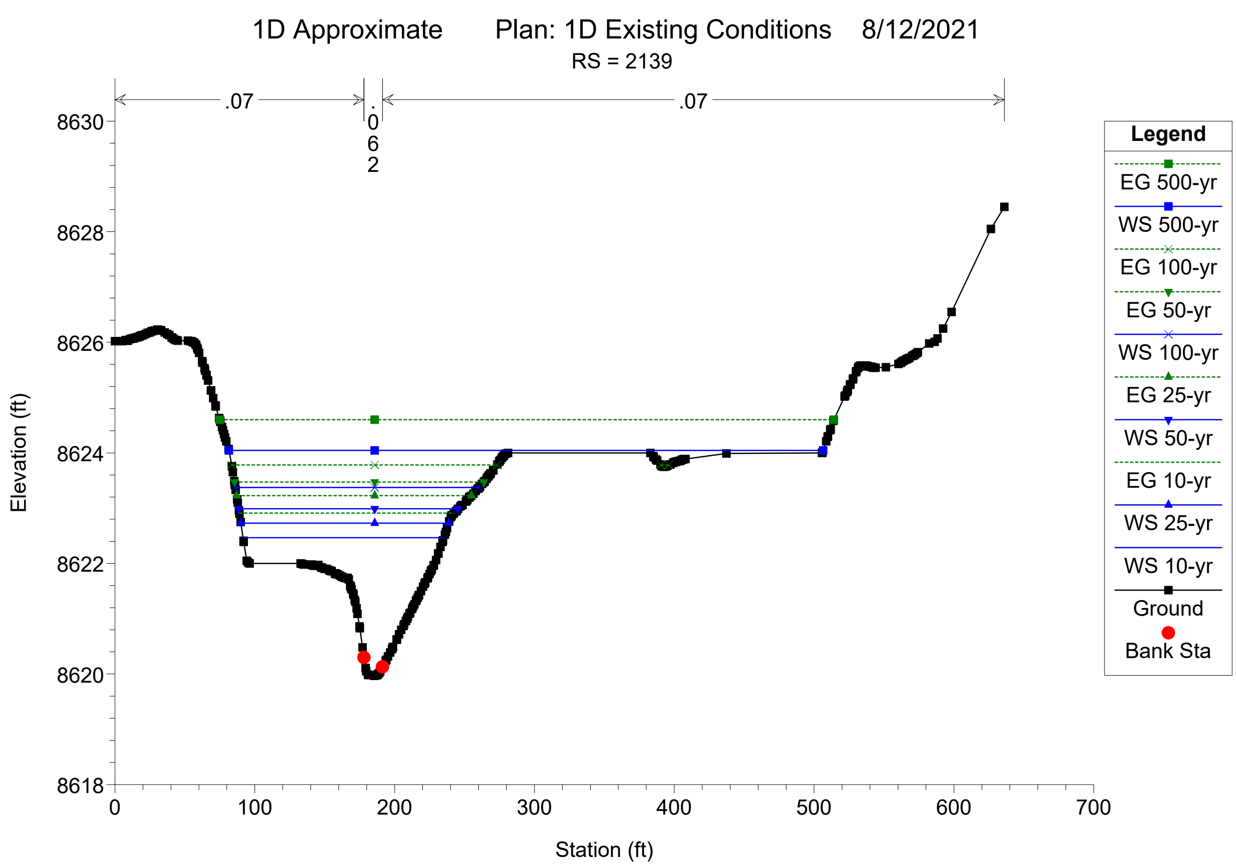


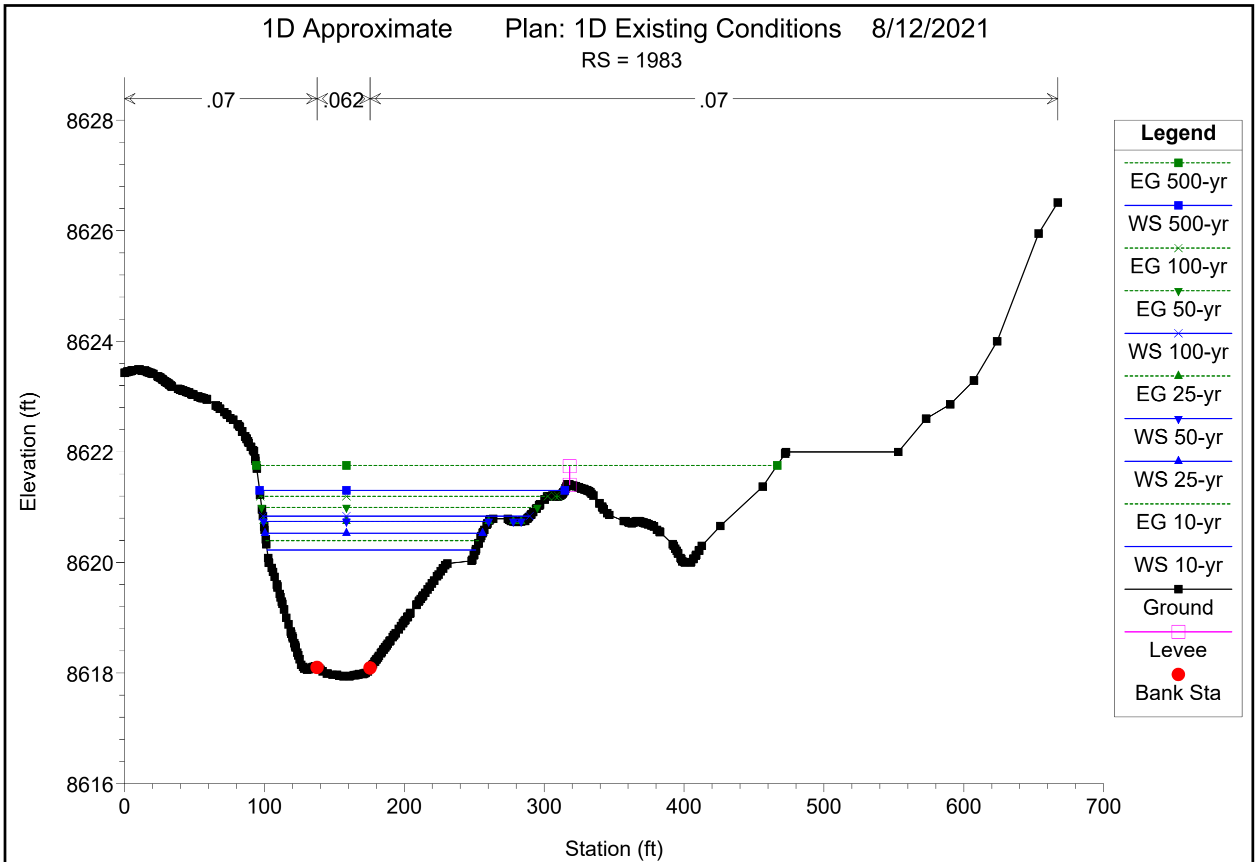
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 2789
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta

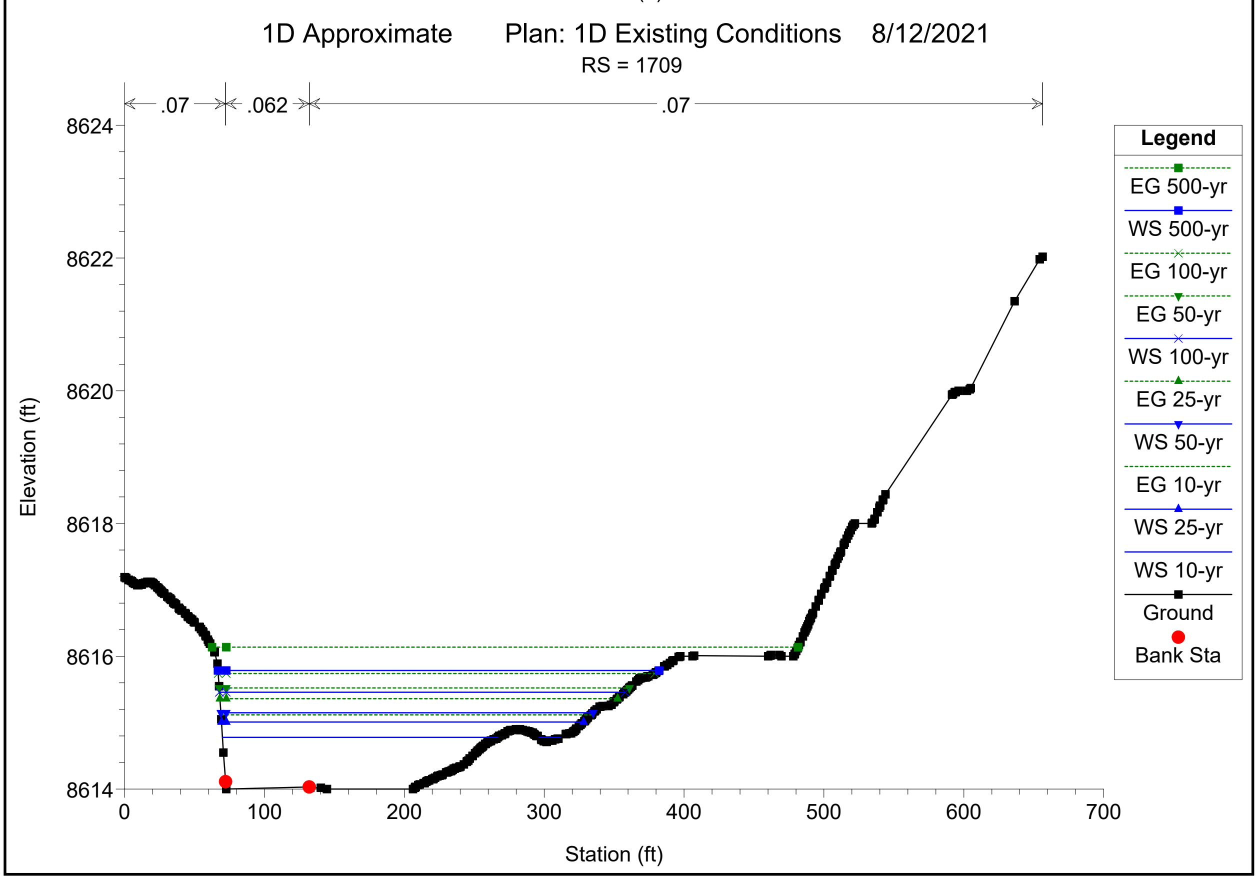


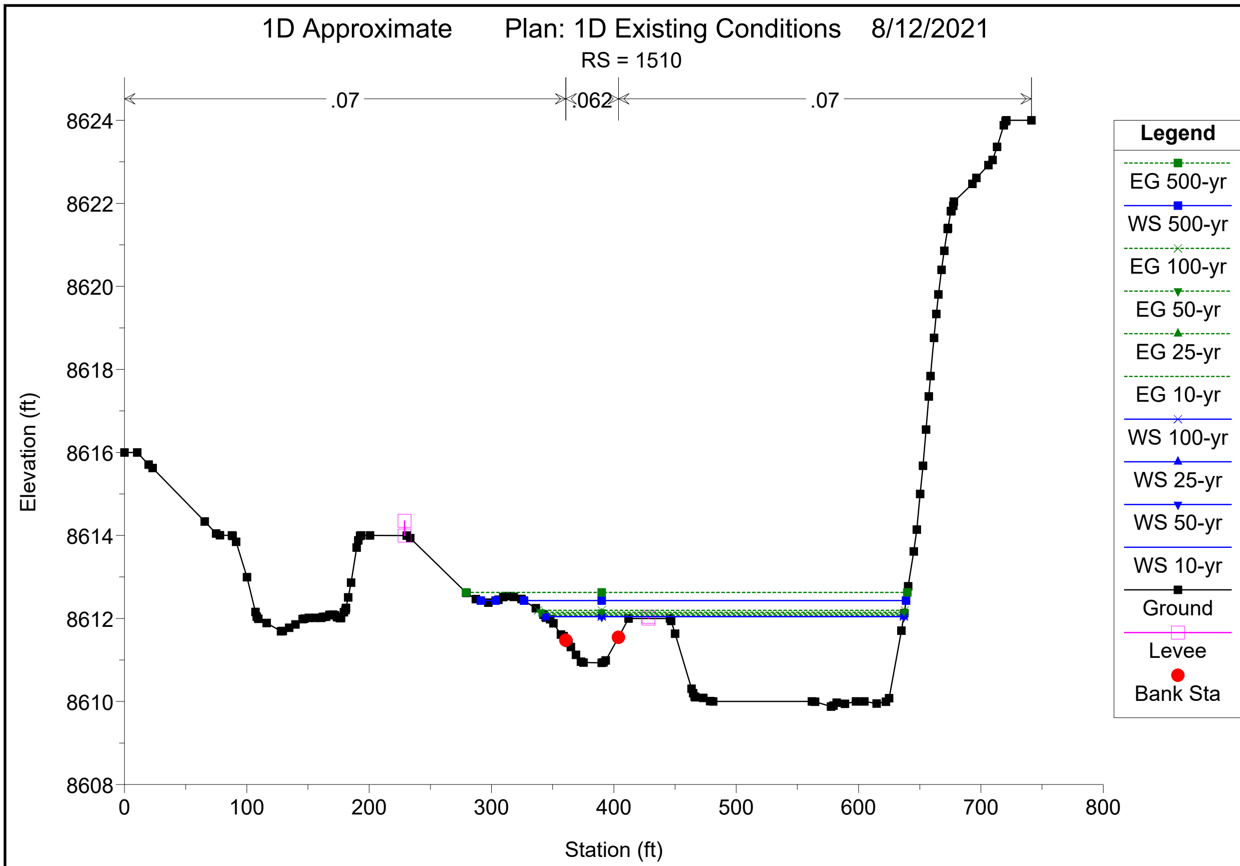
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 2437
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta


1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 2269
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Bank Sta

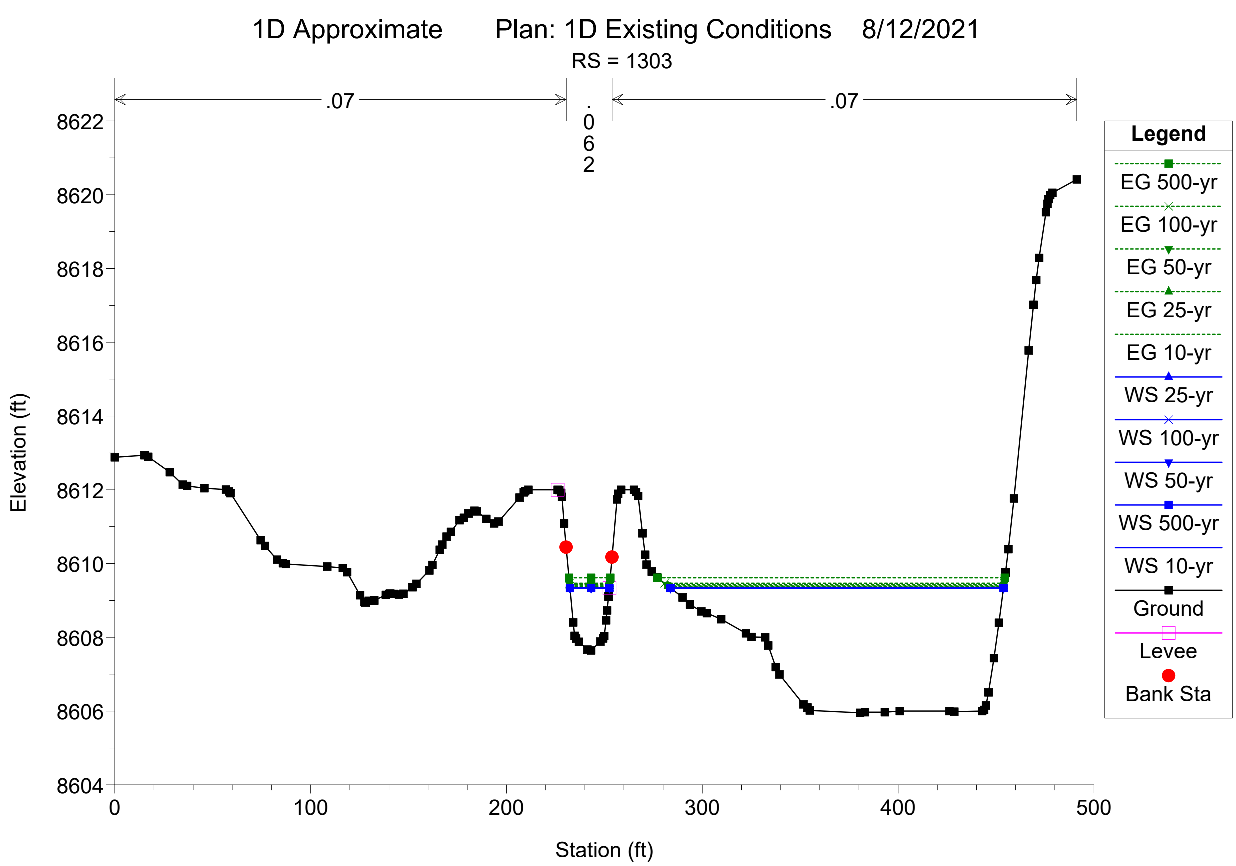

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 2139
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Bank Sta


1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 1983
.07
.062
.07
Elevation (ft)
Station (ft)
8616
8618
8620
8622
8624
8626
8628
0
100
200
300
400
500
600
700
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Levee
Bank Sta

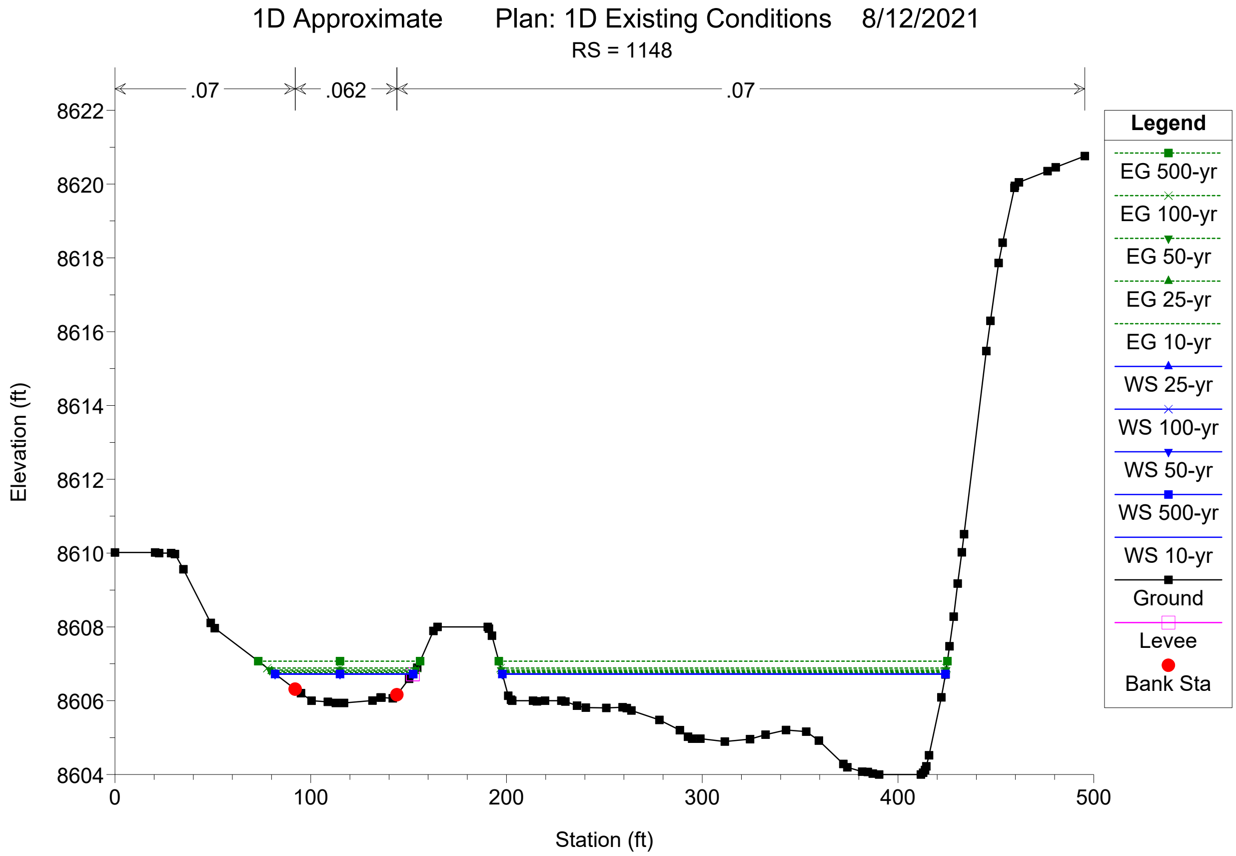

1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 1709
.07
.062
.07
Elevation (ft)
Station (ft)
8614
8616
8618
8620
8622
8624
0
100
200
300
400
500
600
700
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
EG 10-yr
WS 25-yr
WS 10-yr
Ground
Bank Sta

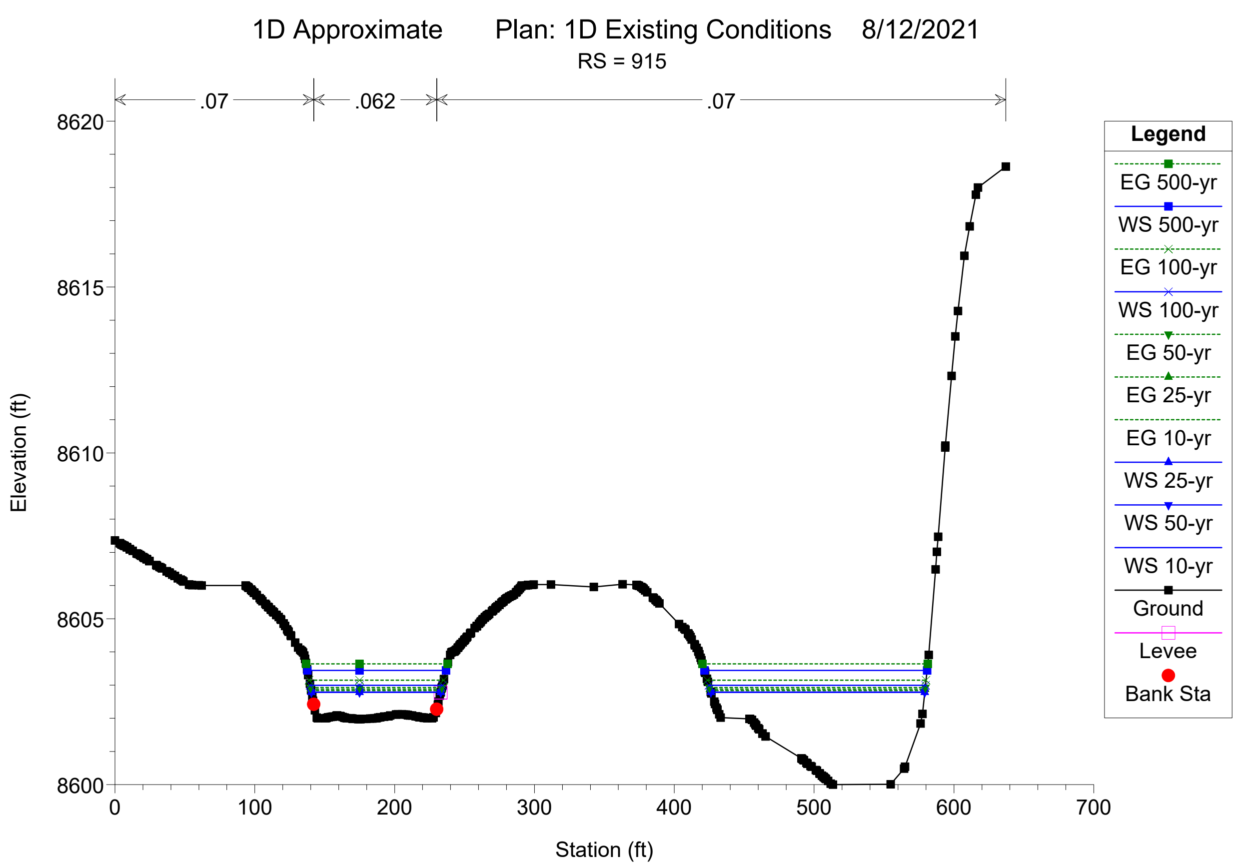


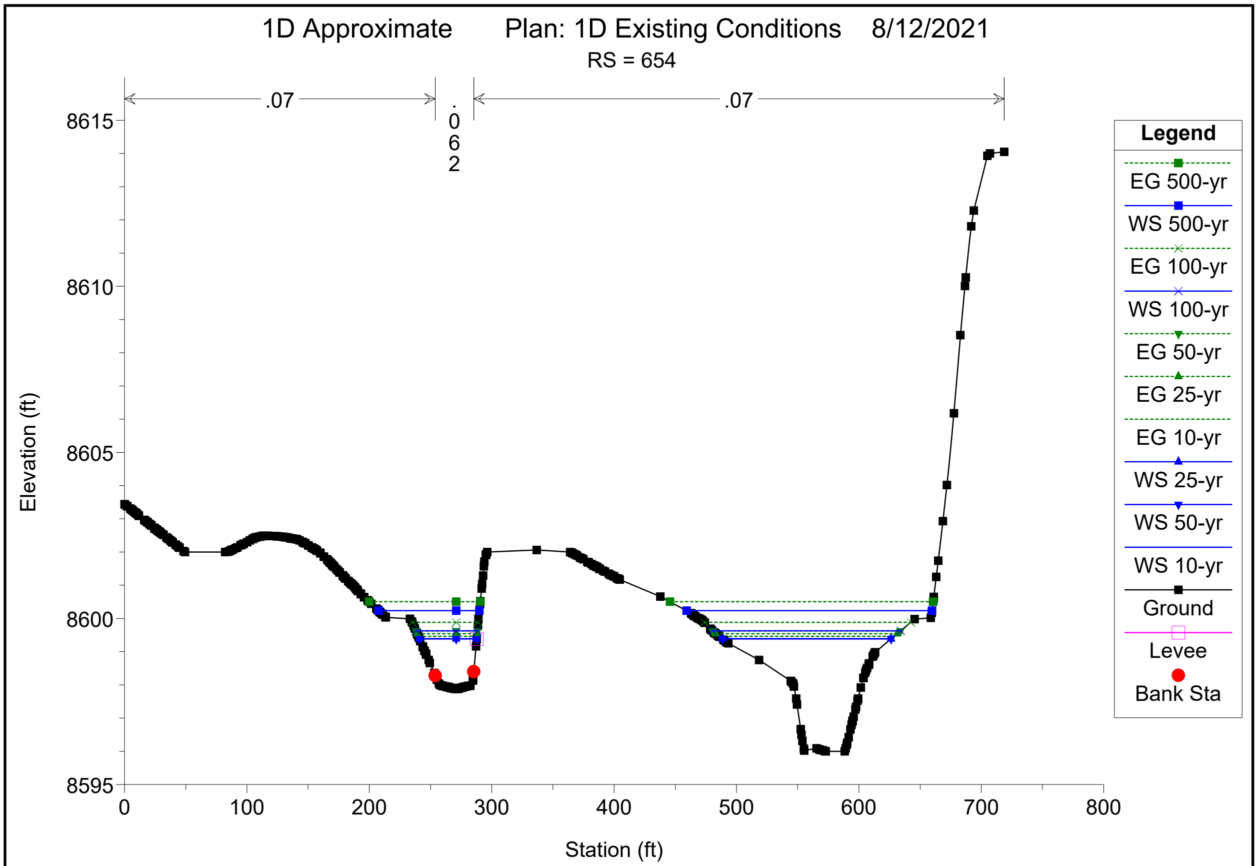
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 1510
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
EG 25-yr
EG 10-yr
WS 100-yr
WS 25-yr
WS 50-yr
WS 10-yr
Ground
Levee
Bank Sta



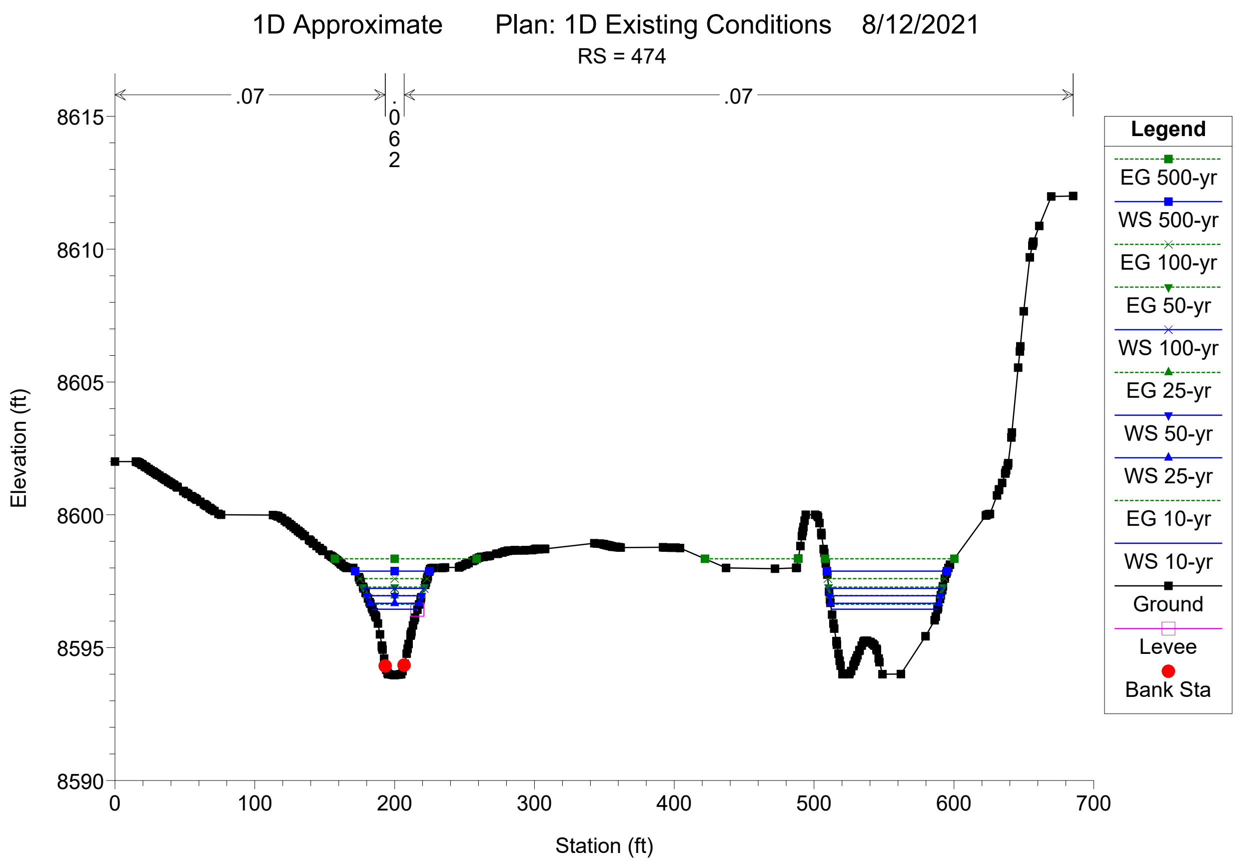
1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 1303
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
EG 100-yr
EG 50-yr
EG 25-yr
EG 10-yr
WS 25-yr
WS 100-yr
WS 50-yr
WS 500-yr
WS 10-yr
Ground
Levee
Bank Sta


1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 1148
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
EG 100-yr
EG 50-yr
EG 25-yr
EG 10-yr
WS 25-yr
WS 100-yr
WS 50-yr
WS 500-yr
WS 10-yr
Ground
Levee
Bank Sta


1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 915
.07
.062
.07
Elevation (ft)
Station (ft)
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
EG 25-yr
EG 10-yr
WS 25-yr
WS 50-yr
WS 10-yr
Ground
Levee
Bank Sta



1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 654
.07
.062
.07
Elevation (ft)
8615
8610
8605
8600
8595
Station (ft)
0
100
200
300
400
500
600
700
800
Legend
EG 500-yr
WS 500-yr
EG 100-yr
WS 100-yr
EG 50-yr
EG 25-yr
EG 10-yr
WS 25-yr
WS 50-yr
WS 10-yr
Ground
Levee
Bank Sta



1D Approximate Plan: 1D Existing Conditions 8/12/2021
RS = 474
.07
.062
.07
Elevation (ft)
8615
8610
8605
8600
8595
8590
Station (ft)
0
100
200
300
400
500
600
700
Legend
EG 500-yr
WS 500-yr
EG 100-yr
EG 50-yr
WS 100-yr
EG 25-yr
WS 50-yr
WS 25-yr
EG 10-yr
WS 10-yr
Ground
Levee
Bank Sta

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	**9606**	**10-yr**	591	8749.83	8752.33	8751.96	8752.78	0.021047	5.49	117.7	85.75	0.69
Reach 1	**9606**	**25-yr**	831	8749.83	8752.71	8752.45	8753.26	0.021377	6.21	151.04	91.2	0.71
Reach 1	**9606**	**50-yr**	1030	8749.83	8753.02	8752.71	8753.63	0.020025	6.54	180.62	94.47	0.7
Reach 1	**9606**	**100-yr**	1250	8749.83	8753.29	8752.98	8753.97	0.020343	7.02	206.05	96.94	0.72
Reach 1	**9606**	**500-yr**	1840	8749.83	8753.79	8753.56	8754.74	0.023791	8.42	255.61	101.28	0.8
Reach 1	**9284**	**10-yr**	591	8743.94	8746.4		8746.76	0.016635	5.55	154.76	149.41	0.63
Reach 1	**9284**	**25-yr**	831	8743.94	8746.71		8747.12	0.017034	6.09	203.04	158.55	0.65
Reach 1	**9284**	**50-yr**	1030	8743.94	8746.89		8747.35	0.018802	6.67	231.05	163.74	0.69
Reach 1	**9284**	**100-yr**	1250	8743.94	8747.1		8747.6	0.019071	7.04	266.21	169.78	0.7
Reach 1	**9284**	**500-yr**	1840	8743.94	8747.68		8748.21	0.017028	7.45	369.99	187.42	0.68
Reach 1	**9091**	**10-yr**	591	8740	8742.92	8742.81	8743.34	0.020455	6.04	137.99	118.09	0.69
Reach 1	**9091**	**25-yr**	831	8740	8743.27	8743.09	8743.74	0.019988	6.55	181.12	126.59	0.7
Reach 1	**9091**	**50-yr**	1030	8740	8743.6	8743.31	8744.05	0.017456	6.59	223.63	134.07	0.66
Reach 1	**9091**	**100-yr**	1250	8740	8743.86	8743.5	8744.35	0.017022	6.89	260.33	140.27	0.66
Reach 1	**9091**	**500-yr**	1840	8740	8744.29	8744.15	8744.91	0.019776	8.04	349.82	245.7	0.73
Reach 1	**8913**	**10-yr**	591	8737.04	8739.3	8738.94	8739.72	0.019943	5.64	123	74.28	0.68
Reach 1	**8913**	**25-yr**	831	8737.04	8739.77	8739.3	8740.26	0.018641	6.22	159.46	80.62	0.68
Reach 1	**8913**	**50-yr**	1030	8737.04	8740.08	8739.6	8740.67	0.019848	6.91	185.31	92.99	0.71
Reach 1	**8913**	**100-yr**	1250	8737.04	8740.46	8739.84	8741.1	0.018716	7.28	227.73	125.17	0.71
Reach 1	**8913**	**500-yr**	1840	8737.04	8740.96	8740.9	8741.58	0.017394	7.71	370.27	230.62	0.7
Reach 1	**8625**	**10-yr**	591	8732	8734.83	8734.2	8735.17	0.013048	5.46	141.52	77.64	0.57
Reach 1	**8625**	**25-yr**	831	8732	8735.28		8735.71	0.013905	6.22	178.17	85.9	0.61
Reach 1	**8625**	**50-yr**	1030	8732	8735.68		8736.14	0.012978	6.49	214.67	93.27	0.6
Reach 1	**8625**	**100-yr**	1250	8732	8736.08		8736.6	0.013505	7.09	256.97	161.03	0.62
Reach 1	**8625**	**500-yr**	1840	8732	8736.72	8735.87	8737.3	0.013272	7.76	383	203.31	0.63
Reach 1	**8336**	**10-yr**	591	8727.98	8730.36		8730.79	0.018187	5.73	131.22	100.28	0.66
Reach 1	**8336**	**25-yr**	831	8727.98	8730.75	8730.49	8731.24	0.017762	6.27	171.17	103.19	0.67
Reach 1	**8336**	**50-yr**	1030	8727.98	8730.93	8730.72	8731.53	0.020634	7.04	189.32	104.43	0.73
Reach 1	**8336**	**100-yr**	1250	8727.98	8731.18	8730.95	8731.85	0.021031	7.51	215.66	106.25	0.74
Reach 1	**8336**	**500-yr**	1840	8727.98	8731.8	8731.47	8732.61	0.020772	8.41	283.1	114.68	0.76
Reach 1	**8131**	**10-yr**	591	8724	8726.38	8726.38	8726.69	0.022836	6.44	176.71	227.3	0.74
Reach 1	**8131**	**25-yr**	831	8724	8726.55	8726.55	8726.93	0.026591	7.27	215.73	231.87	0.8
Reach 1	**8131**	**50-yr**	1030	8724	8726.75	8726.67	8727.11	0.023528	7.2	263.15	237.42	0.77
Reach 1	**8131**	**100-yr**	1250	8724	8726.89	8726.79	8727.28	0.024831	7.64	296.15	241.8	0.79
Reach 1	**8131**	**500-yr**	1840	8724	8727.15	8727.09	8727.68	0.030201	8.94	361.35	248.95	0.89
Reach 1	**7874**	**10-yr**	591	8719.91	8721.57		8721.75	0.014264	3.94	176.14	122.63	0.55
Reach 1	**7874**	**25-yr**	831	8719.91	8721.91		8722.15	0.014602	4.54	219.42	132.8	0.57
Reach 1	**7874**	**50-yr**	1030	8719.91	8722.27		8722.51	0.015656	5.25	297.46	244.14	0.61
Reach 1	**7874**	**100-yr**	1250	8719.91	8722.48		8722.72	0.01477	5.4	347.14	247.3	0.6
Reach 1	**7874**	**500-yr**	1840	8719.91	8723.01		8723.27	0.012112	5.55	480.76	254.9	0.56
Reach 1	**7699**	**10-yr**	591	8716.86	8718.73	8718.4	8719.03	0.019948	4.5	140.7	108.7	0.64
Reach 1	**7699**	**25-yr**	831	8716.86	8719.1	8718.68	8719.46	0.018839	5.04	184.4	132.26	0.64
Reach 1	**7699**	**50-yr**	1030	8716.86	8719.33	8718.86	8719.74	0.018505	5.4	216.45	138.95	0.65
Reach 1	**7699**	**100-yr**	1250	8716.86	8719.55	8719.19	8720.02	0.018756	5.8	247.33	144.69	0.67
Reach 1	**7699**	**500-yr**	1840	8716.86	8719.99	8719.64	8720.66	0.021853	7.03	320.12	235.62	0.74
Reach 1	**7521**	**10-yr**	591	8714	8715.48	8715.08	8715.73	0.019169	4.31	155.81	124.61	0.62
Reach 1	**7521**	**25-yr**	831	8714	8715.68	8715.35	8716	0.02231	5.06	205.4	198.35	0.69
Reach 1	**7521**	**50-yr**	1030	8714	8715.84	8715.67	8716.2	0.023823	5.54	236.06	204.29	0.72
Reach 1	**7521**	**100-yr**	1250	8714	8716.08	8715.8	8716.45	0.023417	5.97	287.17	228.61	0.73
Reach 1	**7521**	**500-yr**	1840	8714	8716.5	8716.25	8716.93	0.021437	6.47	386.68	237.85	0.72
Reach 1	**7267**	**10-yr**	591	8709.98	8710.97		8711.1	0.02094	3.42	212.19	267.79	0.61
Reach 1	**7267**	**25-yr**	831	8709.98	8711.21		8711.36	0.018147	3.69	279.19	283.24	0.59
Reach 1	**7267**	**50-yr**	1030	8709.98	8711.38		8711.55	0.017312	3.93	327.78	295.2	0.59
Reach 1	**7267**	**100-yr**	1250	8709.98	8711.52		8711.71	0.018169	4.29	369.6	311.87	0.61
Reach 1	**7267**	**500-yr**	1840	8709.98	8711.81		8712.08	0.02097	5.17	463.74	348.72	0.68
Reach 1	**7047**	**10-yr**	591	8704	8706.4	8706.4	8706.72	0.021217	6.13	180.94	224.33	0.71
Reach 1	**7047**	**25-yr**	831	8704	8706.57	8706.57	8706.95	0.025184	6.99	217.69	226.42	0.78
Reach 1	**7047**	**50-yr**	1030	8704	8706.7	8706.68	8707.12	0.026656	7.45	248.12	228.52	0.81
Reach 1	**7047**	**100-yr**	1250	8704	8706.88	8706.81	8707.3	0.025087	7.55	289.47	231.64	0.79
Reach 1	**7047**	**500-yr**	1840	8704	8707.36	8707.1	8707.77	0.020519	7.58	401.3	239.67	0.74

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	**6876**	**10-yr**	591	8701.99	8703.57	8703.57	8703.65	0.007164	2.73	257.62	195.08	0.39
Reach 1	**6876**	**25-yr**	831	8701.99	8703.64	8703.57	8703.79	0.012214	3.68	272.17	196.7	0.51
Reach 1	**6876**	**50-yr**	1030	8701.99	8703.82	8703.57	8704.01	0.012646	4.02	308.62	200.53	0.52
Reach 1	**6876**	**100-yr**	1250	8701.99	8704.11	8703.57	8704.31	0.012408	4.38	370.35	250.75	0.53
Reach 1	**6876**	**500-yr**	1840	8701.99	8704.36	8703.7	8704.63	0.016116	5.38	506.74	533.95	0.62
Reach 1	**6665**	**10-yr**	591	8697.76	8699.61	8699.61	8699.88	0.032203	6.23	166.44	212.28	0.83
Reach 1	**6665**	**25-yr**	831	8697.76	8699.73	8699.72	8700.12	0.042069	7.44	192.3	218.36	0.96
Reach 1	**6665**	**50-yr**	1030	8697.76	8699.88	8699.88	8700.29	0.041135	7.74	224.83	225.77	0.96
Reach 1	**6665**	**100-yr**	1250	8697.76	8699.97	8699.97	8700.47	0.046748	8.5	246	230.86	1.03
Reach 1	**6665**	**500-yr**	1840	8697.76	8700.22	8700.09	8700.6	0.03326	7.72	398.24	323.68	0.89
Reach 1	**6438**	**10-yr**	591	8694	8695.09	8694.74	8695.18	0.012105	2.77	256.48	287.97	0.47
Reach 1	**6438**	**25-yr**	831	8694	8695.28	8694.83	8695.4	0.012609	3.16	313.7	292.1	0.49
Reach 1	**6438**	**50-yr**	1030	8694	8695.47	8694.96	8695.6	0.011501	3.31	369.39	295.64	0.48
Reach 1	**6438**	**100-yr**	1250	8694	8695.63	8695.07	8695.77	0.011766	3.58	414.37	298.89	0.5
Reach 1	**6438**	**500-yr**	1840	8694	8695.93	8695.29	8696.15	0.013639	4.33	507.54	309.62	0.55
Reach 1	**6187**	**10-yr**	591	8689.26	8689.61	8689.55	8689.87	0.049804	2.35	147.96	215.39	0.77
Reach 1	**6187**	**25-yr**	831	8689.26	8689.8	8689.73	8690.11	0.046331	3.16	189.94	227.78	0.8
Reach 1	**6187**	**50-yr**	1030	8689.26	8689.86	8689.82	8690.27	0.057006	3.81	204.53	232.09	0.91
Reach 1	**6187**	**100-yr**	1250	8689.26	8690	8689.98	8690.45	0.053884	4.31	237.7	245.89	0.92
Reach 1	**6187**	**500-yr**	1840	8689.26	8690.35	8690.35	8690.81	0.042287	5.05	365.14	369.22	0.87
Reach 1	**5953**	**10-yr**	591	8685.39	8686.34	8685.98	8686.39	0.009879	2.24	313.42	378.22	0.41
Reach 1	**5953**	**25-yr**	831	8685.39	8686.52	8686.05	8686.59	0.01027	2.58	382.19	383.23	0.43
Reach 1	**5953**	**50-yr**	1030	8685.39	8686.7	8686.14	8686.78	0.009178	2.7	452.26	388.71	0.42
Reach 1	**5953**	**100-yr**	1250	8685.39	8686.84	8686.2	8686.93	0.009416	2.93	506.04	392.37	0.43
Reach 1	**5953**	**500-yr**	1840	8685.39	8687.19	8686.43	8687.31	0.009422	3.39	644.59	402.38	0.45
Reach 1	**5731**	**10-yr**	591	8680	8680.96	8680.96	8681.27	0.062632	5.64	133.89	199.89	1.04
Reach 1	**5731**	**25-yr**	831	8680	8681.18	8681.12	8681.54	0.054073	6.05	173.84	214.93	1
Reach 1	**5731**	**50-yr**	1030	8680	8681.23	8681.23	8681.73	0.071163	7.13	182.59	218.69	1.16
Reach 1	**5731**	**100-yr**	1250	8680	8681.39	8681.39	8681.93	0.063838	7.36	213.42	229.37	1.12
Reach 1	**5731**	**500-yr**	1840	8680	8681.73	8681.73	8682.41	0.058922	8.22	279.3	250.44	1.12
Reach 1	**5477**	**10-yr**	591	8675.92	8676.84	8676.84	8676.9	0.010242	2.19	287.74	318.42	0.42
Reach 1	**5477**	**25-yr**	831	8675.92	8676.92	8676.84	8677.03	0.015117	2.83	315.24	321.56	0.51
Reach 1	**5477**	**50-yr**	1030	8675.92	8677.18	8676.84	8677.29	0.010936	2.83	398.9	330	0.46
Reach 1	**5477**	**100-yr**	1250	8675.92	8677.37	8676.84	8677.49	0.010114	3	461.66	335.93	0.45
Reach 1	**5477**	**500-yr**	1840	8675.92	8677.56	8676.98	8677.76	0.014318	3.9	527.84	341.76	0.55
Reach 1	**5210**	**10-yr**	591	8671.56	8672.03	8672.03	8672.12	0.014924	1.67	250.4	373.4	0.45
Reach 1	**5210**	**25-yr**	831	8671.56	8672.03	8672.03	8672.2	0.029506	2.35	250.4	373.4	0.63
Reach 1	**5210**	**50-yr**	1030	8671.56	8672.03	8672.03	8672.3	0.057086	3.29	252.23	376.58	0.88
Reach 1	**5210**	**100-yr**	1250	8671.56	8672.07	8672.07	8672.42	0.071923	3.88	265.11	377.19	1
Reach 1	**5210**	**500-yr**	1840	8671.56	8672.49	8672.29	8672.79	0.033984	4.1	427.27	384.13	0.76
Reach 1	**4963**	**10-yr**	591	8666	8668.03		8668.12	0.00627	3.05	273.59	212.01	0.38
Reach 1	**4963**	**25-yr**	831	8666	8668.38		8668.48	0.006006	3.31	348.72	222.31	0.38
Reach 1	**4963**	**50-yr**	1030	8666	8668.64		8668.75	0.00579	3.48	407.42	229.54	0.38
Reach 1	**4963**	**100-yr**	1250	8666	8668.9		8669.03	0.005605	3.65	468.93	236.9	0.38
Reach 1	**4963**	**500-yr**	1840	8666	8669.25		8669.44	0.007421	4.53	552.59	245.5	0.44
Reach 1	**4745**	**10-yr**	591	8662.4	8664.64	8664.64	8665.27	0.036083	7.66	106.45	82.06	0.91
Reach 1	**4745**	**25-yr**	831	8662.4	8665.04	8665.04	8665.75	0.03425	8.35	141.84	95.68	0.92
Reach 1	**4745**	**50-yr**	1030	8662.4	8665.3	8665.3	8666.08	0.03421	8.89	167.57	103.9	0.93
Reach 1	**4745**	**100-yr**	1250	8662.4	8665.55	8665.55	8666.4	0.034268	9.41	194.54	111.86	0.94
Reach 1	**4745**	**500-yr**	1840	8662.4	8666.39	8666.39	8666.9	0.01869	8.16	429.2	337.32	0.73
Reach 1	**4492**	**10-yr**	591	8658	8660.01		8660.2	0.009966	3.76	183.04	127.21	0.47
Reach 1	**4492**	**25-yr**	831	8658	8660.39		8660.62	0.010326	4.3	243.38	180.34	0.49
Reach 1	**4492**	**50-yr**	1030	8658	8660.65		8660.91	0.010216	4.58	292.67	199.14	0.5
Reach 1	**4492**	**100-yr**	1250	8658	8660.88		8661.17	0.010385	4.89	340.9	215.77	0.51
Reach 1	**4492**	**500-yr**	1840	8658	8661.39		8661.74	0.010888	5.59	473.13	293.14	0.54
Reach 1	**4240**	**10-yr**	591	8653.95	8656.34	8655.96	8656.8	0.020753	6.11	136.56	131.12	0.7
Reach 1	**4240**	**25-yr**	831	8653.95	8656.67	8656.6	8657.18	0.020857	6.69	183.47	151.25	0.72
Reach 1	**4240**	**50-yr**	1030	8653.95	8656.91	8656.75	8657.47	0.021592	7.19	221.48	178.93	0.74
Reach 1	**4240**	**100-yr**	1250	8653.95	8657.12	8657.11	8657.71	0.021733	7.56	262.43	198.68	0.75

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	**4240**	**500-yr**	1840	8653.95	8657.58	8657.54	8658.23	0.022013	8.33	359.75	229.28	0.78
Reach 1	**3913**	**10-yr**	591	8649.72	8651.26		8651.4	0.014467	3.69	206.53	178.51	0.54
Reach 1	**3913**	**25-yr**	831	8649.72	8651.52		8651.7	0.014963	4.19	253.46	182.82	0.57
Reach 1	**3913**	**50-yr**	1030	8649.72	8651.73		8651.93	0.014864	4.5	291.12	186.15	0.57
Reach 1	**3913**	**100-yr**	1250	8649.72	8651.93		8652.16	0.014843	4.82	329.64	189.57	0.58
Reach 1	**3913**	**500-yr**	1840	8649.72	8652.44		8652.73	0.014655	5.52	427.66	201.34	0.6
Reach 1	**3656**	**10-yr**	591	8645.98	8647.5	8647.39	8647.76	0.023338	4.81	170.13	199.71	0.69
Reach 1	**3656**	**25-yr**	831	8645.98	8647.72	8647.59	8648.02	0.023961	5.34	214.87	207.59	0.72
Reach 1	**3656**	**50-yr**	1030	8645.98	8647.87	8647.71	8648.22	0.024983	5.76	246.09	212.84	0.74
Reach 1	**3656**	**100-yr**	1250	8645.98	8648.04	8647.86	8648.44	0.02569	6.2	284.87	235.77	0.76
Reach 1	**3656**	**500-yr**	1840	8645.98	8648.33	8648.23	8648.85	0.029471	7.24	352.42	239.22	0.84
Reach 1	**3359**	**10-yr**	591	8640.36	8642.64		8642.8	0.013003	4.68	209.84	184.84	0.55
Reach 1	**3359**	**25-yr**	831	8640.36	8642.94		8643.12	0.012386	4.96	265.37	186.81	0.55
Reach 1	**3359**	**50-yr**	1030	8640.36	8643.17		8643.37	0.011795	5.14	308.97	188.32	0.54
Reach 1	**3359**	**100-yr**	1250	8640.36	8643.41		8643.62	0.011356	5.32	353.48	189.91	0.54
Reach 1	**3359**	**500-yr**	1840	8640.36	8644.06		8644.3	0.009443	5.53	478.38	194.49	0.51
Reach 1	**3054**	**10-yr**	591	8635.78	8638.02		8638.34	0.017262	5.22	139.4	89.3	0.63
Reach 1	**3054**	**25-yr**	831	8635.78	8638.43		8638.82	0.01678	5.79	177	93.39	0.64
Reach 1	**3054**	**50-yr**	1030	8635.78	8638.71		8639.16	0.017009	6.24	203.31	95.67	0.66
Reach 1	**3054**	**100-yr**	1250	8635.78	8639		8639.51	0.016966	6.66	231.49	98	0.67
Reach 1	**3054**	**500-yr**	1840	8635.78	8639.48		8640.25	0.020788	8.12	280.38	102.33	0.75
Reach 1	**2789**	**10-yr**	591	8631.98	8633.74		8633.96	0.017749	4.64	163.74	124.17	0.62
Reach 1	**2789**	**25-yr**	831	8631.98	8634.08		8634.37	0.019	5.41	213.15	185.53	0.66
Reach 1	**2789**	**50-yr**	1030	8631.98	8634.26		8634.59	0.019899	5.85	246.18	188.15	0.68
Reach 1	**2789**	**100-yr**	1250	8631.98	8634.42		8634.8	0.021348	6.33	276.12	190.2	0.72
Reach 1	**2789**	**500-yr**	1840	8631.98	8634.96		8635.38	0.018206	6.69	381.31	196.51	0.68
Reach 1	**2437**	**10-yr**	591	8625.87	8627.62		8627.89	0.02289	5.21	145.79	109.26	0.7
Reach 1	**2437**	**25-yr**	831	8625.87	8628		8628.32	0.021228	5.73	189.49	119.16	0.7
Reach 1	**2437**	**50-yr**	1030	8625.87	8628.29		8628.65	0.019745	6.03	225.47	126.14	0.69
Reach 1	**2437**	**100-yr**	1250	8625.87	8628.63		8628.99	0.017591	6.21	268.95	134.34	0.66
Reach 1	**2437**	**500-yr**	1840	8625.87	8629.1		8629.61	0.020507	7.46	335.51	146.61	0.73
Reach 1	**2269**	**10-yr**	591	8621.89	8624.94	8624.43	8625.23	0.012907	5.67	167.06	117.17	0.58
Reach 1	**2269**	**25-yr**	831	8621.89	8625.32	8624.81	8625.66	0.013762	6.33	215.19	135.94	0.61
Reach 1	**2269**	**50-yr**	1030	8621.89	8625.54	8625.06	8625.93	0.01517	6.94	246.39	147	0.64
Reach 1	**2269**	**100-yr**	1250	8621.89	8625.69		8626.17	0.018154	7.79	268.35	154.93	0.71
Reach 1	**2269**	**500-yr**	1840	8621.89	8626.4		8626.87	0.01503	7.96	414.71	244.85	0.66
Reach 1	**2139**	**10-yr**	591	8619.97	8622.47	8622.47	8622.91	0.027878	7.25	139.59	143.61	0.82
Reach 1	**2139**	**25-yr**	831	8619.97	8622.73	8622.72	8623.23	0.028997	7.91	177.98	148.67	0.85
Reach 1	**2139**	**50-yr**	1030	8619.97	8622.99		8623.47	0.026327	8.01	217.34	156.81	0.82
Reach 1	**2139**	**100-yr**	1250	8619.97	8623.38		8623.78	0.019801	7.54	281.44	174.38	0.73
Reach 1	**2139**	**500-yr**	1840	8619.97	8624.04	8623.46	8624.6	0.02204	8.98	422.7	425.04	0.79
Reach 1	**1983**	**10-yr**	591	8617.94	8620.23	8619.49	8620.39	0.009003	3.89	204.91	149.18	0.46
Reach 1	**1983**	**25-yr**	831	8617.94	8620.53	8619.76	8620.74	0.010011	4.47	251.03	155.56	0.49
Reach 1	**1983**	**50-yr**	1030	8617.94	8620.74	8619.96	8620.99	0.010779	4.89	284.74	166.58	0.52
Reach 1	**1983**	**100-yr**	1250	8617.94	8620.84	8620.23	8621.2	0.014863	5.88	302.28	190.74	0.61
Reach 1	**1983**	**500-yr**	1840	8617.94	8621.31	8620.71	8621.76	0.016044	6.76	396.68	218.23	0.65
Reach 1	**1709**	**10-yr**	591	8614	8614.78	8614.78	8615.12	0.072511	5.38	129.88	211.82	1.09
Reach 1	**1709**	**25-yr**	831	8614	8615.01	8615.01	8615.36	0.059282	5.82	186.25	258.94	1.03
Reach 1	**1709**	**50-yr**	1030	8614	8615.15	8615.12	8615.52	0.052596	5.98	222.91	266.15	0.99
Reach 1	**1709**	**100-yr**	1250	8614	8615.46	8615.22	8615.74	0.029725	5.27	308.49	289.92	0.77
Reach 1	**1709**	**500-yr**	1840	8614	8615.79		8616.14	0.028741	5.94	407.18	315.44	0.79
Reach 1	**1510**	**10-yr**	591	8610.93	8612.05	8612.05	8612.08	0.002743	1.21	407.31	293.19	0.22
Reach 1	**1510**	**25-yr**	831	8610.93	8612.05	8612.05	8612.11	0.005423	1.7	407.31	293.19	0.31
Reach 1	**1510**	**50-yr**	1030	8610.93	8612.05	8612.05	8612.15	0.008331	2.11	407.31	293.19	0.38
Reach 1	**1510**	**100-yr**	1250	8610.93	8612.05	8612.05	8612.2	0.012271	2.56	407.31	293.19	0.46
Reach 1	**1510**	**500-yr**	1840	8610.93	8612.43	8612.05	8612.63	0.012216	3.21	523.52	324.48	0.49
Reach 1	**1303**	**10-yr**	591	8607.64	8609.34	8609.34	8609.37	0.001275	1.01	439.65	190.17	0.15
Reach 1	**1303**	**25-yr**	831	8607.64	8609.34	8609.34	8609.39	0.002521	1.42	439.65	190.17	0.22
Reach 1	**1303**	**50-yr**	1030	8607.64	8609.34	8609.34	8609.42	0.003872	1.76	439.65	190.17	0.27

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	**1303**	**100-yr**	1250	8607.64	8609.34	8609.34	8609.47	0.005703	2.13	439.65	190.17	0.33
Reach 1	**1303**	**500-yr**	1840	8607.64	8609.34	8609.34	8609.61	0.012358	3.14	439.65	190.17	0.48
Reach 1	**1148**	**10-yr**	591	8605.94	8606.73	8606.73	8606.76	0.002923	1.02	396.89	297	0.22
Reach 1	**1148**	**25-yr**	831	8605.94	8606.73	8606.73	8606.8	0.00578	1.44	396.89	297	0.3
Reach 1	**1148**	**50-yr**	1030	8605.94	8606.73	8606.73	8606.84	0.008879	1.79	396.89	297	0.38
Reach 1	**1148**	**100-yr**	1250	8605.94	8606.73	8606.73	8606.89	0.013077	2.17	396.89	297	0.46
Reach 1	**1148**	**500-yr**	1840	8605.94	8606.73	8606.73	8607.07	0.028335	3.19	396.89	297	0.67
Reach 1	**915**	**10-yr**	591	8601.97	8602.79	8602.79	8602.83	0.003101	1.1	354.69	245.48	0.22
Reach 1	**915**	**25-yr**	831	8601.97	8602.79	8602.79	8602.88	0.006131	1.54	354.69	245.48	0.31
Reach 1	**915**	**50-yr**	1030	8601.97	8602.79	8602.79	8602.93	0.009419	1.91	354.69	245.48	0.39
Reach 1	**915**	**100-yr**	1250	8601.97	8602.99	8602.79	8603.15	0.009353	2.24	405.21	249.52	0.41
Reach 1	**915**	**500-yr**	1840	8601.97	8603.44	8602.79	8603.64	0.009592	2.94	519.31	258.46	0.44
Reach 1	**654**	**10-yr**	591	8597.88	8599.39	8599.39	8599.46	0.006118	2.36	267.35	184.85	0.35
Reach 1	**654**	**25-yr**	831	8597.88	8599.39	8599.39	8599.54	0.012095	3.32	267.35	184.85	0.49
Reach 1	**654**	**50-yr**	1030	8597.88	8599.39	8599.39	8599.62	0.018582	4.11	267.35	184.85	0.61
Reach 1	**654**	**100-yr**	1250	8597.88	8599.63	8599.39	8599.88	0.018246	4.53	314.31	204.15	0.62
Reach 1	**654**	**500-yr**	1840	8597.88	8600.23	8599.42	8600.51	0.016075	5.23	459.05	282.76	0.61
Reach 1	**474**	**10-yr**	591	8593.97	8596.45	8596.45	8596.64	0.011072	4.53	178.86	108.16	0.51
Reach 1	**474**	**25-yr**	831	8593.97	8596.67	8596.45	8596.96	0.01501	5.59	203.56	112.8	0.61
Reach 1	**474**	**50-yr**	1030	8593.97	8596.95	8596.45	8597.28	0.015012	5.98	236.15	118.78	0.62
Reach 1	**474**	**100-yr**	1250	8593.97	8597.23	8596.47	8597.6	0.01501	6.36	270.26	124.68	0.63
Reach 1	**474**	**500-yr**	1840	8593.97	8597.88	8597.02	8598.34	0.015008	7.19	355.66	139.02	0.65

APPENDIX C

FHWA Hydraulic Toolbox Hydraulic Calculations

Hydraulic Analysis Report
Proposed Cross Section

Project Data

Project Title: Lower Willow Creek Proposed Profile

Designer: JDH

Project Date: Thursday, August 12, 2021

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel Analysis

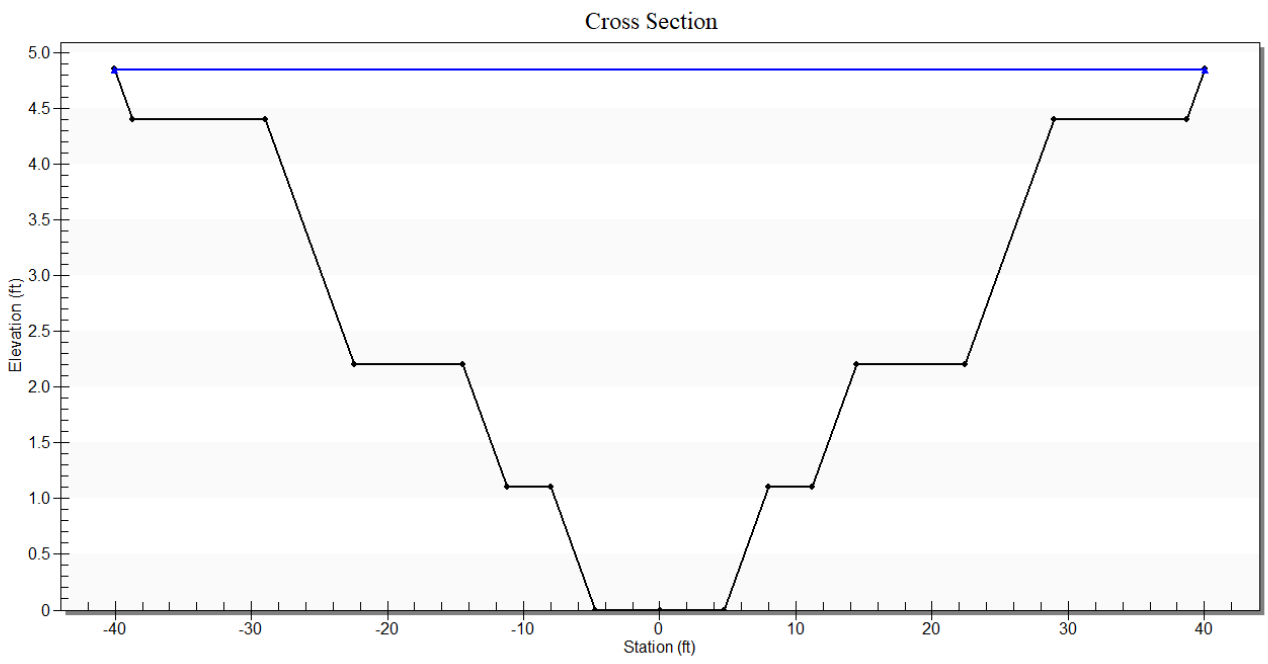
Notes:

Input Parameters

Channel Type: Custom Cross Section

Cross Section Data

Elevation (ft)	Elevation (ft)	Manning's n
-40.02	4.85	0.0700
-38.70	4.40	0.0700
-29.00	4.40	0.0700
-22.40	2.20	0.0700
-14.50	2.20	0.0620
-11.20	1.10	0.0620
-8.00	1.10	0.0620
-4.70	0.00	0.0620
0.00	0.00	0.0620
4.70	0.00	0.0620
8.00	1.10	0.0620
11.20	1.10	0.0620
14.50	2.20	0.0700
22.40	2.20	0.0700
29.00	4.40	0.0700
38.70	4.40	0.0700
40.02	4.85	-----



Longitudinal Slope: 0.0190 ft/ft

Flow: 1250.0000 cfs

Result Parameters

Depth: 4.8462 ft

Area of Flow: 190.4376 ft^2

Wetted Perimeter: 81.5990 ft

Hydraulic Radius: 2.3338 ft

Average Velocity: 6.5638 ft/s

Top Width: 80.0234 ft

Froude Number: 0.7498

Critical Depth: 4.1285 ft

Critical Velocity: 8.9415 ft/s

Critical Slope: 0.0385 ft/ft

Critical Top Width: 56.37 ft

Calculated Max Shear Stress: 5.7456 lb/ft^2

Calculated Avg Shear Stress: 2.7670 lb/ft^2

Composite Manning's n Equation: Lotter method

Manning's n: 0.0549

APPENDIX D

RiverMORPH Sediment Transport Output

POWERSED Evaluation Worksheet. Predicted annual sediment transport capacity using the POWERSED model for the evaluation condition.

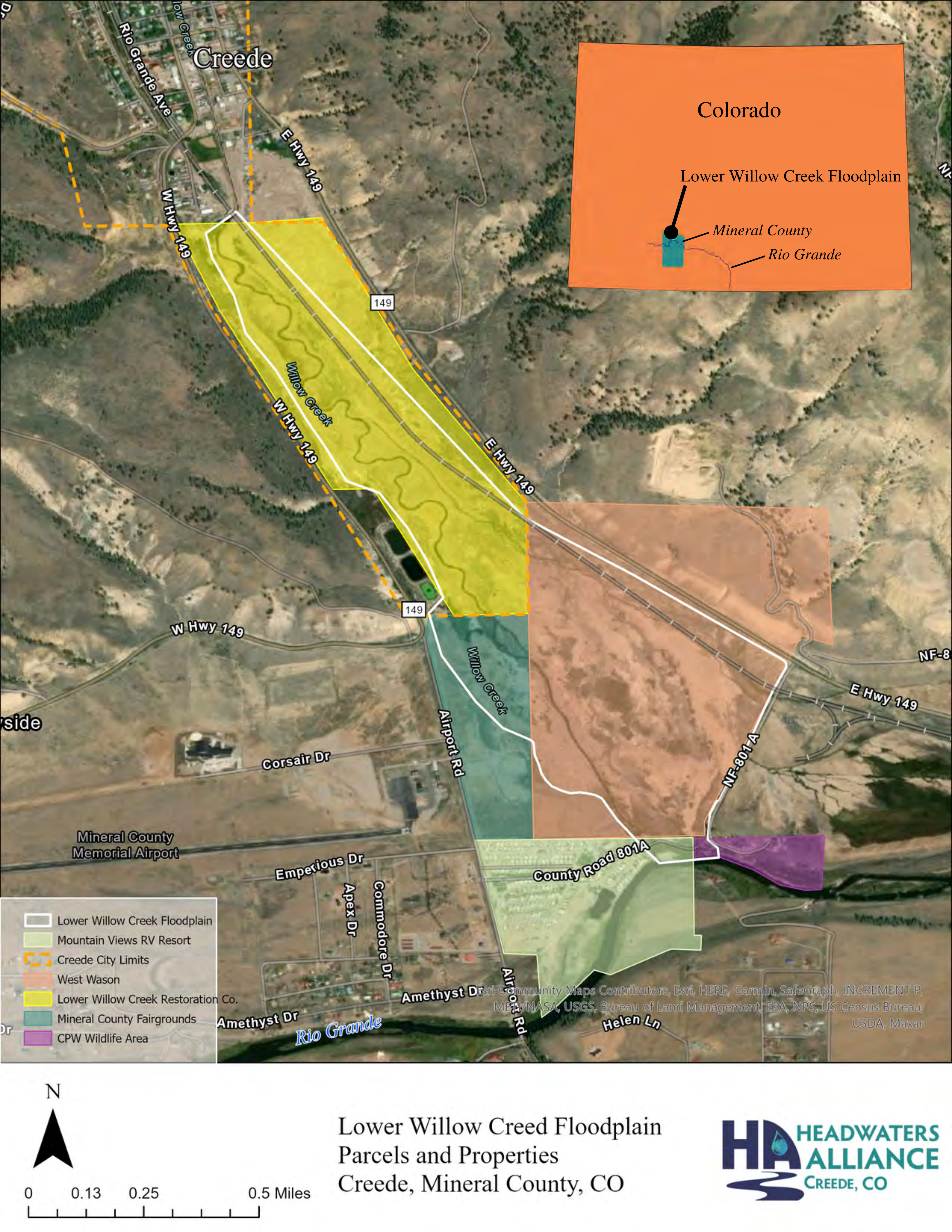
Stream: **Lower Willow Creek @ Flume Outlet** Location: **Creede, CO** Date: **8/12/2021**

Observers: **AS** Gage Station #: **N/A** Stream Type: Landscape Type: **U-AL-AF**

From Localized Flow-Duration Curve					Hydraulic Geometry				Measure	Calculate			Daily Transport Rates			Calculate Annual Transport Capacity			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Percentage of Time	Mean Daily Discharge	Mid-Ordinate Stream-flow	Time Increment (percent)	Time Increment (days)	Area	Width	Depth	Velocity	Slope	Shear Stress	Stream Power	Unit Stream Power	Daily Mean Bedload Transport Rate	Daily Mean Suspended Transport Rate	Daily Mean Susp. Sand Transport Rate	Time Adjusted Bedload Transport [(5)×(14)]	Time Adjusted Suspended Transport [(5)×(15)]	Time Adjusted Susp. Sand Transport [(5)×(16)]	Time Adj.Total Transport: Bedload & Susp. Sand [(17)+(19)]
(%)	(cfs)	(cfs)	(%)	(days)	(ft^2)	(ft)	(ft)	(ft/s)	(ft/ft)	(lb/ft^2)	(lb/s)	(lb/ft/s)	(tons/day)	(tons/day)	(tons/day)	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)
100	**0.18**																		
90	**3.50**	**1.84**	**10**	**36.50**	**1.83**	**11.59**	**0.16**	**0.95**	**0.0190**	**0.19**	**2.18**	**0.19**	**0.00**	**0.05**	**0.02**	**0.00**	**1.83**	**0.73**	**0.73**
80	**4.42**	**3.96**	**10**	**36.50**	**3.01**	**12.18**	**0.25**	**1.29**	**0.0190**	**0.29**	**4.70**	**0.39**	**0.00**	**0.10**	**0.05**	**0.00**	**3.65**	**1.83**	**1.83**
70	**5.34**	**4.88**	**10**	**36.50**	**3.47**	**12.41**	**0.28**	**1.41**	**0.0190**	**0.33**	**5.79**	**0.47**	**0.00**	**0.13**	**0.06**	**0.00**	**4.75**	**2.19**	**2.19**
60	**6.63**	**5.98**	**10**	**36.50**	**3.93**	**12.63**	**0.31**	**1.50**	**0.0190**	**0.37**	**7.09**	**0.56**	**0.00**	**0.16**	**0.08**	**0.00**	**5.84**	**2.92**	**2.92**
50	**9.02**	**7.82**	**10**	**36.50**	**4.69**	**12.99**	**0.36**	**1.67**	**0.0190**	**0.42**	**9.27**	**0.71**	**0.00**	**0.22**	**0.11**	**0.00**	**8.03**	**4.01**	**4.01**
40	**12.34**	**10.68**	**10**	**36.50**	**5.73**	**13.46**	**0.43**	**1.85**	**0.0190**	**0.50**	**12.66**	**0.94**	**0.00**	**0.31**	**0.16**	**0.00**	**11.31**	**5.84**	**5.84**
30	**18.42**	**15.38**	**10**	**36.50**	**7.29**	**14.14**	**0.52**	**2.11**	**0.0190**	**0.60**	**18.23**	**1.29**	**0.04**	**0.51**	**0.26**	**1.46**	**18.62**	**9.49**	**10.95**
20	**27.63**	**23.02**	**10**	**36.50**	**9.53**	**15.05**	**0.63**	**2.41**	**0.0190**	**0.74**	**27.29**	**1.81**	**0.13**	**0.99**	**0.49**	**4.75**	**36.13**	**17.88**	**22.63**
10	**55.25**	**41.44**	**10**	**36.50**	**16.32**	**23.93**	**0.68**	**2.53**	**0.0190**	**0.80**	**49.13**	**2.05**	**0.17**	**2.04**	**1.02**	**6.21**	**74.46**	**37.23**	**43.44**
5	**92.08**	**73.66**	**5**	**18.25**	**23.66**	**25.41**	**0.93**	**3.11**	**0.0190**	**1.08**	**87.33**	**3.44**	**0.65**	**7.40**	**3.70**	**11.86**	**135.05**	**67.53**	**79.39**
4	**104.42**	**98.25**	**1**	**3.65**	**28.56**	**26.36**	**1.08**	**3.44**	**0.0190**	**1.26**	**116.49**	**4.42**	**1.12**	**16.10**	**8.05**	**4.09**	**58.77**	**29.38**	**33.47**
3	**118.61**	**111.52**	**1**	**3.65**	**31.04**	**26.83**	**1.16**	**3.59**	**0.0190**	**1.34**	**132.22**	**4.93**	**1.47**	**23.01**	**11.51**	**5.37**	**83.99**	**42.01**	**47.38**
2	**143.28**	**130.94**	**1**	**3.65**	**34.53**	**27.47**	**1.26**	**3.79**	**0.0190**	**1.46**	**155.24**	**5.65**	**2.03**	**36.46**	**18.23**	**7.41**	**133.08**	**66.54**	**73.95**
1.5	**164.65**	**153.97**	**0.5**	**1.83**	**38.46**	**28.18**	**1.37**	**4.00**	**0.0190**	**1.58**	**182.55**	**6.48**	**2.76**	**58.99**	**29.49**	**5.04**	**107.66**	**53.82**	**58.86**
1	**186.20**	**175.43**																	
0.9	**188.22**	**187.21**																	
0.8	**194.48**	**191.35**																	
0.7	**199.46**	**196.97**																	
0.6	**210.69**	**205.07**																	
0.5	**224.13**	**217.41**																	
0.25	**0.00**	**0.00**	**0.25**	**0.91**	**0.57**	**10.93**	**0.05**	**0.52**		**0.06**		**0.00**	**0.00**	**0.00**	**0.00**				
0.1	**0.00**	**0.00**	**0.15**	**0.55**	**0.57**	**10.93**	**0.05**	**0.52**		**0.06**		**0.00**	**0.00**	**0.00**	**0.00**				
0.05	**0.00**	**0.00**	**0.05**	**0.18**	**0.57**	**10.93**	**0.05**	**0.52**		**0.06**		**0.00**	**0.00**	**0.00**	**0.00**				
0.01	**0.00**	**0.00**	**0.04**	**0.15**	**0.57**	**10.93**	**0.05**	**0.52**		**0.06**		**0.00**	**0.00**	**0.00**	**0.00**				
0.005	**0.00**	**0.00**	**0.005**	**0.02**	**0.57**	**10.93**	**0.05**	**0.52**		**0.06**		**0.00**	**0.00**	**0.00**	**0.00**				
0.001	**0.00**	**0.00**	**0.004**	**0.01**	**0.57**	**10.93**	**0.05**	**0.52**		**0.06**		**0.00**	**0.00**	**0.00**	**0.00**				

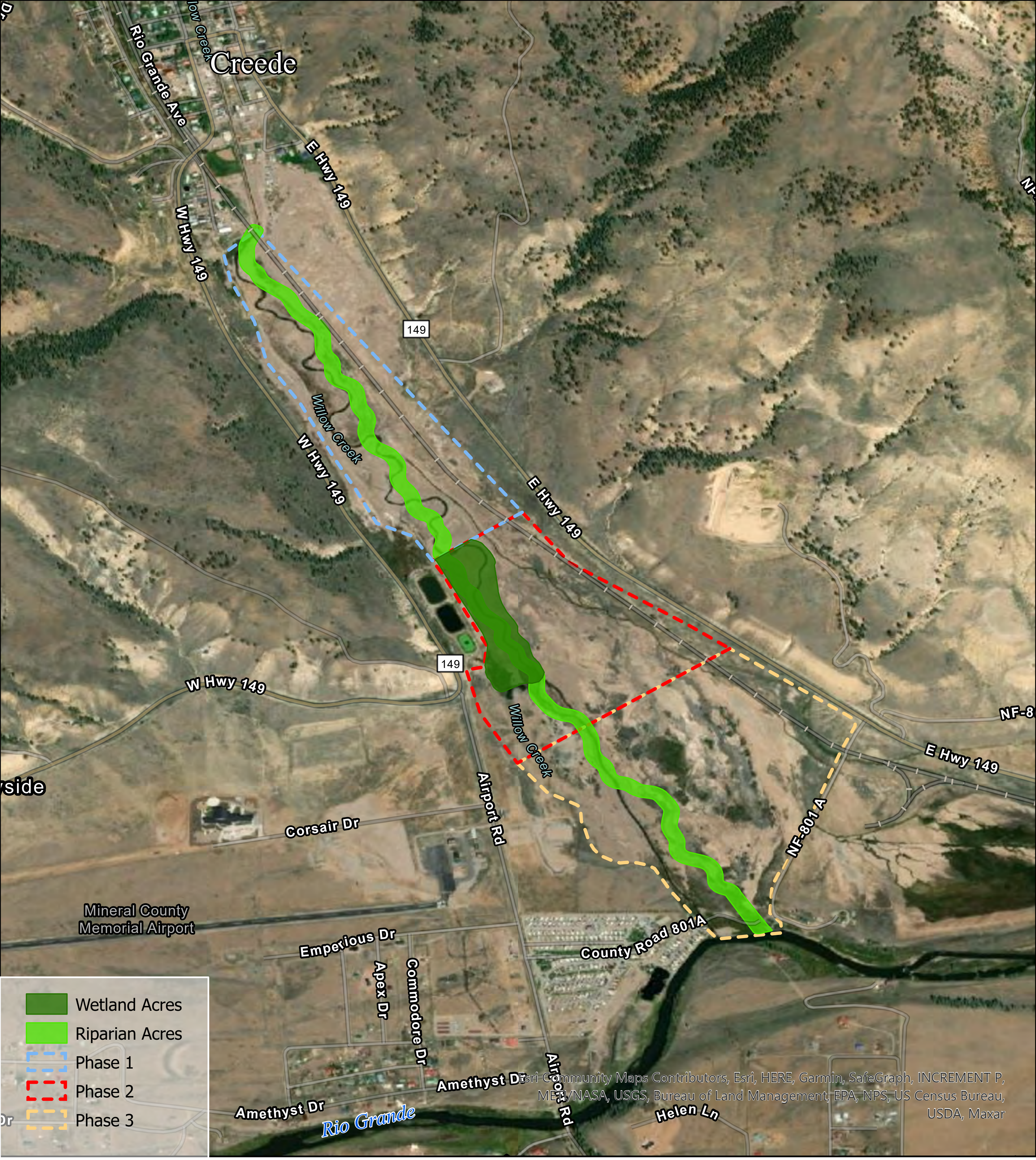
Notes:

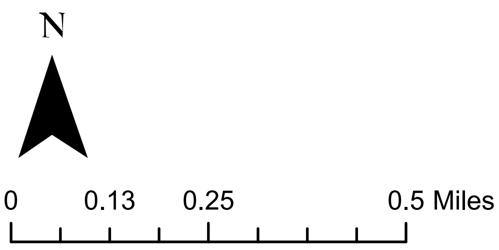
	(17)	(18)	(19)	(20)
Total Annual Sediment Transport Capacity (Bedload and Suspended Sand Sediment) for Evaluation Condition (tons/yr):	**46.3**	**683.2**	**341.2**	**387.5**
Total Annual Sediment Transport Capacity for Comparative Condition (tons/yr) (Comparative Worksheet):	**29.3**	**601.5**	**300.8**	**330.1**
Difference in Sediment Transport Capacity (tons/yr) (+ / -):	**17.0**	**81.7**	**40.4**	**57.4**
Stability Evaluation – Stable, Aggradation, or Degradation:	**Degradation**			



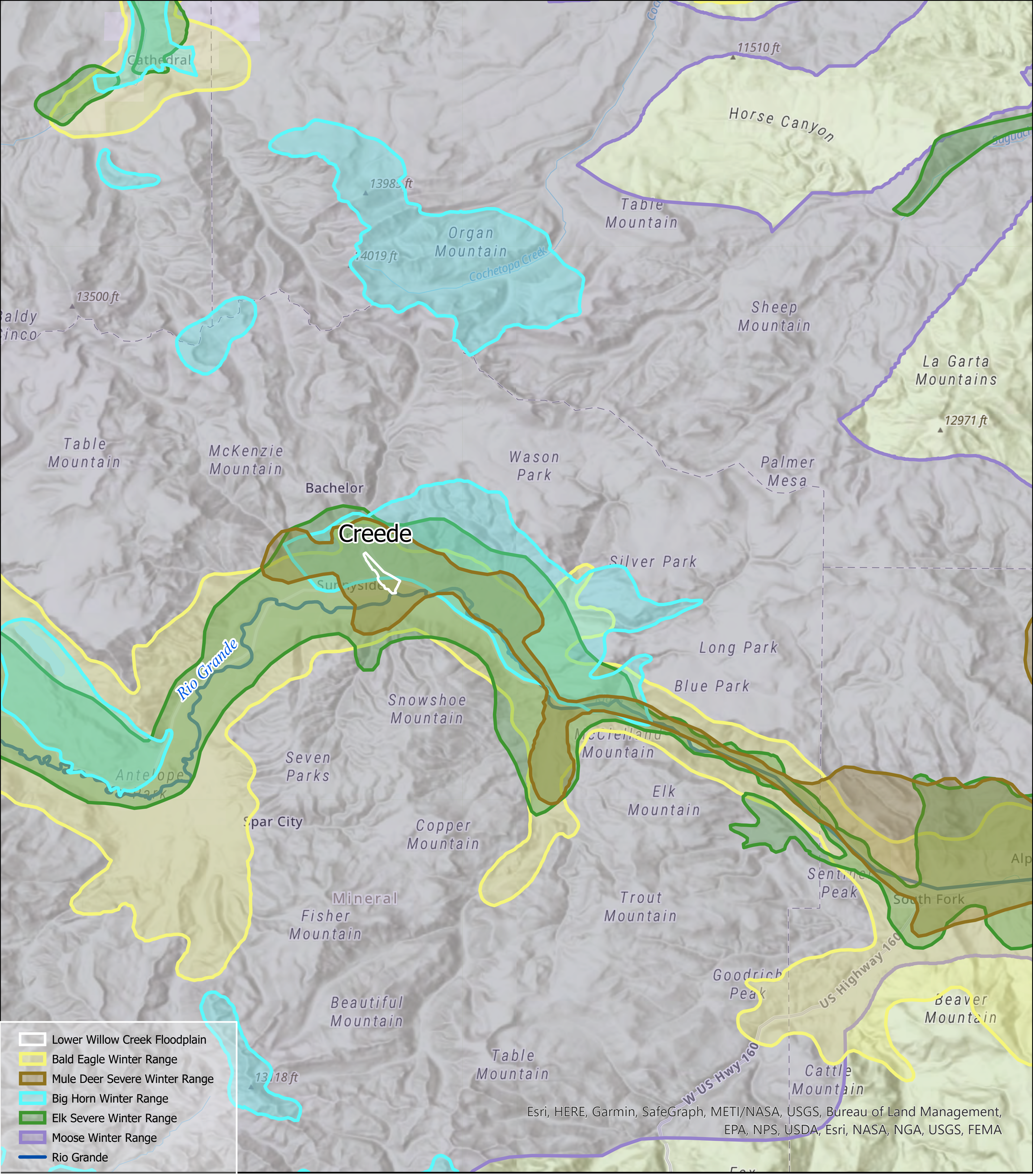
Lower Willow Creed Floodplain
Parcels and Properties
Creede, Mineral County, CO

HEADWATERS ALLIANCE CREEDE, CO





Lower Willow Creed Floodplain
Wetland and Riparian Acres Restored
Project Phases
Creede, Mineral County, CO



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Lower Willow Creek Floodplain
Large Mammal Winter and Severe Winter Ranges
Creede, Mineral County, CO

HEADWATERS ALLIANCE
CREEDE, CO