



2023 319 Application Form - General and Focus Watershed

General Information

Project Name Lower O'Brien Creek Stream Restoration- Crossing Upgrade

Sponsor Name Clark Fork Coalition

Registered with the Secretary of State? ☐ Y

Registered with SAM? ☐ Y

UEI # J389TMMMS3J5

Does your organization have liability insurance? ☐ Y

Primary Contact Jed Whiteley

Signatory Karen Knudsen

Title Project Manager

Title Executive Director

Address 140 S 4th St W #1

Address 140 S 4th St W #1

City Missoula State ☐ MT Zip Code 59801

City Missoula State ☐ MT Zip Code 59801

Phone Number 406-531-0256

Phone Number 406-

Email Address jed@clarkfork.org

Email Address karen@clarkfork.org

Signature Jed Whiteley Digitally signed by Jed Whiteley
Date: 2022.10.07 15:55:32 -06'00'

Signature Karen Knudsen Digitally signed by Karen Knudsen
Date: 2022.10.07 15:56:34 -06'00'

Technical and Administrative Qualifications

CFC brings an experienced technical and grant management team to these projects and a proven track record of performance on government funded projects during its 37 year history. This team includes a full time accountant/grants manager and a development director. CFC's Bring back the Bitterroot campaign is led by CFC's PM Jed Whiteley. Jed has completed over \$15 million dollars of restoration projects in Western Montana and the Idaho Panhandle. He is Rosgen Level III certified with 20 years experience in overseeing heavy equipment driven stream restoration. Adam Switalski and Will McDowell round out CFC's Bitterroot project management team with over 50 years of restoration experience between them.

Budget Summary: *Fields outlined in **black** on this page will auto-populate from other sections of the application form. Fields outlined in **red** on this page will not auto-populate. You must manually input the information for fields outlined in **red**.

	319 Funding Request	Non-Federal Match	Other Funding	Total Cost
Education and Outreach Project	\$ 0	\$ 0	\$ 0	\$ 0
Administration	\$ 0	\$ 0	\$ 0	\$ 0

Project 1 Name	O'Brien Creek Stream Crossing Upgrade			
Project Planning	\$ 3,000	\$ 2,000	\$ 0	\$ 5,000
Landowner Agreements	\$ 0	\$ 0	\$ 0	\$ 0
Project Implementation	\$ 35,000	\$ 23,350	\$ 0	\$ 58,350
Project Effectiveness Monitoring	\$ 0	\$ 0	\$ 0	\$ 0
Total	\$ 38,000	\$ 25,350	\$ 0	\$ 63,350

Project 2 Name				
Project Planning				\$ 0
Landowner Agreements				\$ 0
Project Implementation Project				\$ 0
Effectiveness Monitoring				\$ 0
Total	\$ 0	\$ 0	\$ 0	\$ 0

Project 3 Name				
Project Planning				\$ 0
Landowner Agreements				\$ 0
Project Implementation Project				\$ 0
Effectiveness Monitoring				\$ 0
Total	\$ 0	\$ 0	\$ 0	\$ 0

Project 4 Name				
Project Planning				\$ 0
Landowner Agreements				\$ 0
Project Implementation Project				\$ 0
Effectiveness Monitoring				\$ 0
Total	\$ 0	\$ 0	\$ 0	\$ 0

Grand Total	\$ 38,000	\$ 25,350	\$ 0	\$ 63,350
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Education and Outreach

Developing good projects often requires a considerable amount of time and effort up front to build relationships and trust with individual landowners and stakeholder groups. It also requires adequate training for project sponsor staff (e.g., technical training, project management, public procurement, technical writing, etc). To promote the development of future projects, DEQ is encouraging project sponsors to use up to \$5,000 in 319 funding for education and outreach to develop and capitalize on critical relationships and to improve organizational capacity. DEQ also encourages applicants to incorporate on-the-ground projects into education and outreach efforts through on-site demonstrations and project tours. 319 funding may not be used to pay for food and beverages, or for honorariums and gifts.

Activity (method of delivery)	CFC has already been awarded \$5,000 in 319 funding for E&O for the O'Brien Creek Meadows project and we believe there is not a need to ask for more funding. <ul style="list-style-type: none">• Personal meetings/ phone calls/ emails• Create virtual tour
Target Audience	People on high-priority reaches of O'Brien Creek
Goals	To open additional reaches of the creek to restoration and promote good stewardship of the riparian corridor.
Effectiveness Evaluation	Document how many times virtual tour is shown and to whom Document meetings with landowners
Activity (method of delivery)	
Target Audience	
Goals	
Effectiveness Evaluation	

Activity (method of delivery)

Target Audience

Goals

Effectiveness Evaluation

319 Funding
Request

Non-Federal
Match

Other
Funding*

Total

\$ 0	\$ 0		\$ 0
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Match Source _____

Secured ☐

Match Source _____

Secured ☐

Match Source _____

Secured ☐

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Administration

Project administration includes book keeping, invoicing, interim/annual/final report preparation, office supplies, rent, communications, etc. 319 funding applied to this task must not exceed 10% of the total amount of 319 funding requested, or \$12,000, **whichever is lower**. Like all other tasks, payment is by reimbursement for actual expenses incurred.

319 Funding Request	Non-Federal Match	Other Funding*	Total Cost
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="\$ 0"/>
Match Source _____			Secured <input type="checkbox"/>
Match Source _____			Secured <input type="checkbox"/>

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project 1

Project Form

A separate Project Form (***including providing separate attachments***) must be submitted for each project included in your application. Use the following examples to help determine when to lump and when to split projects. For additional assistance, contact Mark Ockey at mockey@mt.gov or 406-444-5351.

Splitting Examples (fill out multiple Project Forms)

- Stream restoration work occurring on two separate streams, on parcels owned by two separate individuals
- Two projects with significantly different sets of project partners
- Two projects that address substantially different pollution sources (e.g., one project moves a corral off of a streambank, and another removes mine tailings, with both projects being on the same property)

Lumping Examples

- Contiguous stream restoration work spanning multiple land parcels
- 3 projects that address similar sources of pollution on a single land parcel (e.g., moving a corral off a stream, implementing a grazing management plan, and relocating a manure storage facility out of the floodplain, all on the same ranch)

Project 1 Name O'Brien Creek Stream Crossing Upgrade

Project 1 - Problem Description

Select the watershed restoration plan (WRP) that your project will help implement.

Bitterroot - Bitter Root Water Forum

NA

Letter of support from author entity attached? *(If no, explain why below.)*

Because the CFC, with support of the Lolo National Forest and members of the O'Brien Creek HOA, wrote the WRP for O'Brien Creek we felt it redundant and somewhat awkward to submit a letter from the authors in support of our own proposal. We'd be happy to provide a letter from the CFC, if it would assist these efforts. We do have substantive support letters attached from other relevant stakeholders.

Waterbody name from the 2020 List of Impaired Waters

Bitterroot River

Probable causes of impairment to be addressed

Temperature

Waterbody name from the 2020 List of Impaired Waters

Probable causes of impairment to be addressed

Name of healthy waterbody to be protected

O'Brien Creek

Description of identified threat to non-impairment status

This stream is currently being assessed by the DEQ for sediment and habitat impairment. Identified threats from the Lolo NF's assessment include sediment / siltation and alteration in stream-side vegetative cover

Name of healthy waterbody to be protected

Bitterroot River

Description of identified threat to non-impairment status

Recently delisted for sediment/siltation

Detailed Problem Description

Provide a detailed description of the nonpoint source pollution problem you are attempting to address. Be sure to include the following:

- Identify the primary types of pollution
- Identify the primary sources of the pollution
- Identify the root causes of the pollution
- Describe any previous work done to address the problem (who, what, where, when)
- Describe the impacts of the problem (who, what, where)

The 25.4 square-mile O'Brien Creek watershed in Missoula County is an important tributary to the Bitterroot River due to it being a stronghold for native Westslope cutthroat trout. Landownership along the creek includes public ownership on U.S. Forest Service land in the middle and headwaters reaches, and private parcels of various sizes in the lower watershed. The Creek has experienced extensive human uses for more than a century, including a railroad in the valley bottom for timber extraction, a grain mill at the confluence with the Bitterroot, severe manipulation from ditching and irrigation withdrawals, road development and timber harvest in the uplands, among others uses.

These land uses contributed to development of several sources of nonpoint pollution. Sediment from eroding stream banks and upland sources produce sediment at levels high enough to smother fish spawning redds and macroinvertebrate habitat. Sediment sources include bank failures, stream entrenchment and incision, road washouts, and a loss of riparian vegetation and resultant bank erosion (Bitterroot Watershed Restoration Plan, 2020).

Public and private landowners also experience ongoing issues with nonpoint sediment pollution, as found in a 2019 O'Brien Creek habitat assessment by Lolo National Forest. Sediment pollution is causing aggradation and frequent flooding, which washes fertilizers and herbicides into the creek and ultimately the Bitterroot River. In 2019, residents of the O'Brien Creek Meadows HOA filed for an emergency 310 permit after a 12 ft tall, 55 ft long bank failed and deposited large amount of sediment above Tripple Creek Road crossing. This crossing is undersized (see USFS and RDG modeling reports, attached) and the combination of the high flow event and sediment deposition from the failed bank caused O'Brien Creek to back up behind the crossing, increase erosion, and flood their common area and adjacent roadways. In several areas, the stream is entrenched and roads encroach the stream or flood-prone areas. This causes chronic delivery of sediment from eroding banks, roadbeds, and road fills into the stream, and there is at least one serious bank failure that needs immediate remediation.

The O'Brien Creek Homeowners Association approached the Clark Fork Coalition to assist with bank erosion, stream incision, aggradation, and avulsion problems in this reach. The Clark Fork Coalition was awarded 319 funding in 2022 to restore natural stream channel and floodplain function to a 2,500 ft reach of O'Brien Creek by working with the O'Brien Creek Meadows HOA and the upstream landowner. The project will reduce sediment loading, improve riparian and instream wildlife habitat, and dissipate flood energy. While planning for implementation, USFS models (Attachment X) determined that restoring floodplain function and addressing sources of erosion alone would be insufficient at preventing sediment aggradation and flooding above the Tripple Creek Road crossing. Taking feedback from last year's 319 review panel, the Clark Fork Coalition had already reached out to Missoula County about providing funding to upsize this culvert, but because the crossing services ~30 landowners, it is low on their priority list and funding is unavailable.

The Clark Fork Coalition proposes to augment the current 10 ft diameter corrugated metal pipe (CMP) that conveys O'Brien Creek under Tripple Creek Rd by adding two 36" flood relief culverts. USFS models support that the relief culverts will allow a 100-year flood event to pass through the crossing without backwatering. The current 10 ft culvert is undersized and causing significant backwatering at events over a 5-year flood event, inhibiting sediment transport and leading to significant aggradation in the reach upstream of the culvert.

The initial 100-year flood event generated by USGS Streamstats software was 548 cfs, which we believed to be much higher than the actual 100-year flood event for the watershed. We worked with a hydrologist from the Lolo National Forest and his models came up with a 100-year flood event of just over 300 cfs (attached). River Design Group has run extensive modeling (see attached) on the crossing based on this new 100-year flow, and from the models, we have determined that the most cost-effective approach is to install two 36" culverts parallel to the existing culvert. The rest of the restoration project has a final design, permits, and is ready for implementation once funding is secured to upgrade the crossing. The only maintenance we anticipate with the crossing upgrade phase of the project is possible cleaning of the relief culverts after a 10+ year flow event, which will fall to the HOA and Missoula County Roads Department.

Project 1 - Solution Description

Provide a detailed description of the solution you are proposing to implement to address the nonpoint source pollution problem described in the previous section. Be sure to include the following:

- Describe the range of options available for solving the problem, including a no-action alternative
- Describe the practices you intend to design and/or implement to solve the problem (what, where, when, how much or how many)
- Explain why the chosen alternative is the best alternative
- Describe any pre-project planning that has already taken place (e.g., design work, permitting consultation, Endangered Species Act consultation, wetland delineations, landowner agreements, community outreach)
- Describe the anticipated maintenance needs (what, where, who, how long)

The Clark Fork Coalition proposes to augment the current 10 ft diameter corrugated metal pipe (CMP) that conveys O'Brien Creek under Tripple Creek Rd by adding two 36" flood relief culverts that will allow a q100 flow event to pass through the crossing without backwatering. The current culvert is undersized and causing significant backwatering at events over a q5, inhibiting sediment transport and leading to significant aggradation in the reach upstream of the culvert.

The initial q100 generated by Streamstats was 548 cfs, which we believed to be much higher than the actual 100 year flood event for the watershed. We worked with a hydrologist from the Lolo National Forest and both of his models came up with a q100 of just over 300 cfs (attached). River Design Group has run extensive modeling (see attached) on the crossing based on this new q100 and from the models we have determined that the most cost effective approach is to install two 36" culverts parallel to the existing culvert. The rest of the restoration project has a final design, permits filled out and is ready to go to implementation once funding is secured to upgrade the crossing. The only maintenance we anticipate with the crossing upgrade phase of the project is possible cleaning of the relief culverts after a q10+ flow event, which CFC owns the proper equipment to carry out.

Project 1 - Goals and Effectiveness Evaluation

List the specific, measurable nonpoint source goals for your project.

O'Brien Creek:

-Reduce tons / yr sediment delivery from stream bank erosion

(currently 1-2 orders of magnitude above natural levels - From Bitterroot WRP).

Explain how you will determine whether the you have met the goals described above. Identify any data you intend to collect, calculations you'll make, or methods you intend to use.

Reductions in tons/yr of sediment measured through BEHI surveys. DEQ collected pre-project BEHI data on the project reach, and data will be used to estimate post-project conditions and the sediment load reduction. Preliminary analysis suggests an approximate 16 tons/yr sediment load reduction.

Project 1 - Location

Upstream End	Latitude	<input type="text" value="46.847557"/>	Longitude	<input type="text" value="-114.118240"/>
Downstream End	Latitude	<input type="text" value="46.84972"/>	Longitude	<input type="text" value="-114.11002"/>
Centerpoint	Latitude	<input type="text" value="46.848087"/>	Longitude	<input type="text" value="114.114415"/>
Upstream End	Latitude	<input type="text"/>	Longitude	<input type="text"/>
Downstream End	Latitude	<input type="text"/>	Longitude	<input type="text"/>
Centerpoint	Latitude	<input type="text"/>	Longitude	<input type="text"/>
Upstream End	Latitude	<input type="text"/>	Longitude	<input type="text"/>
Downstream End	Latitude	<input type="text"/>	Longitude	<input type="text"/>
Centerpoint	Latitude	<input type="text"/>	Longitude	<input type="text"/>

List the 12-digit Hydrologic Unit Code(s) (HUCs) in which the project area is located

170102051602



Detailed Project site map(s) Attach a map or set of maps showing the location and size of proposed activity. The map scale must be between 1:1,000 and 1:12,500. The map(s) must have an aerial photo background (e.g., USDA NAIP photography, Google Earth imagery, etc.). The map(s) must show the latitude, longitude, site name, and landowner for the activity site. The map(s) should also identify waterbodies affected by the pollution that the activity is designed to address.

Other Attachments - (These documents are not required, but may be submitted to provide more specific details about a project or to demonstrate adequate planning and preparation; please, however, be respectful of the amount of time it will take an application reviewer to find relevant information within a document and use excerpts where appropriate; do not attach WRPs, TMDLs or other large-scale planning documents)

<input checked="" type="checkbox"/>	RDG Flow modeling of crossing
<input checked="" type="checkbox"/>	Construction Estimate
<input checked="" type="checkbox"/>	Final Restoration Plan Set
<input checked="" type="checkbox"/>	Lolo NF q100 estimates for O'Brien Creek
<input checked="" type="checkbox"/>	RDG modeling email

Project 1 - Partners

Identify each of the project partners and describe their contribution to the project. Include landowners, land managers, project designers, funders, and your own organization. Indicate whether each partner, other than your organization, has provided a letter of support. (*Note: each landowner must provide a letter of support.*)

Landowner	Contributions to Project	Letter of Support Attached?
O'Brien Creek Meadows HOA	Landowner, contributor to WRP and funder	<input checked="" type="checkbox"/>
Hillsdales Estates POA, solely owned by Carolyn Diddel	Landowner, timber for structures	<input checked="" type="checkbox"/>
		<input type="checkbox"/>
		<input type="checkbox"/>

Project Partner	Contributions to Project	Letter of Support Attached?
Westslope Chapter of Trout Unlimited	Project supporter, volunteers and potential funds contributor	<input checked="" type="checkbox"/>
Montana Fish Wildlife and Parks	Project funding through Future Fisheries program, assists with project design and monitors the fishery	<input type="checkbox"/>
Missoula Valley Water Quality District	Project supporter, monitors water quality on O'brien Creek	<input checked="" type="checkbox"/>
		<input type="checkbox"/>
		<input type="checkbox"/>

Project 1 - Budget

Use the space below to outline your project budget.

Project Planning This includes costs for surveying, engineering, permitting, procurement, construction oversight, and overall coordination of the proposed project. This does not include things like reporting, book keeping, communications, office space, or utilities, which are all covered in the Project Administration budget.

319 Funding Request	Non-Federal Match	Other Funding*	Total Cost
\$ 3,000	\$ 2,000		\$ 5,000
Match Source _____			Secured <input type="checkbox"/>
Match Source _____			Secured <input type="checkbox"/>
Match Source _____			Secured <input type="checkbox"/>
Match Source _____			Secured <input type="checkbox"/>

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Landowner Agreements This includes costs for developing and managing landowner agreements. The landowner agreement(s) must verify that Contractor and DEQ staff may access the project site, at reasonable times and with prior notification, for the purposes of project planning, implementation, and post-implementation monitoring. The agreement(s) must ensure appropriate operation and maintenance of all structures, vegetation, and management measures for the life of the project. If grazing will be allowed within the project area, the agreement(s) must include a sustainable management plan for livestock grazing, designed to protect and enhance riparian function.

319 Funding Request	Non-Federal Match	Other Funding*	Total Cost
\$ 0	\$ 0		\$ 0
Match Source _____			Secured <input type="checkbox"/>
Match Source _____			Secured <input type="checkbox"/>
Match Source _____			Secured <input type="checkbox"/>
Match Source _____			Secured <input type="checkbox"/>

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Implementation This includes costs for all materials, labor, equipment, and as-built surveys associated with implementing the plans developed under the Project Planning task. If you are requesting funding for design only, leave this task blank.

319 Funding Request	Non-Federal Match	Other Funding*	Total Cost
\$ 35,000	\$ 23,350		\$ 58,350

Match Source	Westslope Chapter Trout Unlimited	Secured	<input type="checkbox"/>
Match Source	Future Fisheries	Secured	<input type="checkbox"/>
Match Source	CFC	Secured	<input checked="" type="checkbox"/>
Match Source		Secured	<input type="checkbox"/>

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Effectiveness Monitoring This includes costs for developing and implementing a reasonable method or set of methods for evaluating and reporting on the effectiveness of the project in achieving NPS pollution goals. It includes preparation and implementation of a monitoring plan, and preparation of a monitoring report. If the project goals include reducing sediment, nitrogen and/or phosphorus, this task will also include calculation of annual load reduction estimates. Photo-point monitoring is also a standard requirement for this task. If you are requesting funding for design only, you may either leave this task blank or request funding for plan development and pre-project monitoring.

319 Funding Request	Non-Federal Match	Other Funding*	Total Cost
\$ 0	\$ 0		\$ 0

Match Source		Secured	<input type="checkbox"/>
Match Source		Secured	<input type="checkbox"/>
Match Source		Secured	<input type="checkbox"/>
Match Source		Secured	<input type="checkbox"/>

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project 1 - Project Timeline

Task Description	3Q 2023	4Q 2023	1Q 2024	2Q 2024	3Q 2024	4Q 2024	1Q 2025	2Q 2025	3Q 2025	4Q 2025	1Q 2026	2Q 2026
Project Planning	✓											
Project Implementation	✓	✓										

Project 1 - Bigger Picture Benefits

Environmental Justice

Explain how your project incorporates disadvantaged community populations and priorities, Tribal and community leader engagement, or socioeconomic barriers in the context of equal protection and access to a healthy environment.

There is not a strong environmental justice component to this project.

Climate Change/Resilience

How will your project improve climate change resilience for communities, native plants, wildlife, or ecosystems?

Upsizing the capacity of Tripple Creek Road crossing will increase resiliency of O'Brien Creek to the flashier stream flows that are predicted under a changing climate. The project as a whole will improve riparian vegetation and fish habitat and allow the creek to access its floodplain. These activities increase the opportunity for groundwater storage and provide shade for cooler stream temperatures, especially during drought years.

Impacts to Downstream Human, Plant and Animal Communities

What sort of an impact will your project have on downstream human, plant or animal communities?

O'Brien Creek flows into the Bitterroot River within one mile of the confluence with the Clark Fork River. Both the Bitterroot and Clark Fork Rivers are an incredible resource that are readily accessible for the public to recreate on and in due to Montana's excellent stream access laws. O'Brien Creek is relatively cold, and as such, is a priority fishery, despite a long history of detrimental impacts. By reducing the source of sediment to the creek and improving stream conditions, this project, coupled with potential future projects, can provide substantive improvements to the overall health of both the Bitterroot and Clark Fork River fishery, stream conditions, and water quality.

Map



IMAGE: DigitalGlobe 2016

1 OBRIEN CREEK PLAN VIEW
1" = 200'

O'BRIEN CREEK WATERSHED DESCRIPTION

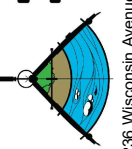
THE O'BRIEN CREEK WATERSHED ENCOMPASSES 25.4 SQUARE MILES AND IS A MAJOR TRIBUTARY TO THE BITTERROOT RIVER UPSTREAM OF THE CONFLUENCE WITH THE CLARK FORK RIVER. ONE OF THE MOST IMPORTANT TRIBUTARIES IN THE LOWER BITTERROOT RIVER FOR RAINBOW AND CUTTHROAT TROUT (MT FWP, 2019), LAND OWNERSHIP IN THE WATERSHED IS A MIX OF US FOREST SERVICE AND PRIVATE OWNERSHIP. SIMILAR TO MOST FORESTED WATERSHEDS IN THE REGION, O'BRIEN CREEK HAS EXPERIENCED HUMAN-CAUSED IMPACTS FROM FORESTRY, GRAZING, MILL OPERATIONS, DEWATERING, CHANNELIZATION, AND DEVELOPMENT. IN THE LOWER WATERSHED, WATER MANIPULATION AND WITHDRAWALS CREATED FLOW INTERMITTENCY AND CHANNEL DEWATERING. RECENT EFFORTS TO BRING AWARENESS TO THIS ISSUE, AND SENIOR WATER RIGHT PURCHASES, HAVE RETURNED PERENNIAL OR YEAR-ROUND FLOW TO ALL REACHES OF O'BRIEN CREEK.

PROJECT BACKGROUND


STREAM INVENTORIES COMPLETED BY THE US FOREST SERVICE IN 2019 IDENTIFIED OPPORTUNITIES TO IMPROVE AQUATIC HABITAT AND STREAM CHANNEL CONDITIONS THROUGHOUT THE O'BRIEN CREEK WATERSHED (USFS, 2019). THESE EFFORTS WERE UNDERTAKEN, IN PART, TO SUPPORT TMDL SEDIMENT LOAD REDUCTION TARGETS FOR THE BITTERROOT RIVER, WHICH HAS BEEN IDENTIFIED AS AN IMPAIRED WATERBODY BY THE MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY. EPISODIC MASS FAILURE EVENTS HAVE OCCURRED IN THE O'BRIEN CREEK WATERSHED, INCLUDING A MASSIVE BANK FAILURE IN 2019 THAT RESULTED IN LARGE-SCALE CHANNEL DEPOSITIONS AND INSTABILITY IN THE LOWER REACHES OF O'BRIEN CREEK UPSTREAM OF TRIPPLE CREEK ROAD. AFTER THE BANK FAILURE, THE O'BRIEN CREEK MEADOW HOMEOWNER'S ASSOCIATION WAS GRANTED A TWO-PHASE 310 PERMIT BY MISSOULA CONSERVATION DISTRICT TO CONDUCT EMERGENCY ACTIONS TO REMOVE

THE SUBSTRATE DEPOSITION. PHASE 1 WORK WAS COMPLETED IN 2019 AND INVOLVED REMOVING SUBSTRATE DEPOSITION AND RETURNING WOOD TO THE CHANNEL.

RIVER DESIGN GROUP, INC. WAS RETAINED BY CLARK FORK COALITION, IN PARTNERSHIP WITH PRIVATE LANDOWNERS AND MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, TO PREPARE RESTORATION PLANS FOR IMPLEMENTATION OF PHASE 2 WORK WHICH HAS NOT BEEN COMPLETED AND WILL INVOLVE REHABILITATING THE CHANNEL TO IMPROVE STREAM FUNCTION AND REDUCE OR ALTOGETHER ELIMINATE THE NEED FOR FUTURE MAINTENANCE. CONCEPTUAL RESTORATION PLAN DRAWINGS INCLUDED IN THIS PLAN SET ILLUSTRATE THE PREFERRED RESTORATION ALTERNATIVE FOR THE SITE, WHICH INCLUDES RESTORING CONDITIONS THAT SUPPORT THE RECOVERY OF RIVER, FLOODPLAIN, AND AQUATIC HABITAT CONDITIONS.



RDG
RIVER DESIGN GROUP
236 Wisconsin Avenue
Whitfish, MT 59837
406.862.4927



EXISTING CONDITIONS
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM
PROJECT NUMBER RDG-21-169				
DRAWING NUMBER 2.0				
Drawing 2 of 22				

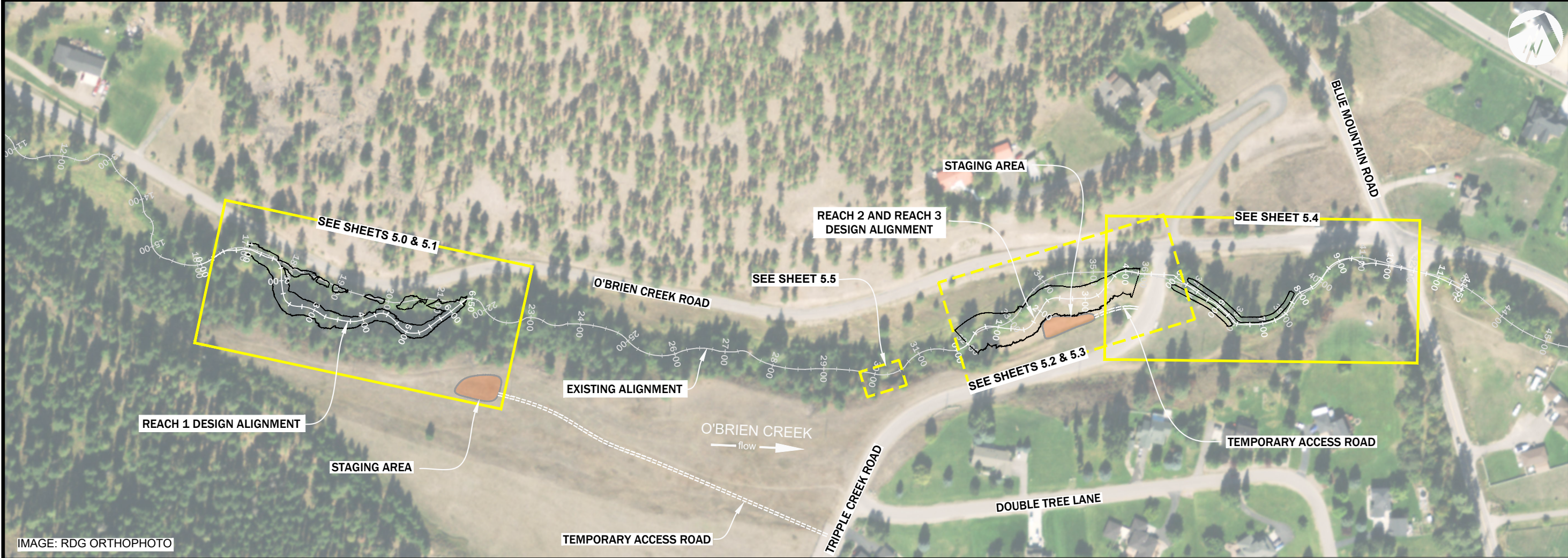
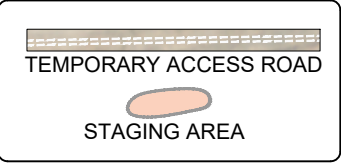


IMAGE: RDG ORTHOPHOTO



LEGEND



NOTES: CONTRACTOR IS RESPONSIBLE FOR MAINTAINING ACCESS ROADS AND TEMPORARY HAUL ROADS. EQUIPMENT, MAINTENANCE AND MATERIALS TO BE STAGED MINIMUM 150' FROM RIVER.

RESTORATION GOALS

THE O'BRIEN CREEK RESTORATION DESIGN ADDRESSES LIMITING FACTORS IDENTIFIED BY PROJECT STAKEHOLDER BASED ON PREVIOUS STUDIES AND INVESTIGATIONS. THE PRIMARY GOALS OF THE PROJECT ARE TO RESTORE CHANNEL AND FLOODPLAIN CONDITIONS THAT SUPPORT HIGH QUALITY AQUATIC HABITAT CONDITIONS, PROMOTE THE ESTABLISHMENT OF A DIVERSE RIPARIAN FLOODPLAIN CORRIDOR THAT IS HYDROLOGICALLY CONNECTED TO THE CHANNEL, AND IMPROVE WATER QUALITY TO SUPPORT DOWNSTREAM BENEFICIAL USES. SPECIFIC GOALS FOR THIS PROJECT INCLUDE:

- REDUCE SEDIMENT LOADING TO O'BRIEN CREEK BY: 1) REALIGNING O'BRIEN CREEK THROUGH HISTORICAL MEANDER SCROLLS IN ORDER TO ISOLATE THE CHANNEL FROM CHRONIC SOURCES OF SEDIMENT ASSOCIATED WITH O'BRIEN CREEK ROAD; AND 2) ISOLATING O'BRIEN CREEK FROM ROTATIONAL SLOPE FAILURES THROUGH FLOODPLAIN CONSTRUCTION.
- CONSTRUCTING A NEW MODERATELY ENTRENCHED, RIFFLE-POOL, B3 STREAM TYPE WITHIN A TERRACED VALLEY, CONNECTED TO A BROAD AND WELL-VEGETATED BANKFULL FLOODPLAIN.
- IMPLEMENTING STREAMBANK, FLOODPLAIN, AND RIPARIAN REVEGETATION TECHNIQUES TO INCREASE THE COVER OF WOODY RIPARIAN SHRUBS AND TREES.
- REDUCING FLOOD HAZARD RISK TO PRIVATE PROPERTY BY CREATING A FUNCTIONAL, INSET FLOODPLAIN THAT IS CONNECTED TO THE CHANNEL AND WILL PROVIDE FLOOD ENERGY DISSIPATION.

RESTORATION TREATMENTS

RESTORATION WILL OCCUR ALONG 0.3 MILES OF O'BRIEN CREEK AND WILL BE COMPLETED IN THE DRY DURING FALL 2022. IMPLEMENTATION WILL BE CLOSELY INTEGRATED WITH CLARK FORK COALITION, MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, PRIVATE LANDOWNERS, AND STAKEHOLDERS. IN REACH 1, O'BRIEN CREEK IS CHANNELIZED AND IS BRACKETED AGAINST THE O'BRIEN CREEK ROAD FILLSLOPE, A CHRONIC SOURCE OF SEDIMENT AND OTHER POLLUTANTS TO O'BRIEN CREEK. IN THIS REACH, THE CHANNEL WILL BE RELOCATED TO THE SOUTH THROUGH HISTORICAL CHANNEL SCROLLS AND RECONNECTED WITH WELL VEGETATED FLOODPLAIN SURFACES, INCREASING STREAM LENGTH BY 20%.

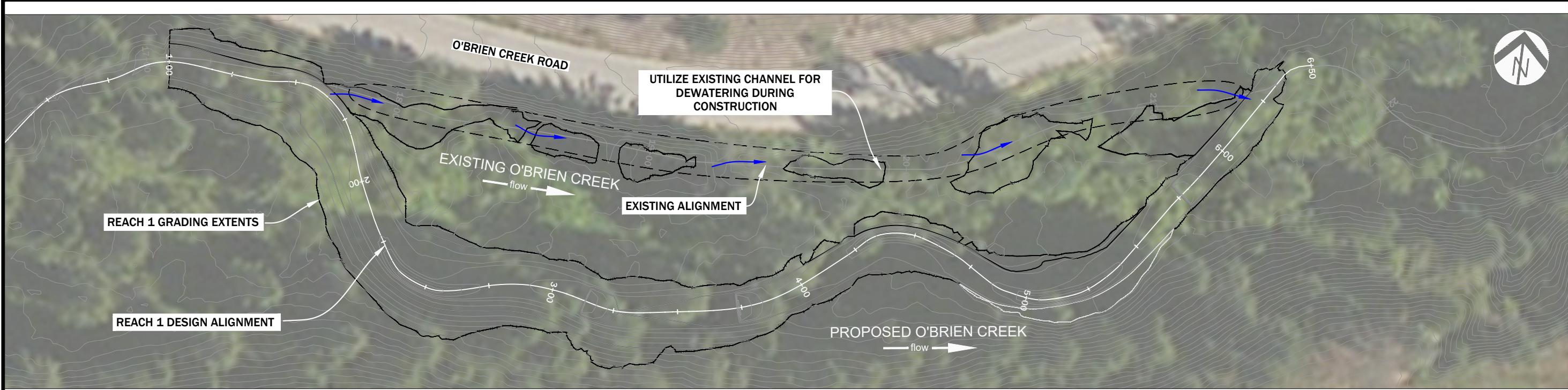
IN REACH 2, A NEW CHANNEL WILL BE CONSTRUCTED TO ADDRESS EXISTING IMPAIRMENTS INCLUDING DEGRADED HABITAT CONDITIONS, HIGH SEDIMENT LOADING FROM BANK EROSION, AND DECREASED SEDIMENT TRANSPORT CAPACITY. A MODERATELY ENTRENCHED, COBBLE DOMINATED, RIFFLE-POOL B3 STREAM TYPE WILL BE CONSTRUCTED WITHIN A BROAD, WELL VEGETATED FLOODPLAIN CORRIDOR. A VARIETY OF STREAMBED, STREAMBANK, FLOODPLAIN AND REVEGETATION TREATMENTS WILL BE IMPLEMENTED TO SUPPORT THE RESTORATION GOALS AND DESIRED OUTCOMES. TREATMENTS ARE NATIVE MATERIALS BASED AND DESIGNED TO MIMIC REFERENCE REACH CONDITIONS OBSERVED UPSTREAM IN RELATIVELY UNDISTURBED SEGMENTS OF O'BRIEN CREEK. STREAMBED TREATMENTS WILL CONSIST OF COMPLEX AQUATIC HABITAT FEATURES INCLUDING RIFFLES, PLUNGE POOLS, LATERAL POOLS AND GLIDES. STREAMBANK TREATMENTS WILL BE COMPOSED OF WOOD, ALLUVIUM, AND VEGETATION, AND WILL INCREASE BANK RESILIENCY TO EROSION. PROVIDING SHORT-TERM STREAMBED AND STREAMBANK STABILITY IS REQUIRED TO SUPPORT THE VEGETATION DESIGN WHICH EMPHASIZES CREATING A SELF-SUSTAINING MOSAIC OF RIPARIAN AND WETLAND COMMUNITIES ON A FLOODPLAIN SURFACE THAT IS HYDROLOGICALLY CONNECTED TO THE CHANNEL. FLOODPLAIN TREATMENTS WILL INCLUDE A VARIETY OF VEGETATION COVER TYPES THAT INTEGRATE PLANT SPECIES COMPOSITION WITH GEOMORPHOLOGY AND HYDROLOGY, AND ACCOUNT FOR ECOLOGICAL PROCESSES THAT SUPPORT PLANT COMMUNITY DEVELOPMENT OVER TIME.

ACTIVE CHANNEL RESTORATION IS NOT PROPOSED IN REACH 3. RESTORATION GOALS IN REACH 3 FOCUS ON LOWERING HIGH, ERODING BANKS TO BANKFULL ELEVATION, AND CREATING A 35-FT. WIDE, WELL-VEGETATED FLOODPLAIN CORRRIDOR THAT INTERACTS WITH THE CHANNEL AT BANKFULL STAGE.

SITE PLAN AND INDEX
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

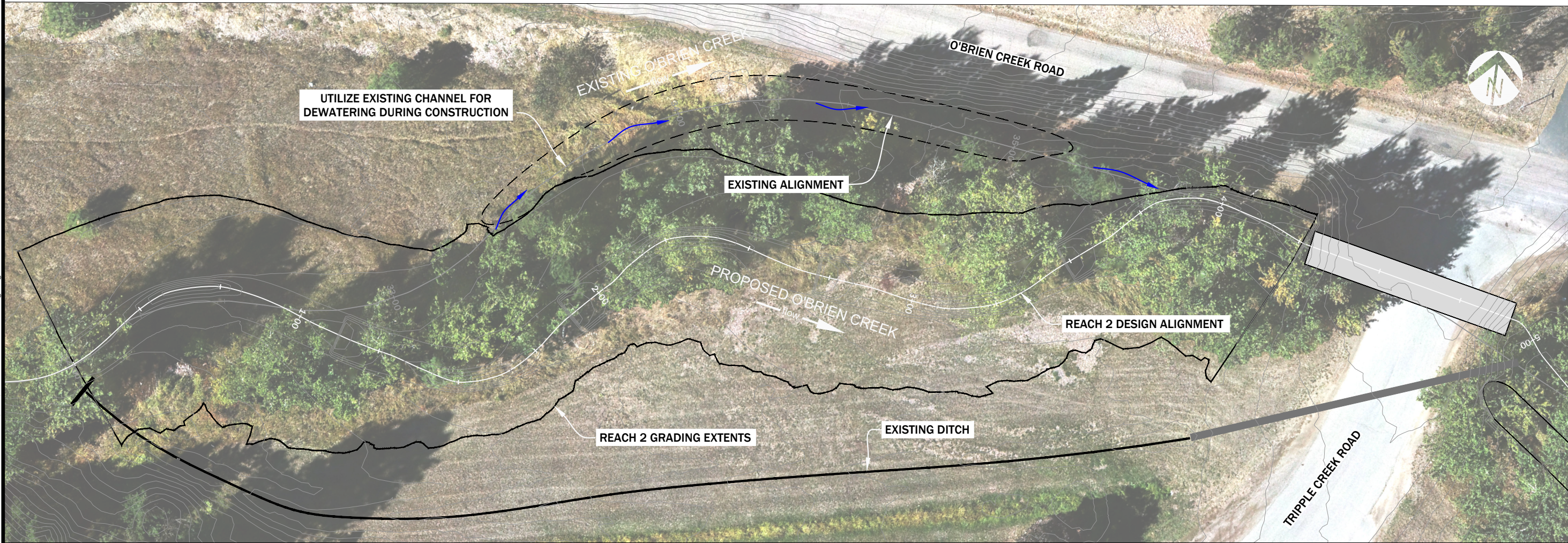
NO.	DATE	BY	DESCRIPTION	CHK		
					NW	JM
1	1/12/22	LS	DESIGN			
2	1/26/22	LS	DESIGN REVISION			

PROJECT NUMBER RDG-21-169
DRAWING NUMBER 3.0
Drawing 3 of 22



1 O'BRIEN CREEK PLAN VIEW - REACH 1

1" = 40'



1 O'BRIEN CREEK PLAN VIEW - REACH 2

1" = 30'

DEWATERING PLAN
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

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TOTAL WOOD QUANTITIES

ITEM	QUANTITY	DIAMETER	LENGTH	ROOTWAD
CATEGORY 1 WOOD	38	10 -14 IN	20 FT	YES
CATEGORY 2 WOOD	763	6 - 12 IN	20 FT	OPTIONAL
CATEGORY 3 WOOD	2,142	< 3 IN	10 - 12 FT	OPTIONAL
WILLOW CUTTINGS	8,485	0.25 - 1.0 IN	8 FT	NO

NOTE:
WOOD LENGTHS SHOWN WILL PRODUCE THE PROPER AMOUNT MATERIAL FOR STRUCTURES WHEN SPLIT INTO APPROPRIATE SIZES DURING CONSTRUCTION. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.

TOTAL EARTHWORK QUANTITIES

ITEM	QUANTITY (CY)
CUT	1,845
BACKFILL	160
NET CUT	1,685

*NOTE: VOLUMES ARE NEATLINE, CONTRACTOR TO APPLY EXPANSION FACTORS TO DETERMINE A MORE ACCURATE BACKFILL VOLUME.

REACH 1 - QUANTITIES

WOOD QUANTITIES

ITEM	QUANTITY	DIAMETER	LENGTH	ROOTWAD
CATEGORY 1 WOOD	18	10 -14 IN	20 FT	YES
CATEGORY 2 WOOD	324	6 - 12 IN	20 FT	OPTIONAL
CATEGORY 3 WOOD	1,052	< 3 IN	10 - 12 FT	OPTIONAL
WILLOW CUTTINGS	4,605	0.25 - 1.0 IN	8 FT	NO

ROCK QUANTITIES

ITEM	QUANTITY	SIZE
CATEGORY 1 ROCK	96 EA	10 - 12 IN
STREAMBED FILL	239 CY	10 INCH MINUS

EARTHWORK QUANTITIES

ITEM	QUANTITY (CY)
CUT	775
BACKFILL	75
NET CUT	700

MISC. QUANTITIES

ITEM	QUANTITY
FABRIC	51 LF
NAILS	60 EA

LARGE WOOD STRUCTURE QUANTITIES

ITEM	QUANTITY
LARGE WOOD STRUCTURES	8 EA
CATEGORY 1 WOOD	24 EA
CATEGORY 2 WOOD	32 EA
CATEGORY 3 WOOD	48 EA
WILLOW CUTTINGS	1,600 EA

VEGETATED WOOD MATRIX QUANTITIES

ITEM	QUANTITY
VEGETATED WOOD MATRIX TYPE 1	788 LF
VEGETATED WOOD MATRIX TYPE 2	561 LF
CATEGORY 2 WOOD	710 EA
CATEGORY 3 WOOD	2,010 EA
WILLOW CUTTINGS	6,745 EA
STREAMBANK FILL	200 CY

TOTAL ROCK QUANTITIES

<u>ITEM</u>	<u>QUANTITY</u>	<u>DIAMETER</u>	
CATEGORY 1 ROCK	166 EA	10 - 12 IN	
<u>ITEM</u>	<u>QUANTITY</u>	<u>GRADATION</u>	
STREAMBED/STREAMBANK FILL	416 CY		
	<u>SIZE (IN)</u>	<u>PERCENT PASSING</u>	<u>REPRESENTATIVE SIZE CLASS</u>
	10	95	D100
	8	90-95	D95
	5	85-90	D84
	3	65-85	D65
	2	50-65	D50
	1	30-50	D35
	0.5	10-30	D15
	Fines	0-10	

REACH 2 - QUANTITIES

WOOD QUANTITIES

ITEM	QUANTITY	DIAMETER	LENGTH	ROOTWAD
CATEGORY 1 WOOD	20	10 -14 IN	20 FT	YES
CATEGORY 2 WOOD	339	6 - 12 IN	20 FT	OPTIONAL
CATEGORY 3 WOOD	890	< 3 IN	10 - 12 FT	OPTIONAL
WILLOW CUTTINGS	3,630	0.25 - 1.0 IN	8 FT	NO

ROCK QUANTITIES

ITEM	QUANTITY	SIZE
CATEGORY 1 ROCK	70 EA	10 - 12 IN
STREAMBED FILL	167 CY	10 IN MINUS

EARTHWORK QUANTITIES

ITEM	QUANTITY (CY)
CUT	870
BACKFILL	85
NET CUT	785

MISC. QUANTITIES

ITEM	QUANTITY
FABRIC	68 LF
NAILS	80 EA

CONSTRUCTED CHANNEL
STREAMBED QUANTITIES

ITEM	QUANTITY
CONSTRUCTED RIFFLE	620 LF
CATEGORY 1 ROCK	124 EA
STREAMBED FILL	217 CY

LOG STEP POOL QUANTITIES

ITEM	QUANTITY
LOG STEP STRUCTURES	7 EA
CATEGORY 1 WOOD	14 EA
CATEGORY 2 WOOD	21 EA
CATEGORY 1 ROCK	42 EA
FILTER FABRIC	68 EA
RING SHANK NAILS	80 EA

TOTAL REVEGETATION - QUANTITIES

PLANT AND SEED QUANTITIES

ITEM	QUANTITY	UNITS	DIMENSIONS
TALL 1-GAL CONTAINERIZED PLANTS	241	EA	VARIES
5-GAL CONTAINERIZED PLANTS	8	EA	DEPENDING
25-GAL CONTAINERIZED PLANTS	5	EA	ON SOURCE
FLOODPLAIN SEEDMIX	18.43	LBS (PLS)	
UPLAND RECLAMATION SEEDMIX	6.67	LBS (PLS)	

FENCE QUANTITIES

ITEM	QUANTITY	UNITS	DIMENSIONS
POLYPROPYLENE MESH FENCE	2.250	EA	7.5' TALL
STEEL T-POSTS (15-FT SPACING)	150	EA	10' TALL
HEAVY-DUTY ZIP TIES	600	EA	

ROTATIONAL SLOPE TREATMENT - QUANTITIES

WOOD QUANTITIES

ITEM	QUANTITY	DIAMETER	LENGTH	ROOTWAD
CATEGORY 2 WOOD	50	6 - 12 IN	20 FT	OPTIONAL
CATEGORY 3 WOOD	100	< 3 IN	10 - 12 FT	OPTIONAL
WILLOW CUTTINGS	125	0.25 - 1.0 IN	8 FT	NO

ROCK QUANTITIES

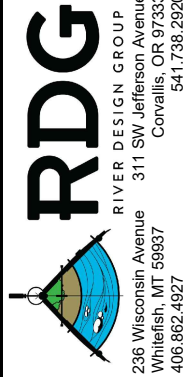
ITEM	QUANTITY	SIZE
STREAMBED FILL	5 CY	10 IN MINUS

EARTHWORK QUANTITIES

ITEM	QUANTITY (CY)
CUT	100
BACKFILL	0
NET CUT	100

VEGETATED BRUSH TRENCH QUANTITIES

ITEM	QUANTITY
VEGETATED BRUSH TRENCH	280 LF
CATEGORY 3 WOOD	84 EA
WILLOW CUTTINGS	140 EA



236 Wisconsin Avenue
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406.862.4927

MATERIALS AND QUANTITIES
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM
3	3/30/22	LS	DESIGN REVISION	JM

PROJECT NUMBER RDG-21-169
DRAWING NUMBER 4.0
Drawing 5 of 22

NOTES: STRUCTURES MAY BE ADJUSTED OR ELIMINATED TO PRESERVE EXISTING HIGH QUALITY VEGETATION. ALL EXISTING HIGH QUALITY VEGETATION TO BE PRESERVED DURING CONSTRUCTION TO THE GREATEST EXTENT POSSIBLE.

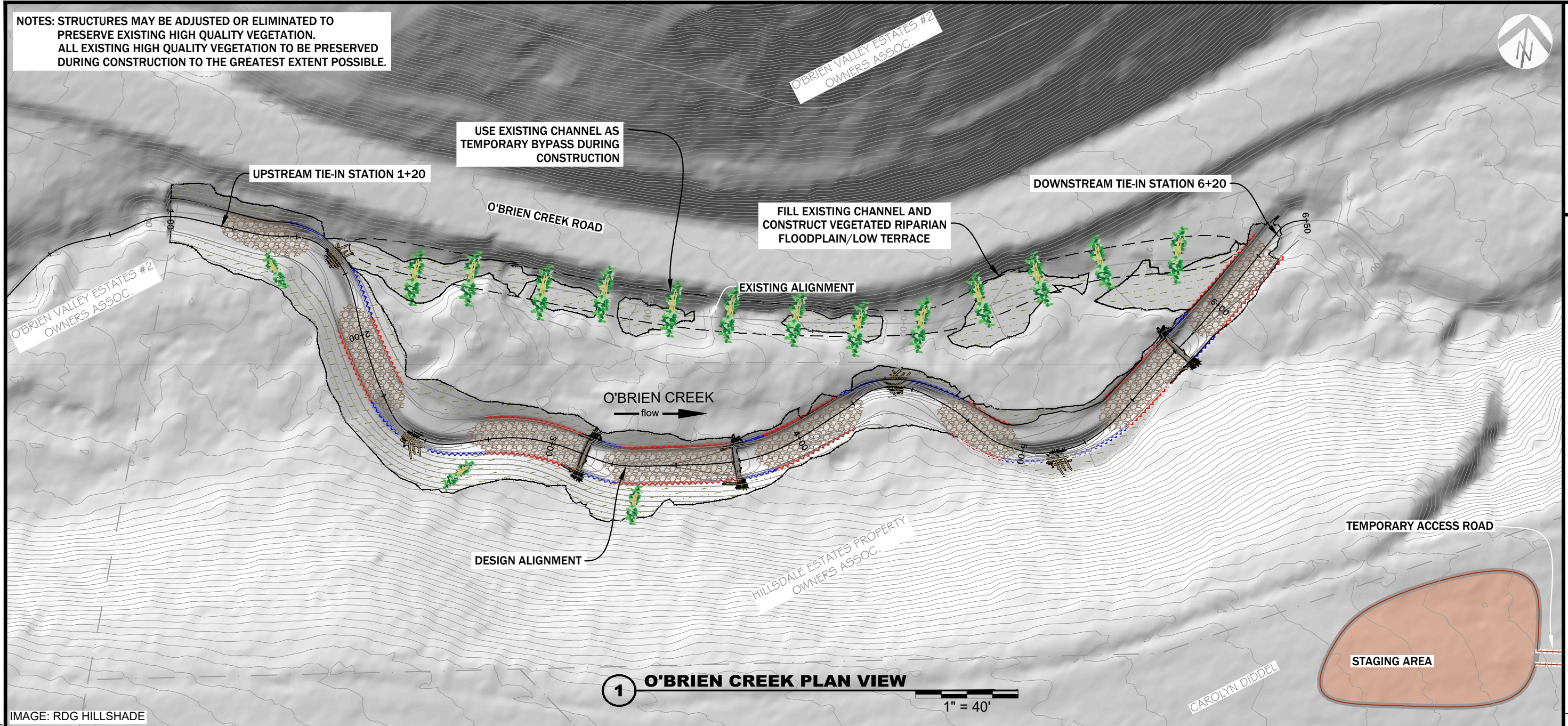









IMAGE: RDG HILLSHADE

LEGEND

	<u>BANK STRUCTURES</u>	<u>DETAIL SHEET #</u>
	LARGE WOOD STRUCTURE (LWS)	8.0
	LOG STEP POOL STRUCTURE (LWS)	8.3
	VEGETATED WOOD MATRIX TYPE 1 (VWM 1)	8.1
	VEGETATED WOOD MATRIX TYPE 2 (VWM 2)	8.1
	VEGETATED BRUSH TRENCH (VBT)	8.4
	<u>CHANNEL STRUCTURES</u> CONSTRUCTED CHANNEL STREAMBED (CCS)	8.2
	<u>FLOODPLAIN STRUCTURE</u> APPLY FLOODPLAIN ROUGHNESS	

—CHANNEL TOP OF BANK ELEVATIONS

<u>STATION</u>	<u>ELEVATION (FT)</u>	<u>STATION</u>	<u>ELEVATION (FT)</u>
1+00	3201.25	3+87	3195.39
1+45	3200.30	4+21	3194.68
1+61	3200.01	4+36	3194.38
1+73	3199.79	4+49	3194.16
1+95	3199.35	4+71	3193.72
2+24	3198.73	4+93	3193.27
2+40	3198.44	5+08	3192.97
2+52	3198.22	5+19	3192.75
2+74	3197.77	5+42	3192.31
3+13	3196.94	5+76	3191.59
3+14	3196.92	5+77	3191.57
3+27	3196.65	5+90	3191.29
3+73	3195.68	6+41	3190.22
3+74	3195.66		

STRUCTURE SCHEDULE

<u>STATION</u> <u>START</u>	<u>STATION</u> <u>END</u>	<u>BANK</u>	<u>STRUCTURE</u>	<u>STATION</u> <u>START</u>	<u>STATION</u> <u>END</u>	<u>BANK</u>	<u>STRUCTURE</u>	<u>STATION</u> <u>START</u>	<u>STATION</u> <u>END</u>	<u>BANK</u>	<u>STRUCTURE</u>
1+00	1+53	C	CCS	3+13	3+27	R	VWM 2	4+71	4+93	R	VWM 1
1+45	1+61	L	VWM 2	3+21	3+73	C	CCS	4+93	5+08	R	VWM 2
1+61	1+73	L	LWS	3+27	3+73	L	VWM 1	5+08	5+19	R	LWS
1+73	1+95	L	VWM 2	3+27	3+73	R	VWM 1	5+19	5+42	R	VWM 2
1+84	2+32	C	CCS	3+73	3+87	C	LSP	5+31	5+77	C	CCS
1+95	2+24	L	VWM 1	3+73	3+87	L	VWM 2	5+42	5+76	L	VWM 1
1+95	2+24	R	VWM 1	3+73	3+87	R	VWM 2	5+42	5+76	R	VWM 1
2+24	2+40	R	VWM 2	3+81	4+21	C	CCS	5+76	5+90	C	LSP
2+40	2+52	R	LWS	3+87	4+21	L	VWM 1	5+76	5+90	L	VWM 2
2+52	2+74	R	VWM 2	3+87	4+21	R	VWM 1	5+76	5+90	R	VWM 2
2+63	3+13	C	CCS	4+21	4+36	L	VWM 2	5+84	6+41	C	CCS
2+74	3+13	L	VWM 1	4+36	4+49	L	LWS	5+90	6+41	L	VWM 1
2+74	3+13	R	VWM 1	4+49	4+71	L	VWM 2	5+90	6+41	R	VWM 1
3+13	3+27	C	LSP	4+60	5+01	C	CCS				
3+13	3+27	L	VWM 2	4+71	4+93	L	VWM 1				

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

PROJECT NUMBER

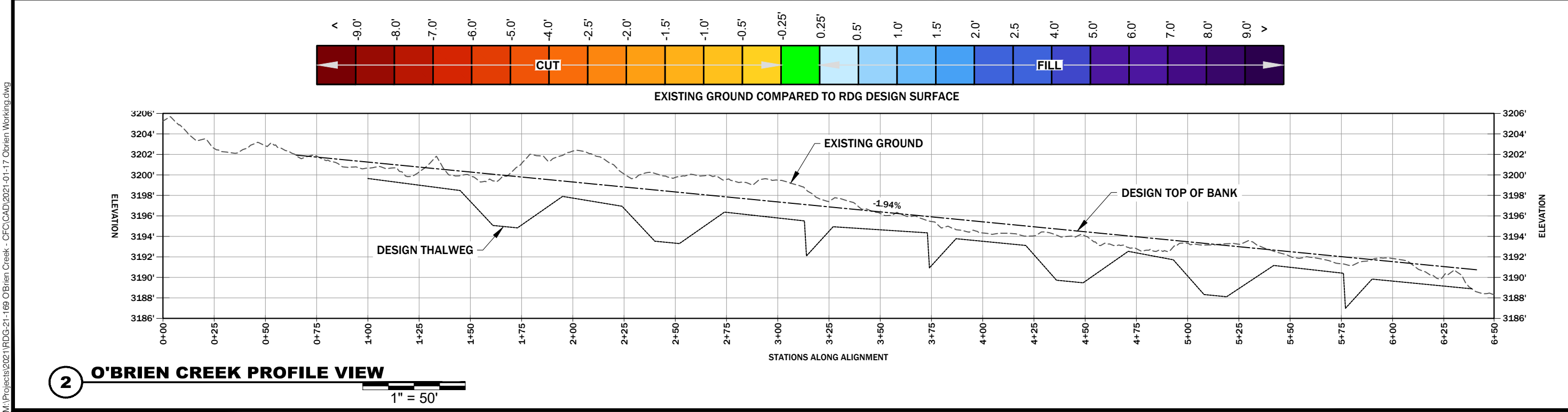
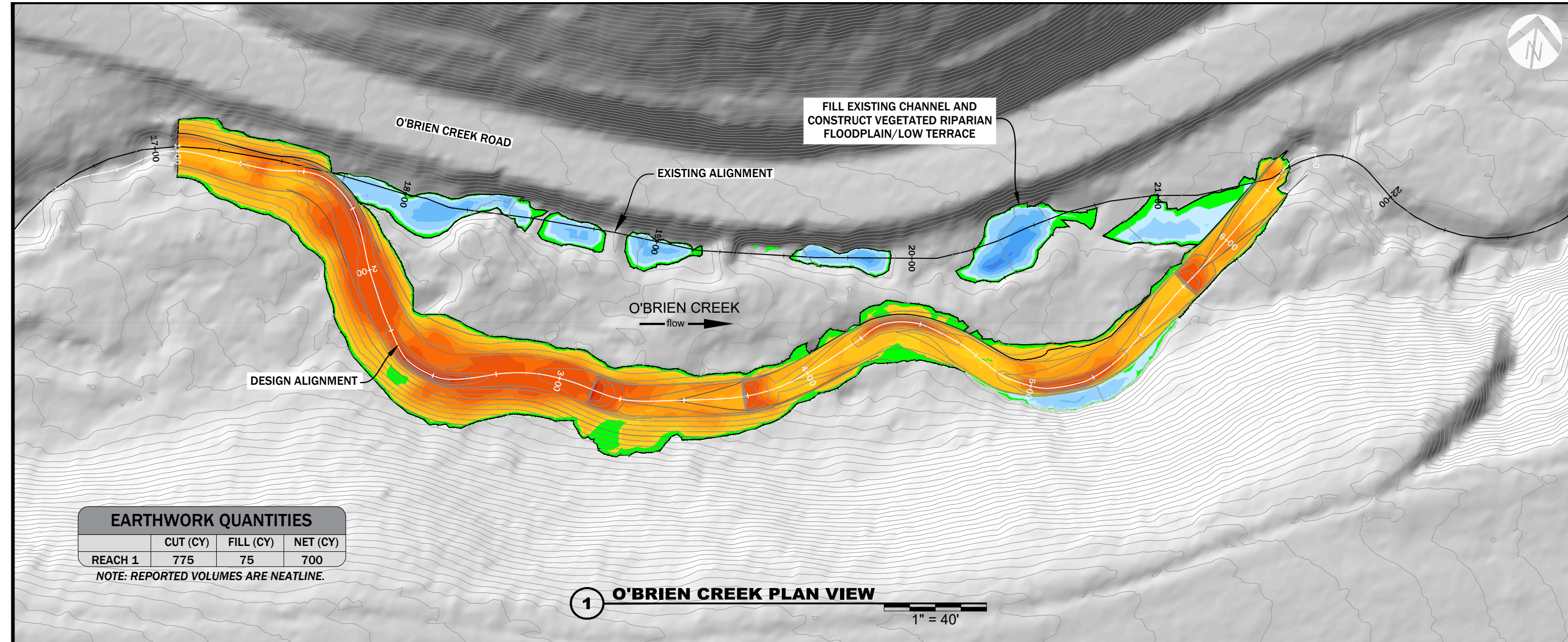
RDG-21-169

DRAWING NUMBER

5.0

Drawing 6 of 22

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RIVER DESIGN GROUP
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

GRADING AND PROFILE - REACH 1

O'BRIEN CREEK RESTORATION PROJECT

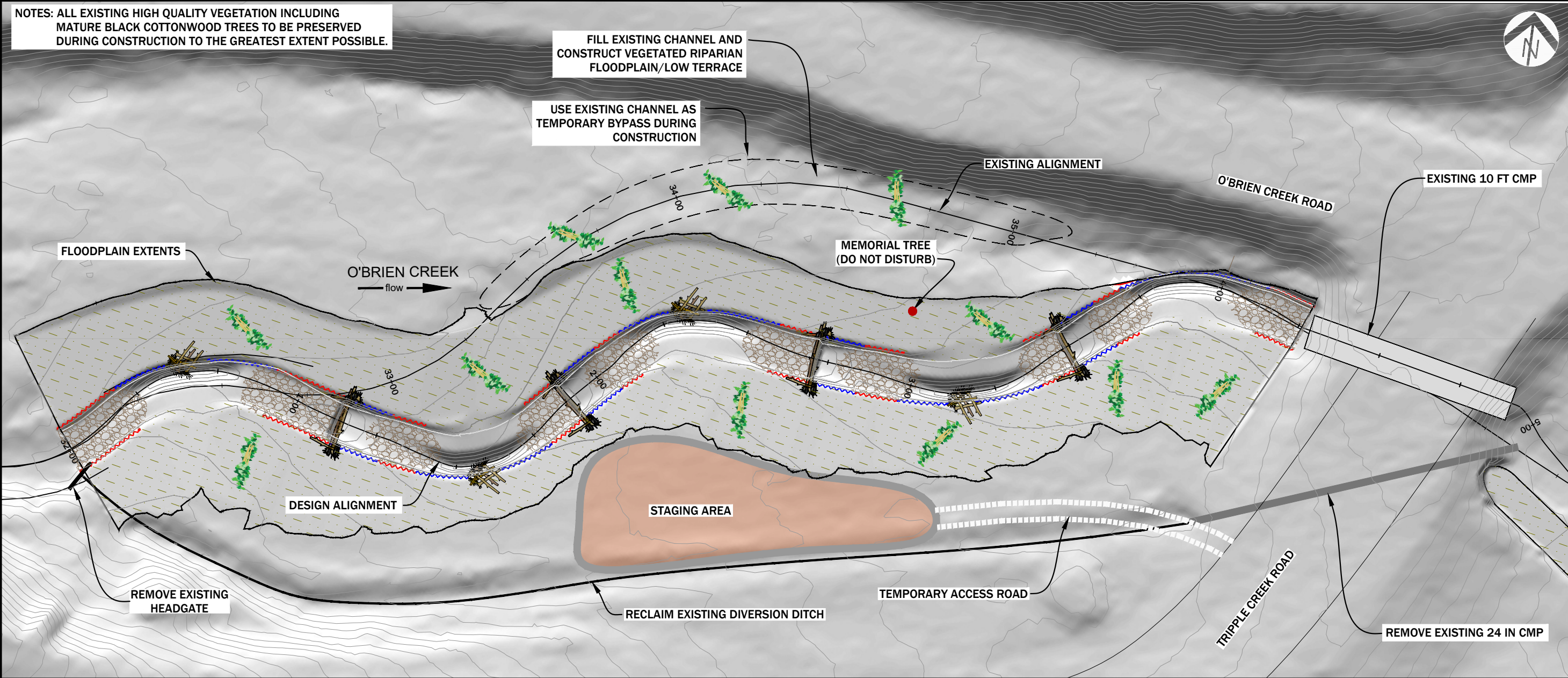
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
5.1








Drawing 7 of 22



1 O'BRIEN CREEK PLAN VIEW

1" = 30'

LEGEND

BANK STRUCTURES		DETAIL SHEET #
	LARGE WOOD STRUCTURE (LWS)	8.0
	LOG STEP POOL STRUCTURE (LWS)	8.3
	VEGETATED WOOD MATRIX TYPE 1 (VWM 1)	8.1
	VEGETATED WOOD MATRIX TYPE 2 (VWM 2)	8.1
	VEGETATED BRUSH TRENCH (VBT)	8.4
CHANNEL STRUCTURES		
	CONSTRUCTED CHANNEL STREAMBED (CCS)	8.2
FLOODPLAIN STRUCTURE		
	APPLY FLOODPLAIN ROUGHNESS	

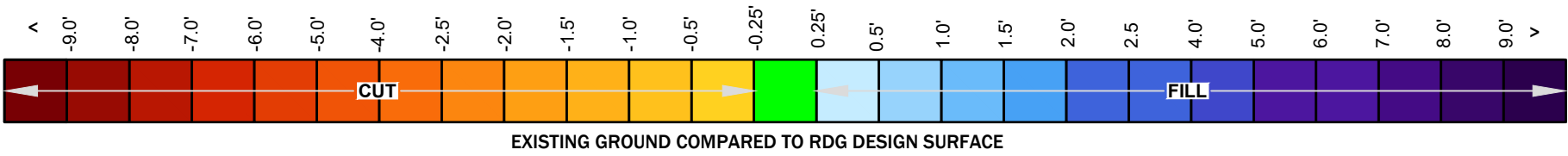
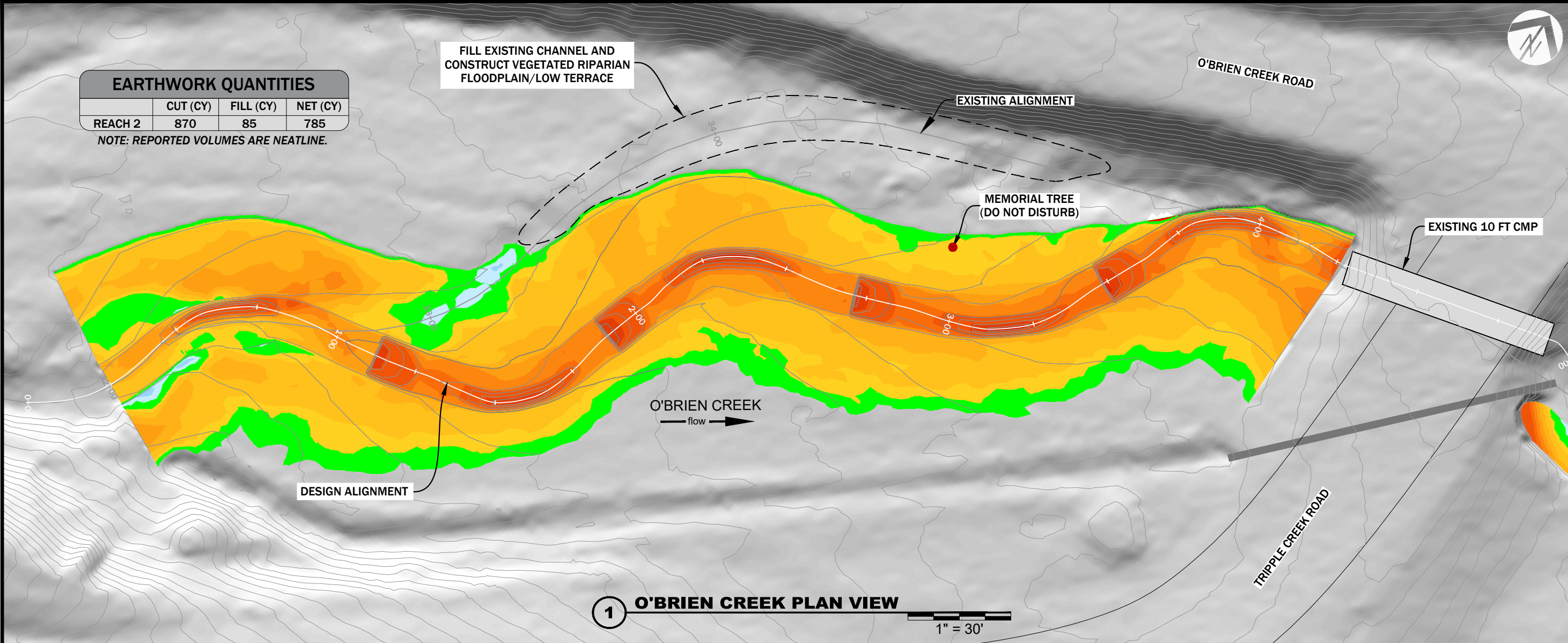
CHANNEL TOP OF BANK ELEVATIONS

STATION	ELEVATION (FT)	STATION	ELEVATION (FT)
0+25	3163.31	2+38	3158.59
0+45	3162.84	2+55	3158.19
0+60	3162.52	2+71	3157.84
0+72	3162.26	2+72	3157.82
0+83	3161.84	2+85	3157.52
0+91	3161.33	2+97	3157.24
1+13	3161.31	3+12	3156.89
1+27	3161.01	3+22	3156.68
1+39	3160.75	3+38	3156.33
1+51	3160.52	3+48	3156.10
1+62	3160.26	3+49	3156.07
1+78	3159.91	3+62	3155.77
1+89	3159.66	3+70	3155.58
1+90	3159.63	3+82	3155.33
2+04	3159.31	3+93	3155.10
2+12	3159.12	4+13	3154.70
2+27	3158.82	4+26	3154.35

STRUCTURE SCHEDULE

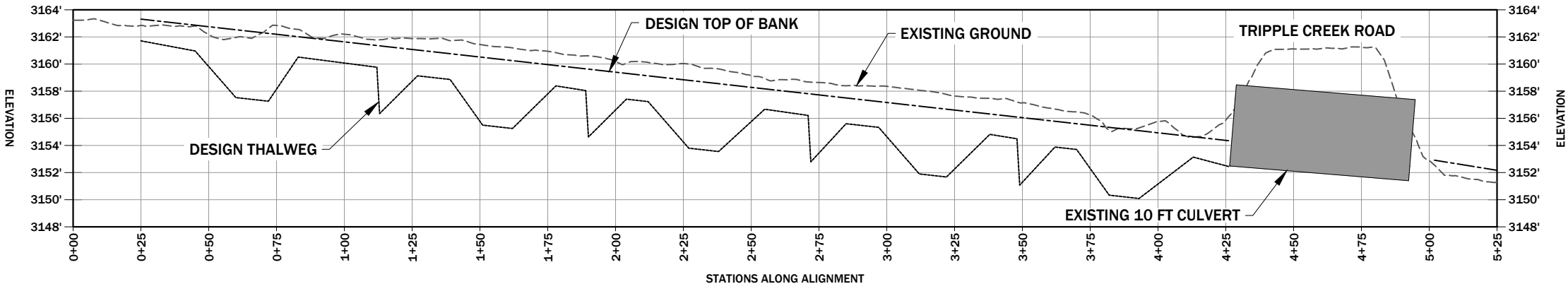
STATION START	STATION END	BANK	STRUCTURE	STATION START	STATION END	BANK	STRUCTURE	STATION START	STATION END	BANK	STRUCTURE	STATION START	STATION END	BANK	STRUCTURE
0+25	0+53	C	CCS	1+27	1+39	L	VWM 1	2+27	2+38	L	LWS	3+30	3+48	C	CCS
0+25	0+45	R	VWM 1	1+39	1+51	R	VWM 2	2+38	2+55	L	VWM 2	3+38	3+48	R	VWM 1
0+25	0+45	L	VWM 1	1+51	1+62	R	LWS	2+47	2+72	C	CCS	3+38	3+48	L	VWM 1
0+45	0+60	L	VWM 2	1+62	1+78	R	VWM 2	2+55	2+71	R	VWM 1	3+48	3+62	C	LSP
0+60	0+72	L	LWS	1+70	1+90	C	CCS	2+55	2+71	L	VWM 1	3+48	3+62	R	VWM 2
0+72	0+83	L	VWM 2	1+78	1+89	R	VWM 1	2+71	2+85	C	LSP	3+48	3+62	L	VWM 2
0+78	1+02	C	CCS	1+78	1+89	L	VWM 1	2+71	2+85	R	VWM 2	3+56	3+76	C	CCS
0+83	0+91	R	VWM 1	1+89	2+04	C	LSP	2+71	2+85	L	VWM 2	3+62	3+70	R	VWM 1
0+83	0+91	L	VWM 1	1+89	2+04	R	VWM 2	2+79	3+05	C	CCS	3+62	3+70	L	VWM 1
0+91	1+27	C	LSP	1+89	2+04	L	VWM 2	2+85	2+97	R	VWM 1	3+70	4+13	L	VWM 2
0+91	1+27	R	VWM 2	1+97	2+20	C	CCS	2+85	2+97	L	VWM 1	4+03	4+26	C	CCS
0+91	1+27	L	VWM 2	2+04	2+12	R	VWM 1	2+97	3+12	R	VWM 2	4+13	4+26	R	VWM 1
1+20	1+45	C	CCS	2+04	2+12	L	VWM 1	3+12	3+22	R	LWS	4+13	4+26	L	VWM 1
1+27	1+39	R	VWM 1	2+12	2+27	L	VWM 2	3+22	3+38	R	VWM 2				

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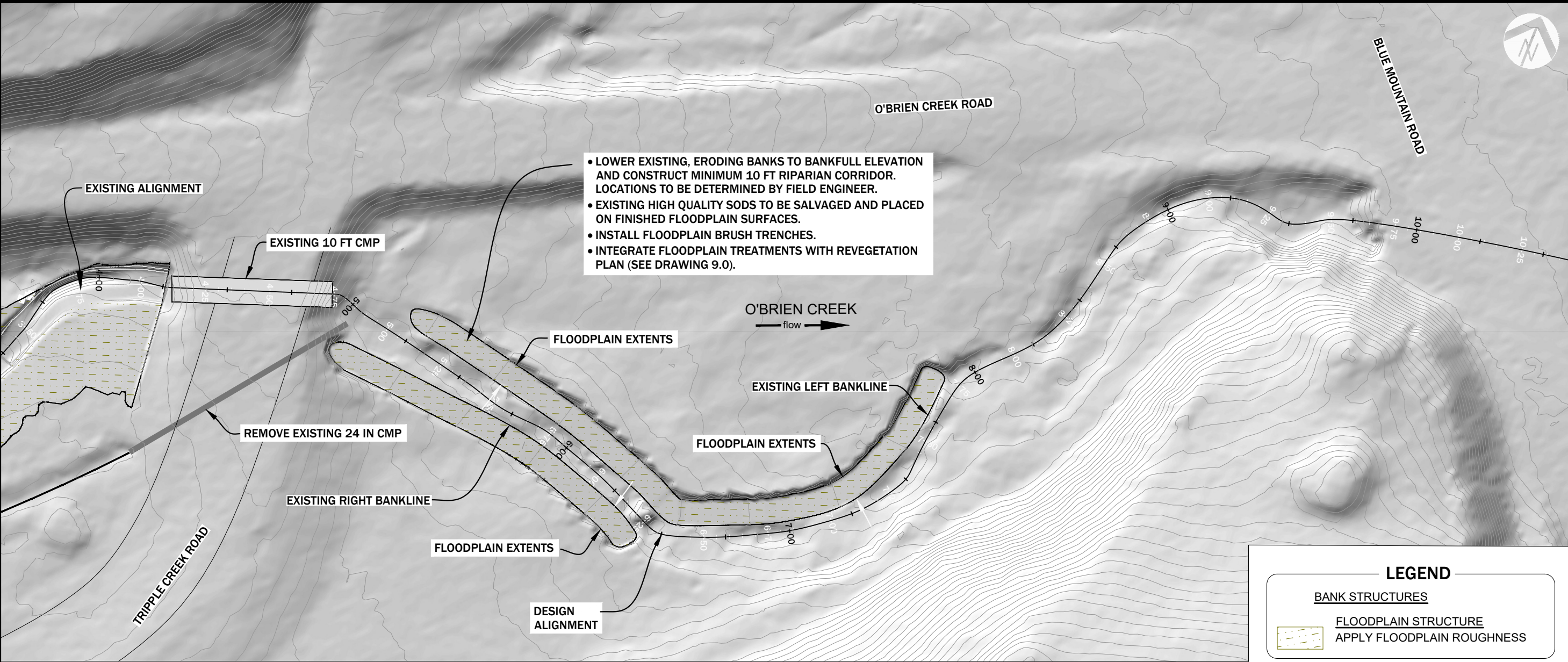


2 O'BRIEN CREEK PROFILE VIEW

1" = 50'

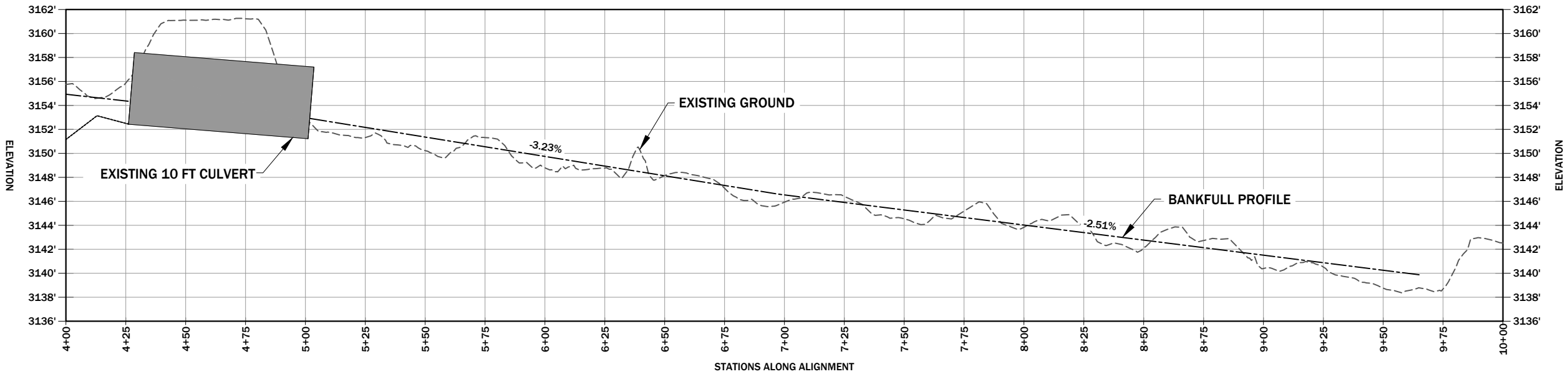


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1 O'BRIEN CREEK PLAN VIEW

1" = 40'





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PLAN AND PROFILE - REACH 3

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

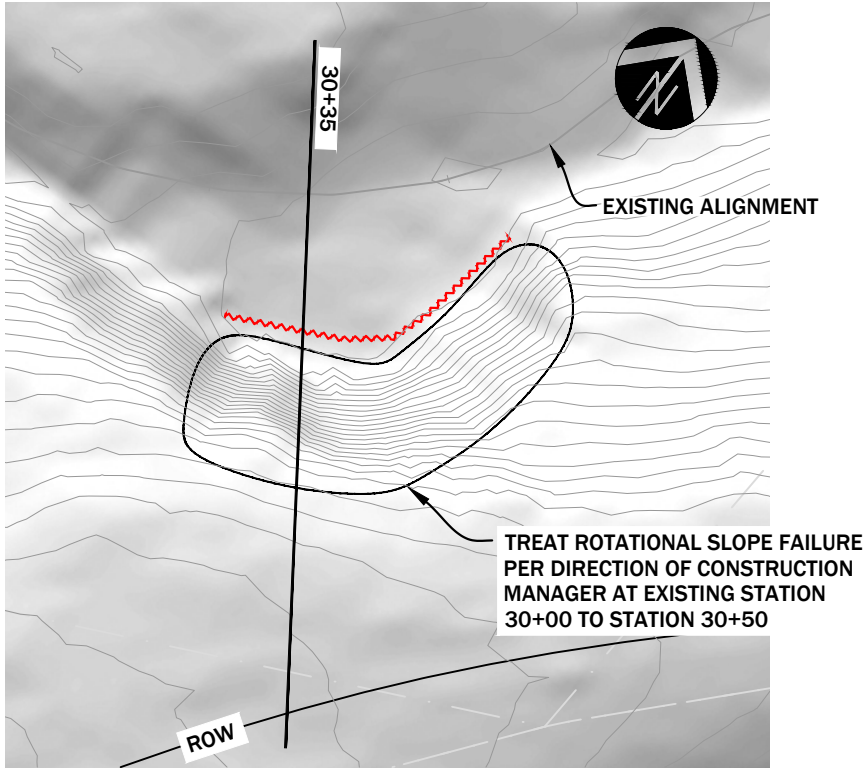
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2	1/26/22	LS	DESIGN REVISION	JM
3	3/30/22	LS	DESIGN REVISION	JM

PROJECT NUMBER
RDG-21-169

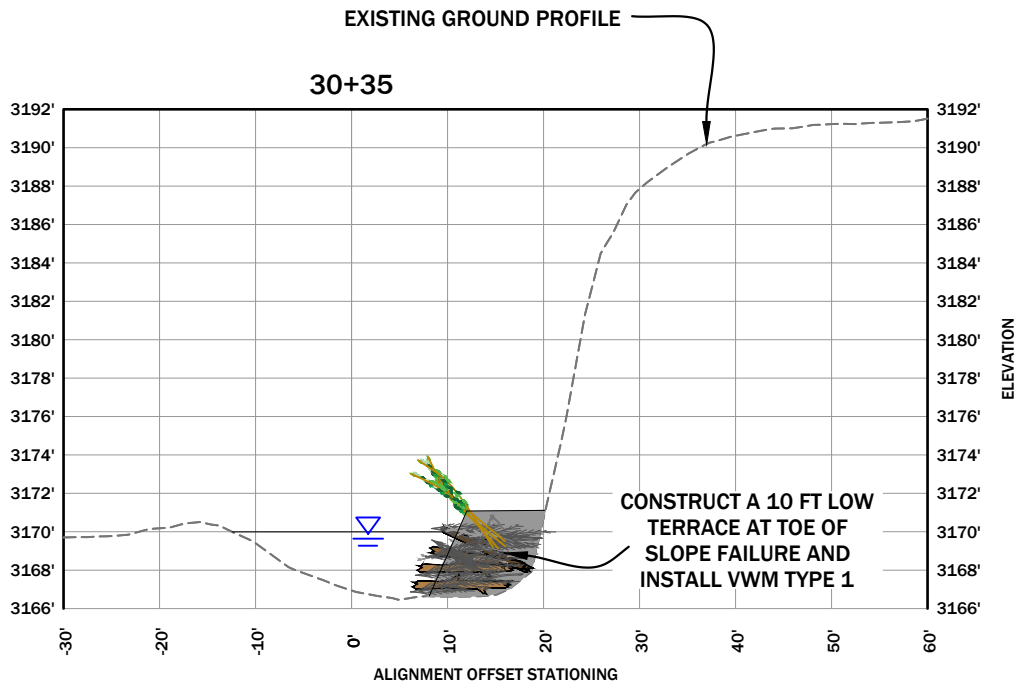
DRAWING NUMBER
5.4

Drawing 10 of 22

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1 O'BRIEN CREEK PLAN VIEW
Station 30+40.00
1" = 20'



2 O'BRIEN CREEK SECTION VIEW
Station 30+40.00
1" = 20'



PHOTO OF EXISTING ROTATIONAL SLOPE FAILURE AT STATION 30+35

LEGEND

BANK STRUCTURE

VEGETATED WOOD
MATRIX TYPE 1 (VWM 1)

DETAIL SHEET #

8.1

ROTATIONAL SLOPE FAILURE PLAN
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM
3	3/30/22	LS	DESIGN REVISION	JM

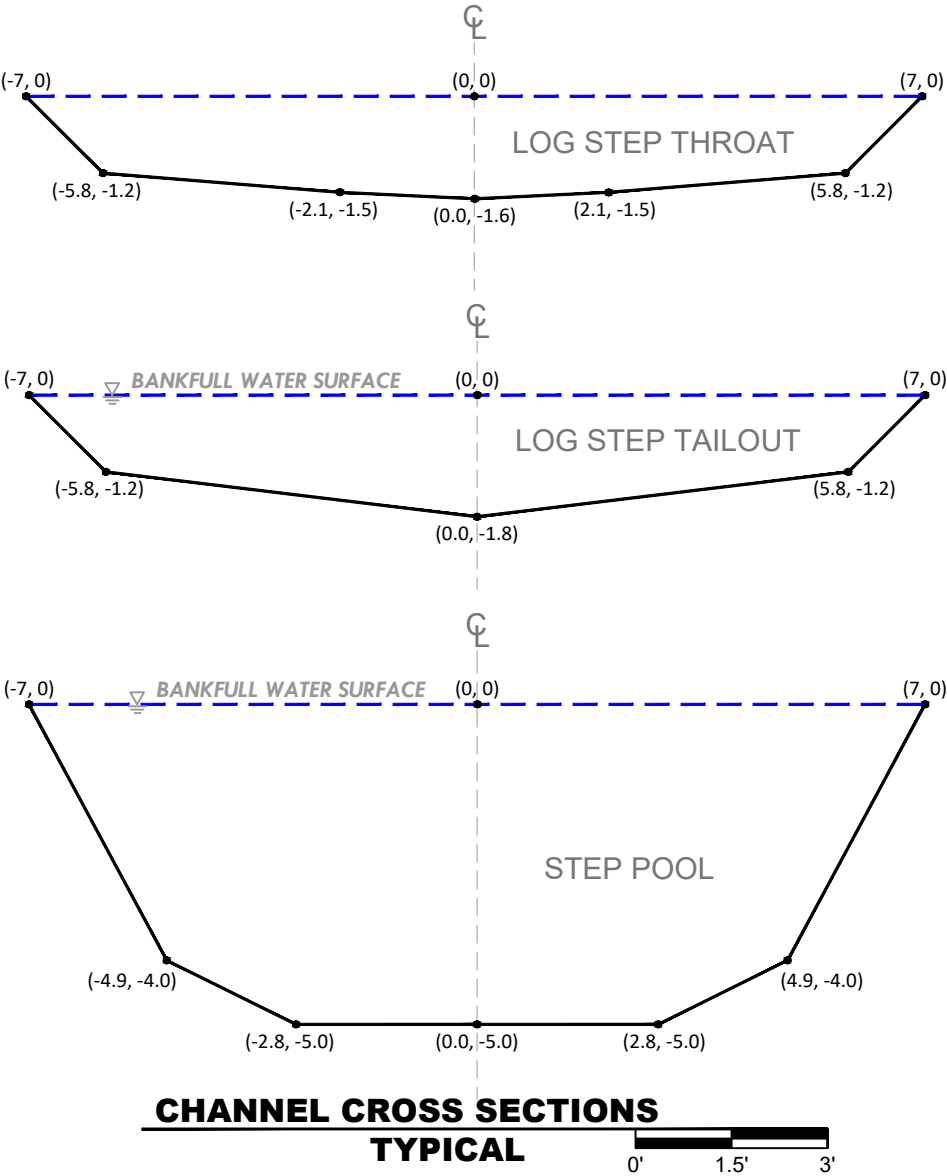
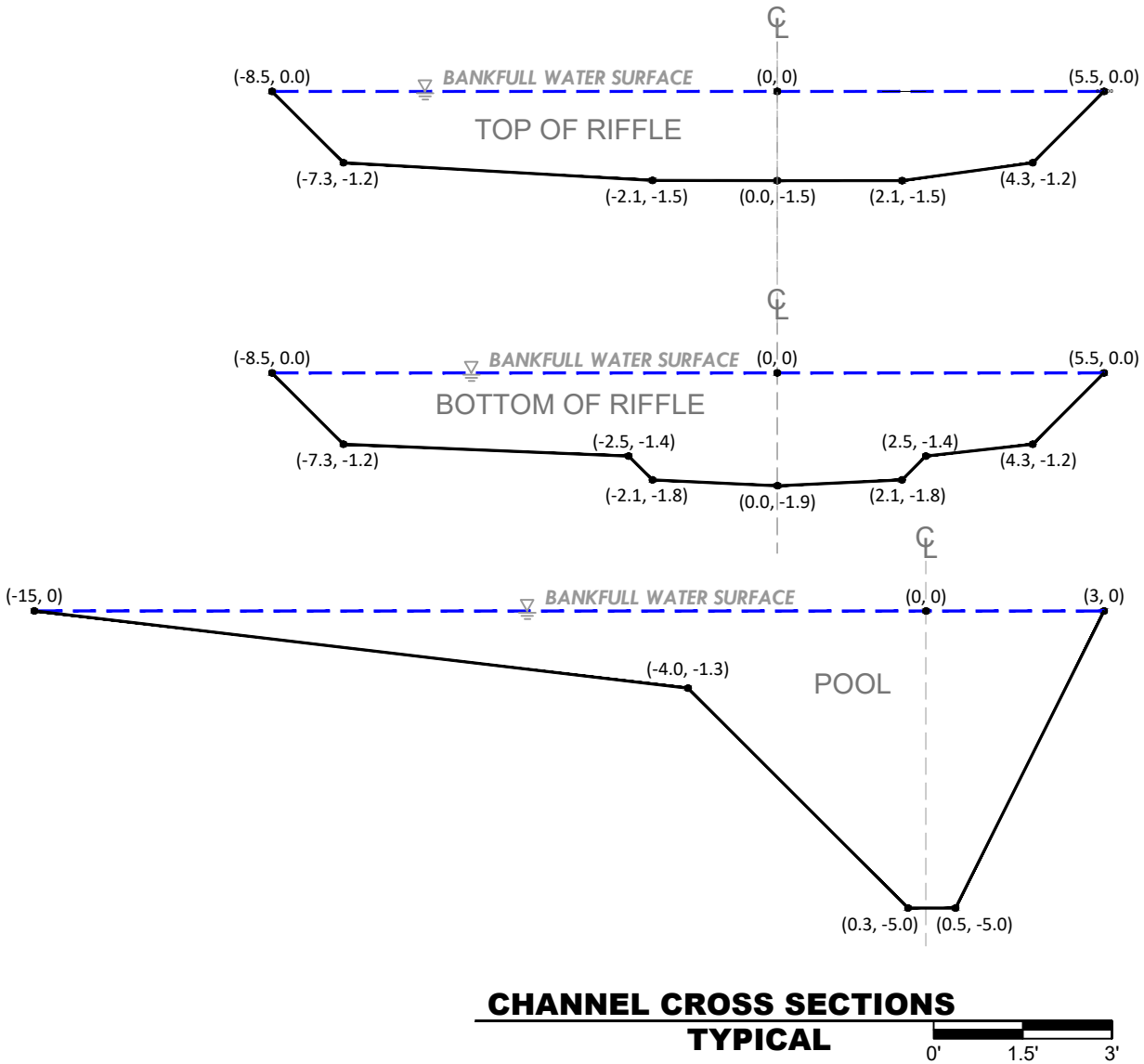
PROJECT NUMBER
RDG-21-169

DRAWING NUMBER

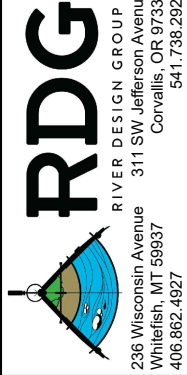
5.5

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BANKFULL CROSS SECTION DESIGN DIMENSIONS			
	Riffle	Run	Pool
	Value (ft)	Value (ft)	Value (ft)
Area	17	18	24
Width/Depth	12	9	14
Range (Low)	10	7	12
Range (High)	14	11	16
Width			
Average	14	13	18
Range (Low)	13	11	17
Range (High)	16	14	20
Avg. Depth			
Average	1.2	1.4	1.3
Range (Low)	1.1	1.3	1.2
Range (High)	1.3	1.6	1.4
Max. Depth			
Average	1.8	2.4	4.3
Range (Low)	1.6	2.1	3.7
Range (High)	2.1	2.8	4.9
Max. Scour	2.4	3.0	5.1



NOTE: COORDINATES ARE REFERENCED FROM TOP OF BANK THALWEG



DESIGN CROSS SECTIONS

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

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RDG-21-169

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6.0

Drawing 12 of 22

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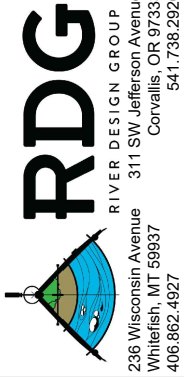
REACH 1 AND 2

BANKFULL CHANNEL HYDRAULIC DESIGN CRITERIA	
Stream Type	B3/4 (Cobble/Gravel Bed)
Valley Type	Confined Alluvial Valley
Bankfull Discharge	80 cfs (+/-15cfs)
Valley Slope	0.024 ft/ft
Sinuosity	1.2
Channel Slope	0.019 ft/ft to 0.22 ft/ft
Reach Average Slope	0.009 ft/ft
Bed Shear Stress	1.6 lbs/ft2
Mobile Particle Size	77 mm - 123 mm (LC-SB)
Mean Velocity	4.1 fps - 4.6 fps

PARTICLE SIZE DISTRIBUTION			
Size Class	Proposed Millimeter	Inches	% Passing
D16	12.7	0.5	10-30
D35	25.4	1	30-50
D50	50.8	2	50-65
D65	76.2	3	65-85
D84	127	5	85-90
D95	203.2	8	90-95
D100	254	10	95

PLANFORM GEOMETRY DESIGN CRITERIA		
Variable	Value (ft)	Dimensionless Ratio
Bankfull Width	14	
Radius of Curvature		
Average	35	2.5
Range (Low)	42	3
Range (High)	56	4.0
Meander Length		
Average	197	14.0
Range (Low)	141	10.0
Range (High)	254	18.0
Belt Width		
Average	85	6.0
Range (Low)	42	3.0
Range (High)	113	8.0
Sinuosity	1.1 - 1.2	

LONGITUDINAL PROFILE DESIGN CRITERIA				
Variable	Feature Length (ft)	Dimensionless Ratio*	Slope Range (ft/ft)	Dimensionless Ratio**
Riffle				
Average	40	2.8	0.0380	1.9
Range (Low)	13	1.0	0.0280	1.4
Range (High)	70	4.5	0.0480	2.4
Run				
Average	14	1.0	0.0360	1.8
Range (Low)	11	0.8	0.0220	1.1
Range (High)	19	1.2	0.0500	2.5
Pool				
Average	35	2.5	0.0040	0.2
Range (Low)	13	1.0	0.0020	0.1
Range (High)	70	4.5	0.0060	0.3
Glide				
Average	16	1.15	0.0030	0.15
Range (Low)	14	1.1	0.0020	0.1
Range (High)	20	1.3	0.0040	0.2
	#REF!			
Pool Spacing				
Average	71	5.0		
Range (Low)	39	3.0	N/A	N/A
Range (High)	124	8.0		
* Relative to bankfull riffle width (14 ft).				
** Relative to reach-averaged water surface slope (0.02 ft/ft).				

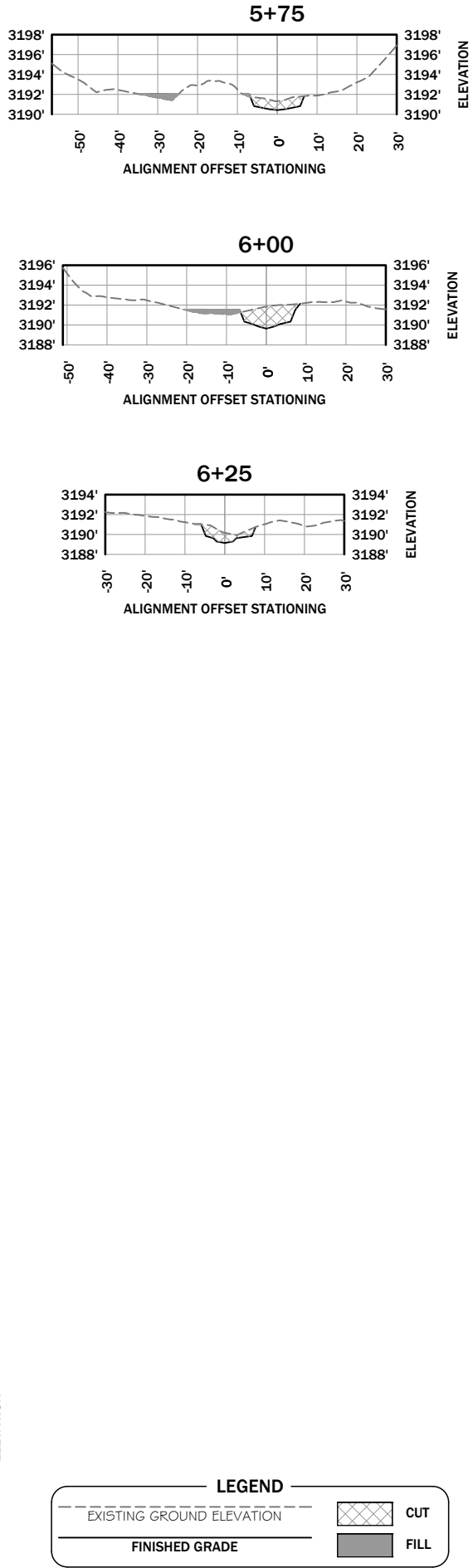
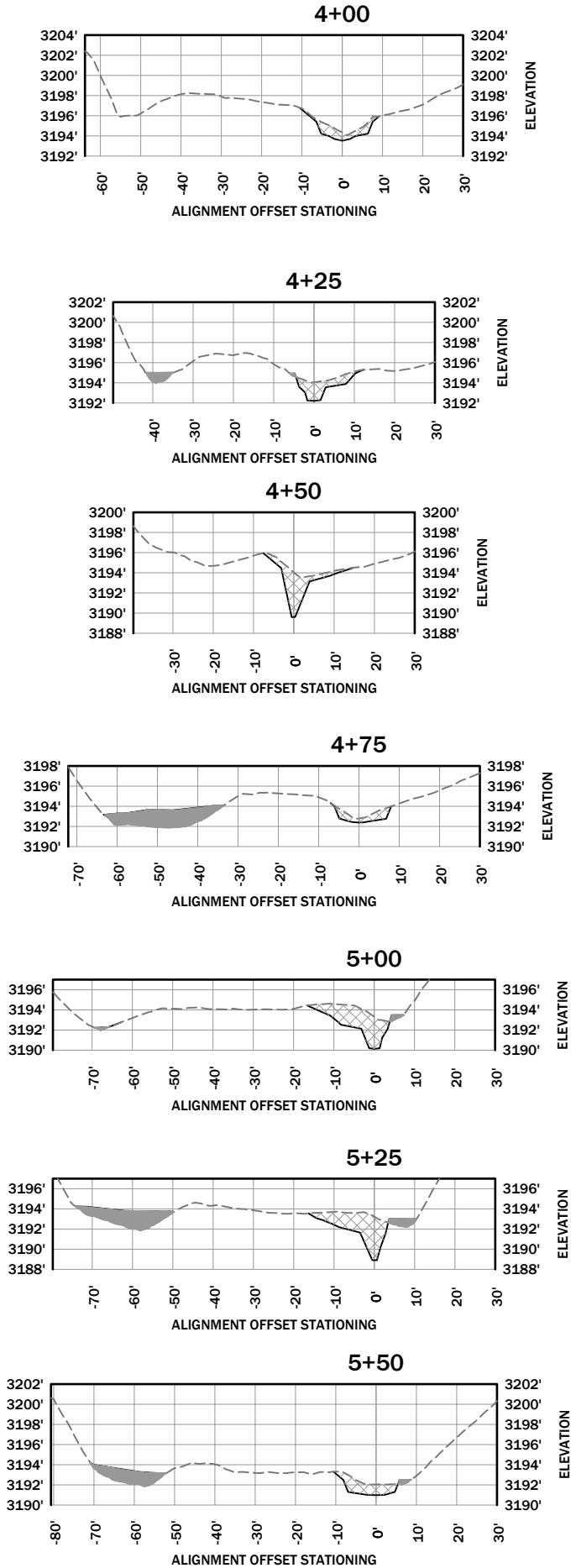
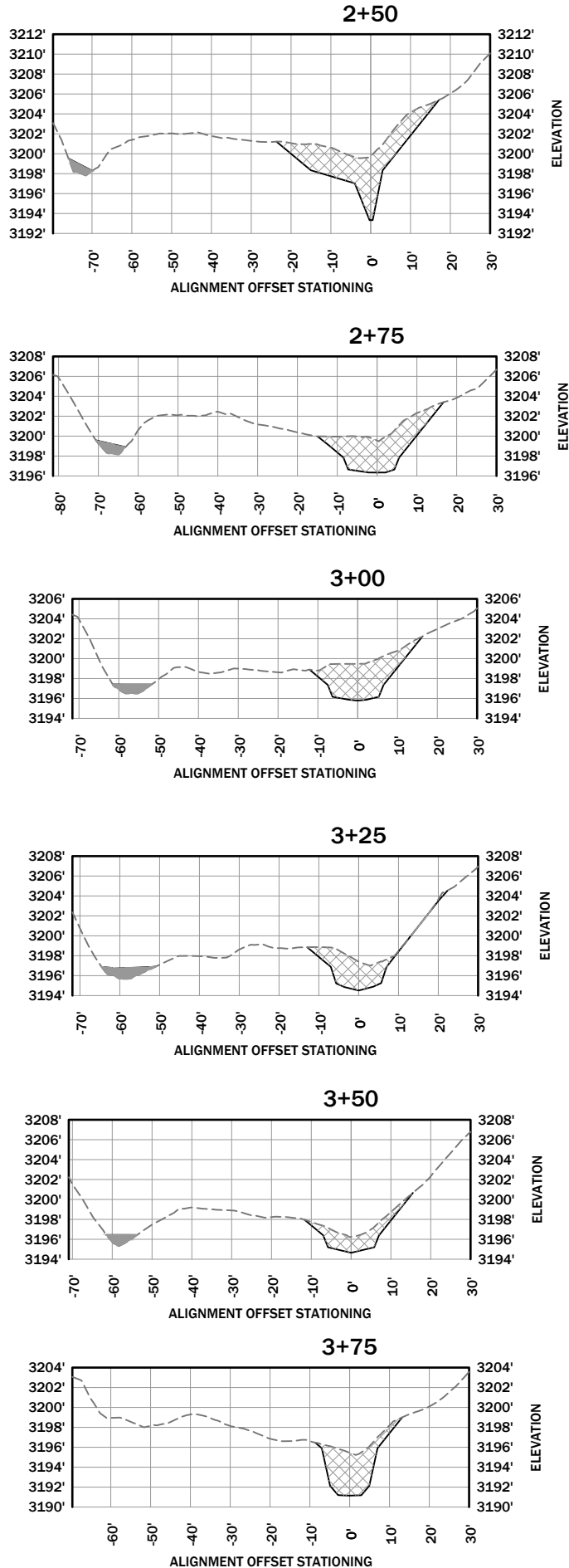
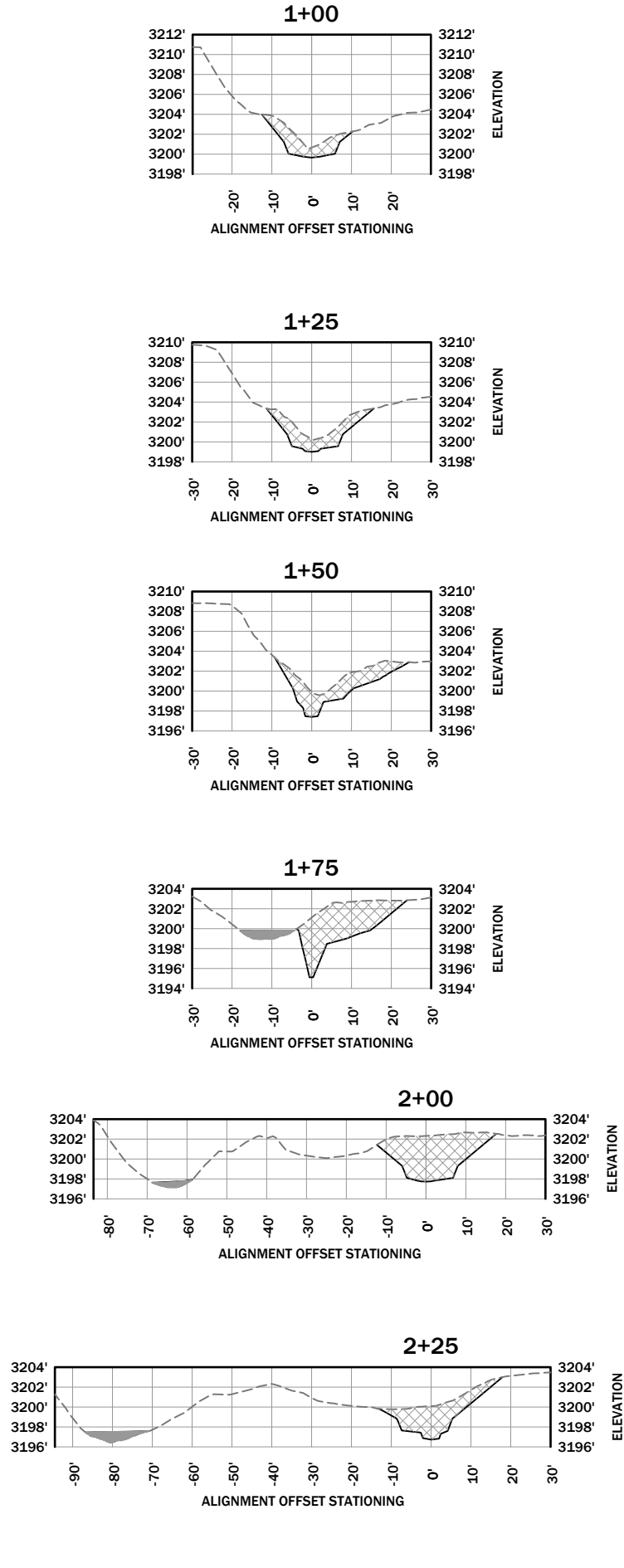


DESIGN CRITERIA
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

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LEGEND

EXISTING GROUND ELEVATION

FINISHED GRADE

CUT

FILL



REACH 1 CROSS SECTIONS

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

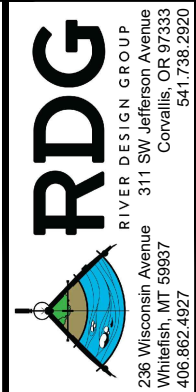
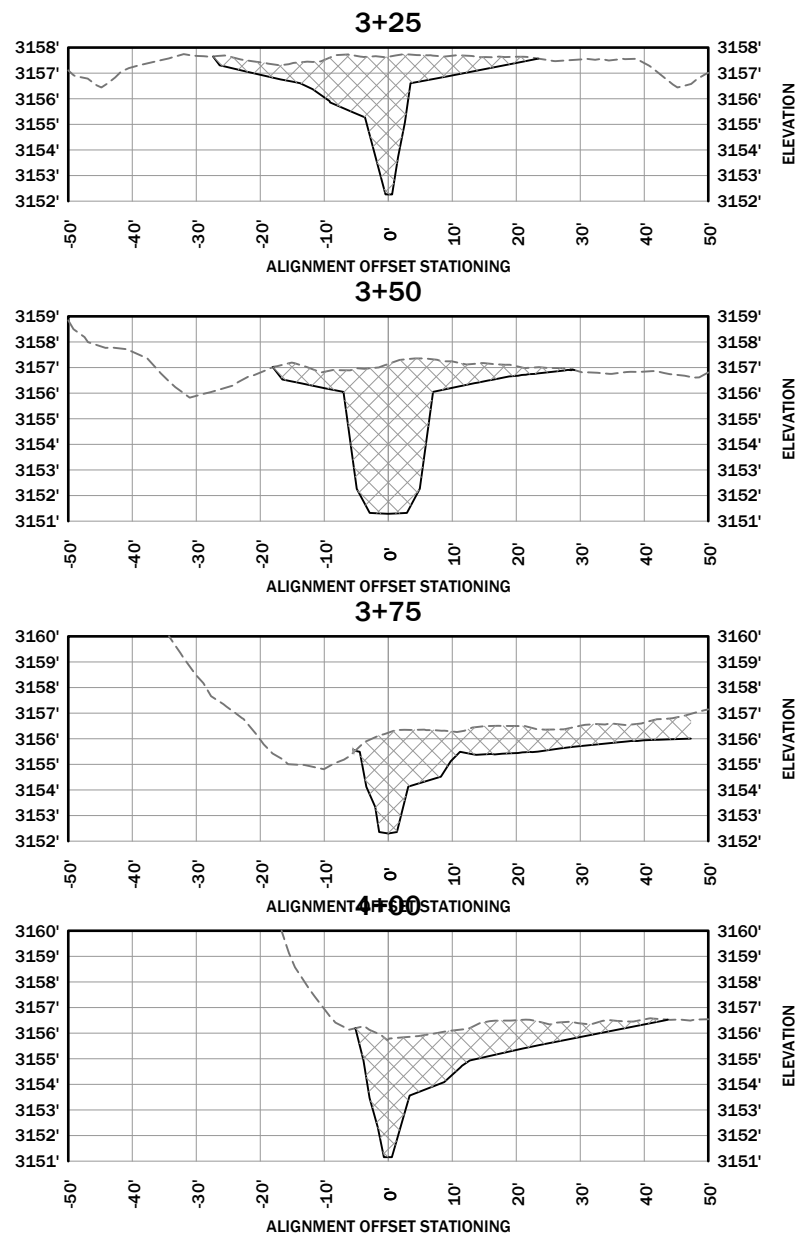
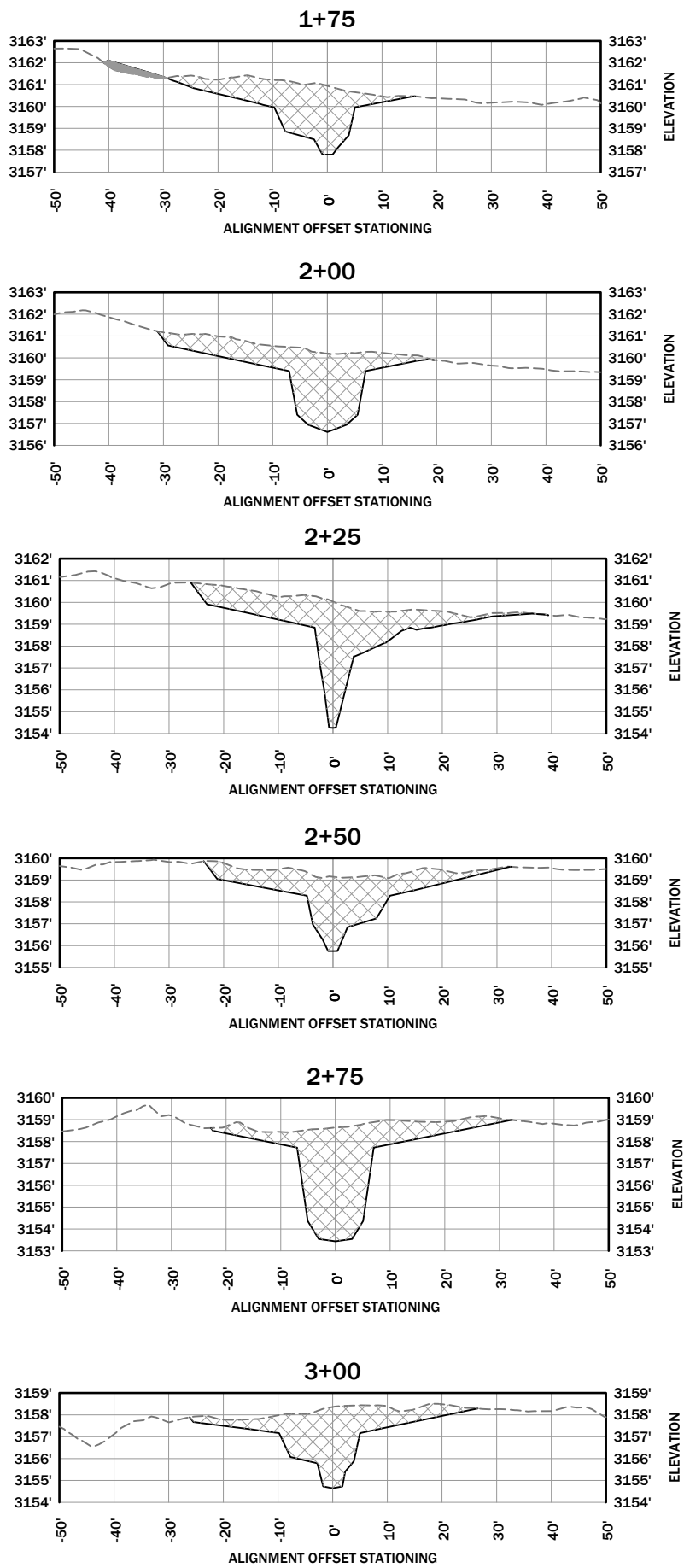
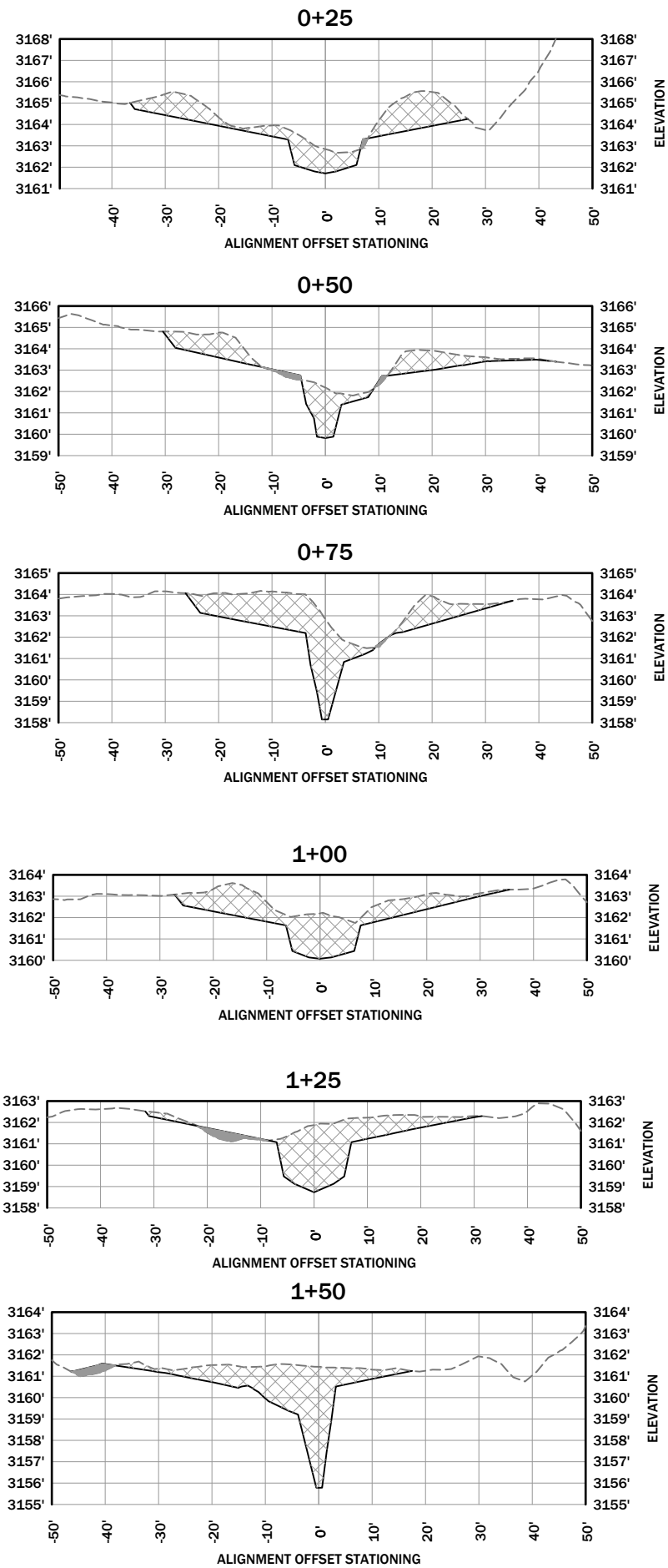
NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

PROJECT NUMBER
RDG-21-169

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REACH 2 CROSS SECTIONS

O'BRIEN CREEK RESTORATION PROJECT

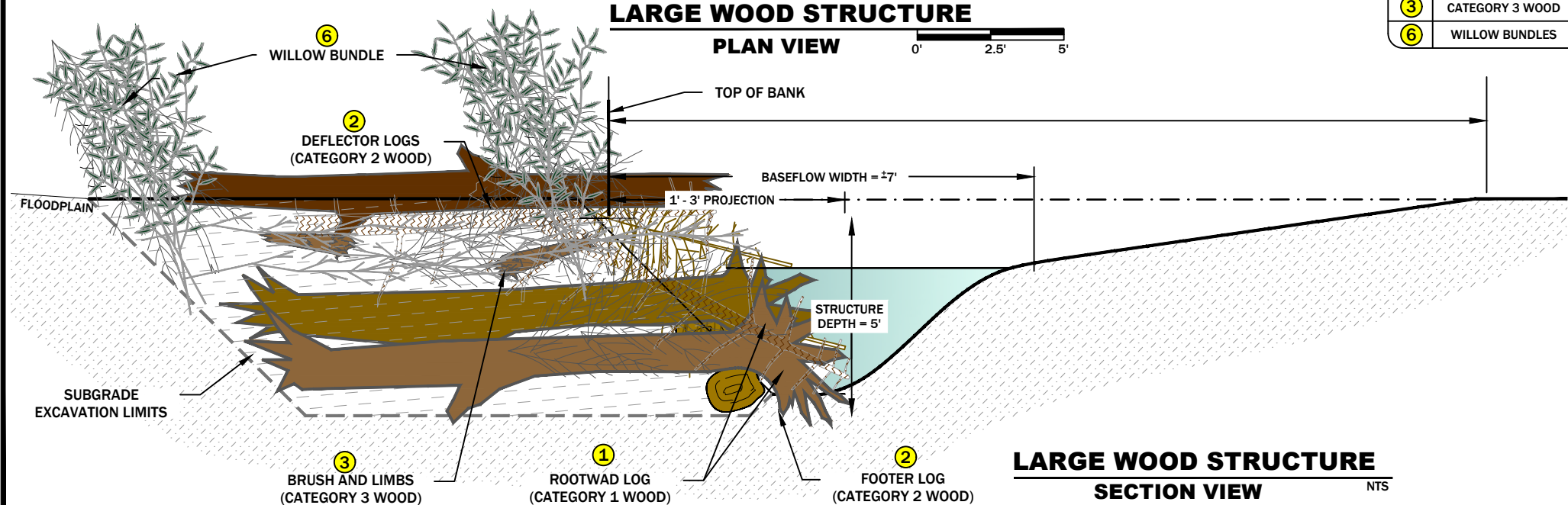
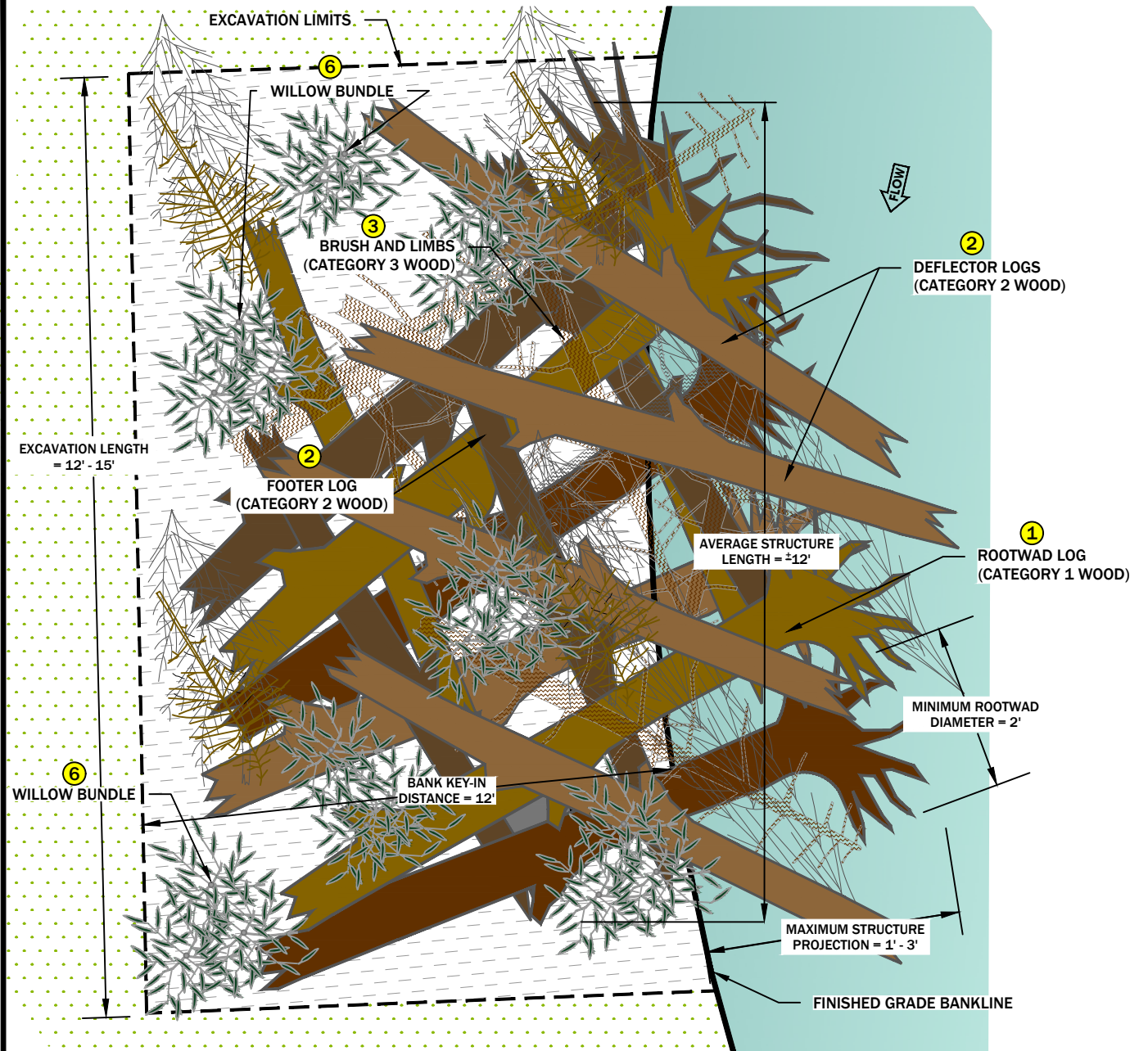
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
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GENERAL NOTES

1. CONSTRUCTION OF THE LARGE WOOD STRUCTURE WILL OCCUR BEFORE THE CONSTRUCTED CHANNEL STREAMBED AND VEGETATED WOOD MATRIX BANK TREATMENTS ARE INSTALLED. INSTALLATION OF FLOODPLAIN TREATMENT SHALL BE COMPLETED AFTER THE LARGE WOOD STRUCTURES ARE INSTALLED.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY THE CONSTRUCTION MANAGER.
3. CONSTRUCTION MANAGER SHALL MARK THE GENERAL CONSTRUCTION LOCATION FOR EACH LARGE WOOD STRUCTURE PRIOR TO CONSTRUCTION.

NOTES ON LARGE WOOD STRUCTURE INSTALLATION

1. EXCAVATE TO THE EXCAVATION LIMITS. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. INSTALL TWO FOOTER LOGS (CATEGORY 2 WOOD) AT THE BASE OF THE EXCAVATED TRENCH AT THE ORIENTATIONS NOTED IN PLAN VIEW. FOOTER LOGS SHALL PROJECT INTO THE DESIGN CHANNEL NO GREATER THAN 3 FT OR AT DISTANCE DIRECTED BY THE CONSTRUCTION MANAGER. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
3. INSTALL TWO ROOTWAD LOGS (CATEGORY 1 WOOD) INTERSECTING BOTH FOOTER LOGS AT THE ORIENTATION NOTED IN PLAN VIEW. THE UPSTREAM ROOTWAD SHALL NOT PROJECT INTO THE CHANNEL AND SHALL BE FLUSH WITH THE FINISHED BANK LINE. THE DOWNSTREAM ROOTWAD SHALL PROJECT NO GREATER THAN 1 - 3 FT. BEYOND THE FINISHED BANK LINE.
4. BACKFILL TRENCH WITH STOCKPILED MATERIAL UP TO THE TOP OF THE ROOTWAD LOGS. BACKFILL SHALL BE BUCKET COMPACTED.
5. INSTALL BRUSH AND LIMBS (CATEGORY 3 WOOD) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. BRUSH AND LIMBS SHALL PROJECT NO GREATER THAN 3 FT BEYOND THE FINISHED BANK LINE.
6. INSTALL ONE ROOTWAD LOG (CATEGORY 1 WOOD) ON TOP OF THE BRUSH AND LIMBS AT THE ORIENTATION NOTED IN PLAN VIEW. THE TOP OF THE ROOTWAD STEMS SHALL SIT AT OR BELOW BASEFLOW ELEVATION. THE UPSTREAM ROOTWAD SHALL NOT PROJECT INTO THE CHANNEL AND SHALL BE FLUSH WITH THE FINISHED BANK LINE. THE DOWNSTREAM ROOTWAD SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE.
7. INSTALL BRUSH AND LIMBS (CATEGORY 3 WOOD) UP TO TOP OF BANK AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. BRUSH AND LIMBS SHALL PROJECT NO GREATER THAN 3 FT BEYOND THE FINISHED BANK LINE.
8. PLACE TWO WILLOW BUNDLES INTERWOVEN INTO WOOD MATRIX AS SHOWN IN THE PLAN VIEW. WILLOW BUNDLES SHALL BE SET AS TO BE IN CONTACT WITH LOW FLOW WATER SURFACE ELEVATION.
9. BACKFILL STRUCTURE WITH STOCKPILED MATERIAL UP TO THE TOP OF BANK LINE ELEVATION. BACKFILL SHALL BE BUCKET COMPACTED.
10. INSTALL TWO DEFLECTOR LOGS (CATEGORY 2 WOOD) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. TOP OF DEFLECTOR LOGS CAN BE UP TO 0.5 FT ABOVE TOP OF BANK ELEVATION AND SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
11. PLACE AND BUCKET COMPACT STOCKPILED MATERIAL TO THE FINISHED BANK LINE. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.

MATERIAL SCHEDULE
(PER STRUCTURE)

	ITEM	DIA.	QUANTITY
①	CATEGORY 1 WOOD	10" - 14"	3
②	CATEGORY 2 WOOD	6" - 12"	4
③	CATEGORY 3 WOOD	< 3"	6
⑥	WILLOW BUNDLES	0.25" - 1"	4



EXAMPLE OF A LARGE WOOD STRUCTURE

LARGE WOOD STRUCTURE DETAIL
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

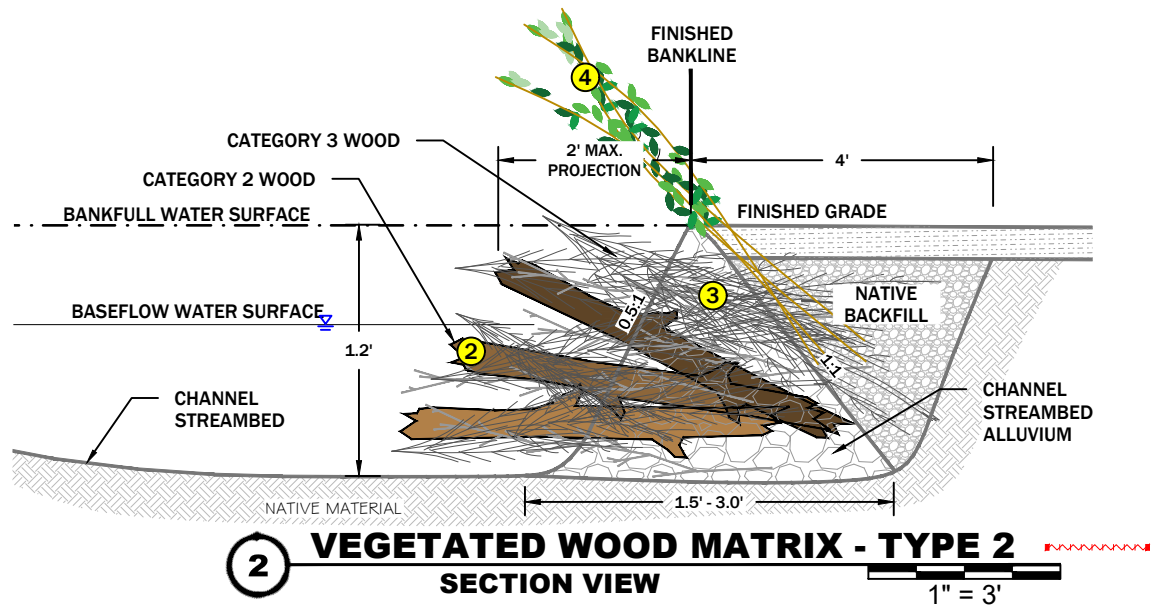
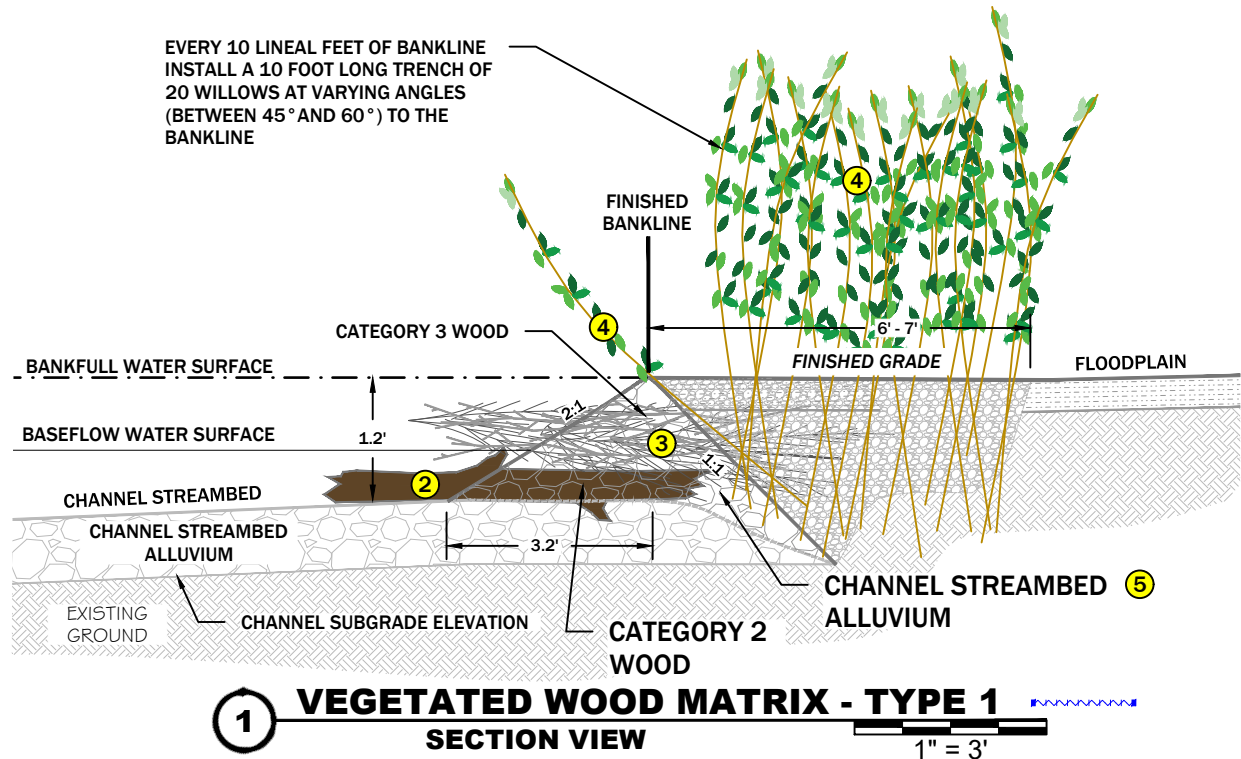
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1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

PROJECT NUMBER
RDG-21-169

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8.0

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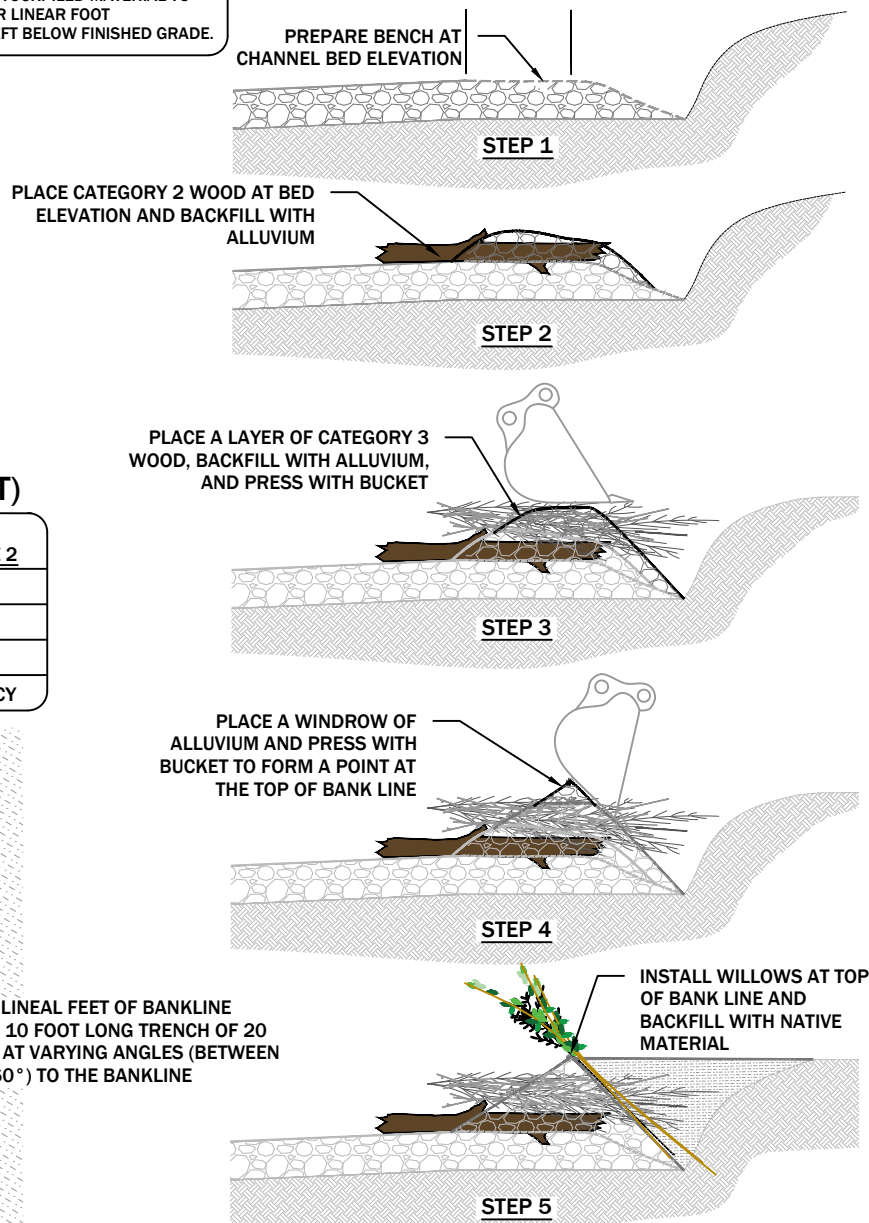
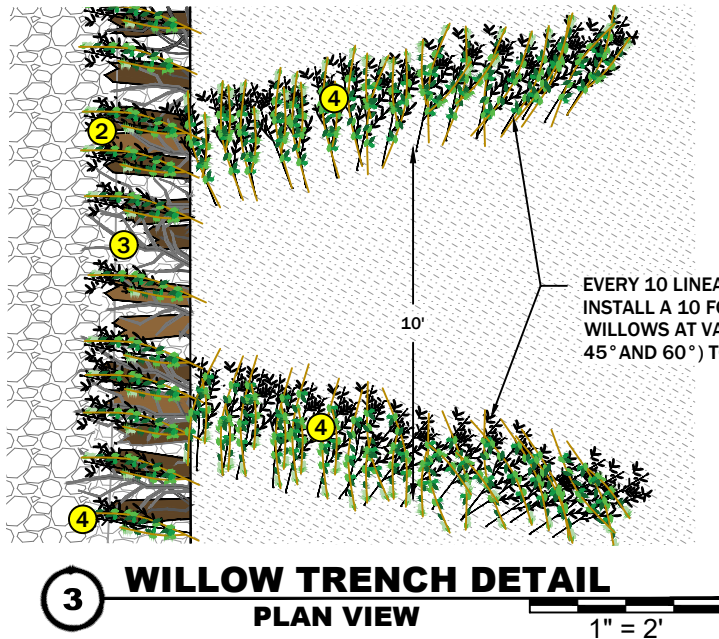


- ### GENERAL NOTES
1. CONSTRUCTION OF THE VEGETATED WOOD MATRIX WILL OCCUR AFTER THE CHANNEL AND FLOODPLAIN BACKFILL IS PLACED AND THE CHANNEL STREAMBED IS CONSTRUCTED. INSTALLATION OF FLOODPLAIN TREATMENT SHALL BE COMPLETED AFTER VEGETATED WOOD MATRIXES ARE INSTALLED.
 2. IF VEGETATED WOOD MATRIX STRUCTURES ARE INSTALLED PRIOR TO OCTOBER 1, LEAVE BACK TRENCH UNFILLED AND COMPLETE STRUCTURE WHEN DORMANT WILLOWS ARE AVAILABLE.
 3. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
 4. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY CONSTRUCTION MANAGER.
 5. CONTRACTOR SHALL MARK AND CONSTRUCTION ENGINEER SHALL APPROVE THE GENERAL LOCATION FOR EACH VEGETATED WOOD MATRIX STRUCTURE PRIOR TO CONSTRUCTION.

- ### NOTES ON VEGETATED WOOD MATRIX INSTALLATION
1. EXCAVATE TO THE EXCAVATION LIMITS AS SHOWN. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
 2. PREPARE THE BENCH OF THE STRUCTURE BY PLACING CHANNEL STREAMBED ALLUVIUM FROM THE BASE OF THE EXCAVATION DEPTH/BOTTOM OF EXCAVATION TO WITHIN 1.0-FT. OF FINISHED GRADE.
 3. CATEGORY 2 AND CATEGORY 3 WOOD, AND CHANNEL STREAMBED ALLUVIUM SHALL BE PLACED IN ALTERNATING LAYERS AND BUCKET COMPACTED UP TO THE TOP OF BANK ELEVATION AS SHOWN BELOW IN THE INSTALLATION SEQUENCE. PLACE SIX (6) FT TO EIGHT (8) FT. DORMANT WILLOW CUTTINGS AT A DENSITY OF 5 PER LINEAR FT ALONG THE TOP OF BANK LINE ELEVATION. WILLOW CUTTINGS SHALL SLOPE AT AN APPROXIMATE 1:1 SLOPE AS SHOWN IN SECTION VIEW. STEMS MAY OVERLAP. THE CUT ENDS SHALL BE PLACED AT THE BASE OF THE SLOPES WITH THE UN-CUT ENDS EXTENDING BEYOND THE EDGE OF THE TRENCH SO NO GREATER THAN ONE-THIRD OF THE TOTAL CUTTING LENGTH IS EXPOSED BEYOND THE TOP OF BANK EDGE. WILLOW CUTTINGS SHOULD INTERCEPT THE DESIGN TOP OF BANK LINE AS SHOWN IN STEP 5 OF THE INSTALLATION SEQUENCE.
 4. THE UPSTREAM AND DOWNSTREAM ENDS OF THE STRUCTURE SHALL TRANSITION SMOOTHLY INTO ADJACENT STREAMBANK STRUCTURES TO MINIMIZE EROSION, FLANKING, AND BANK FAILURE. STRUCTURE ENDS MAY BE STABILIZED WITH ADDITIONAL CATEGORY 1 ROCK AS APPROVED BY ENGINEER.
 5. AFTER INSTALLATION OF THE VEGETATED WOOD MATRIX, BACKFILL THE STRUCTURE WITH STOCKPILED MATERIAL TO FINISHED GRADE, AND BUCKET COMPACT. INSTALL WILLOW TRENCHES AT A RATE OF 2 PER LINEAR FOOT (OR 20 PER TRENCH) AS SHOWN. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.

STREAMBED ALLUVIUM GRADATION		
SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
10	95	D100
8	90-95	D95
5	85-90	D84
3	65 - 85	D65
2	50 - 65	D50
1	30 - 50	D35
0.5	10 - 30	D15
FINES	0-10	

MATERIAL SCHEDULE (PER LINEAR FOOT)				
	ITEM	DIA.	QUANTITY	
			TYPE 1	TYPE 2
②	CATEGORY 2 WOOD	3" - 6"	0.25	2
③	CATEGORY 3 WOOD	< 3"	2	4
④	WILLOW CUTTINGS	0.25" - 1"	5	5
⑤	STREAMBANK ALLUVIUM	6" MINUS	0.2 CY	0.6 CY



RECOMMENDED VEGETATED WOOD MATRIX INSTALLATION SEQUENCE

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

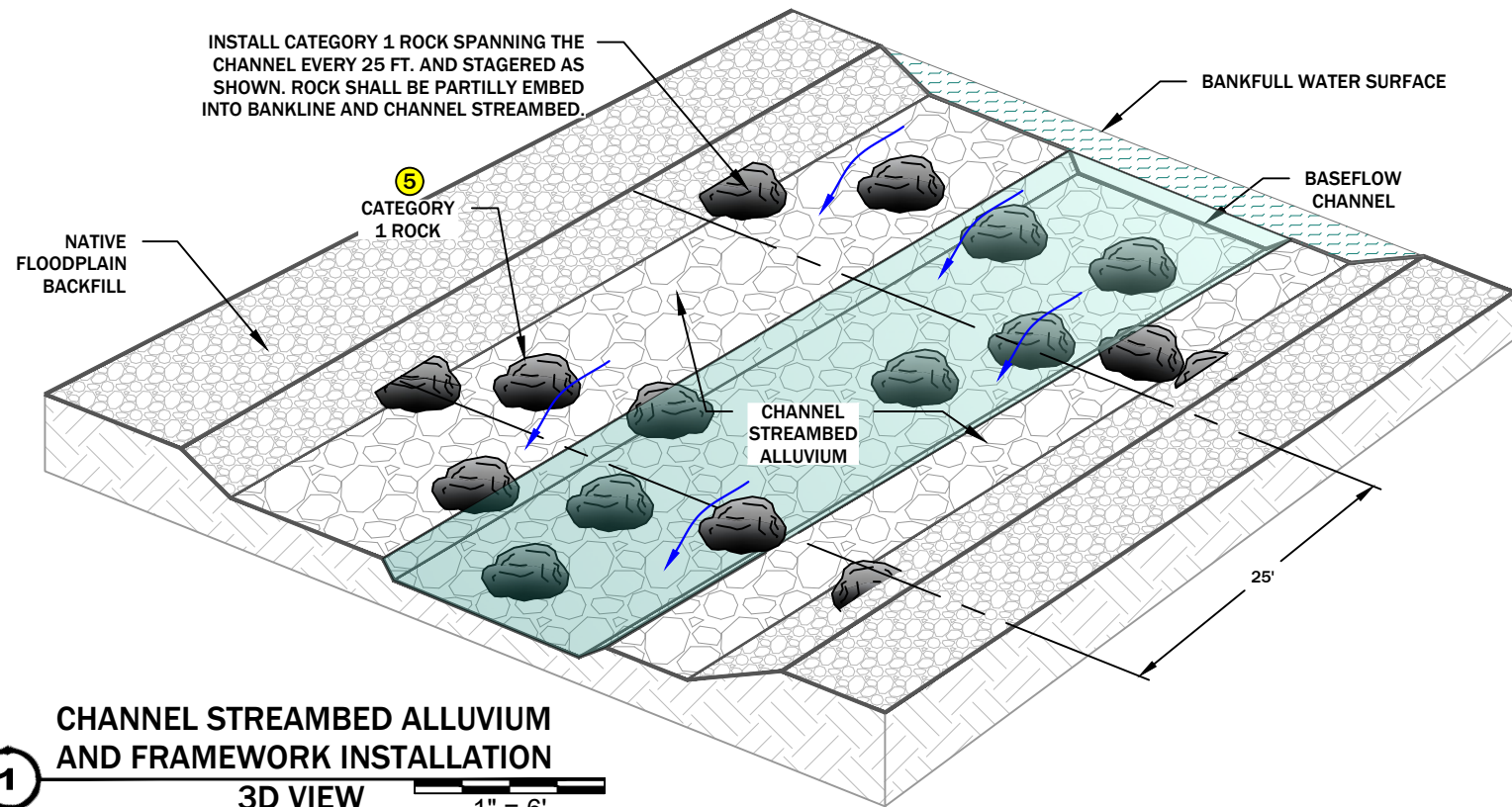
PROJECT NUMBER
RDG-21-169

DRAWING NUMBER

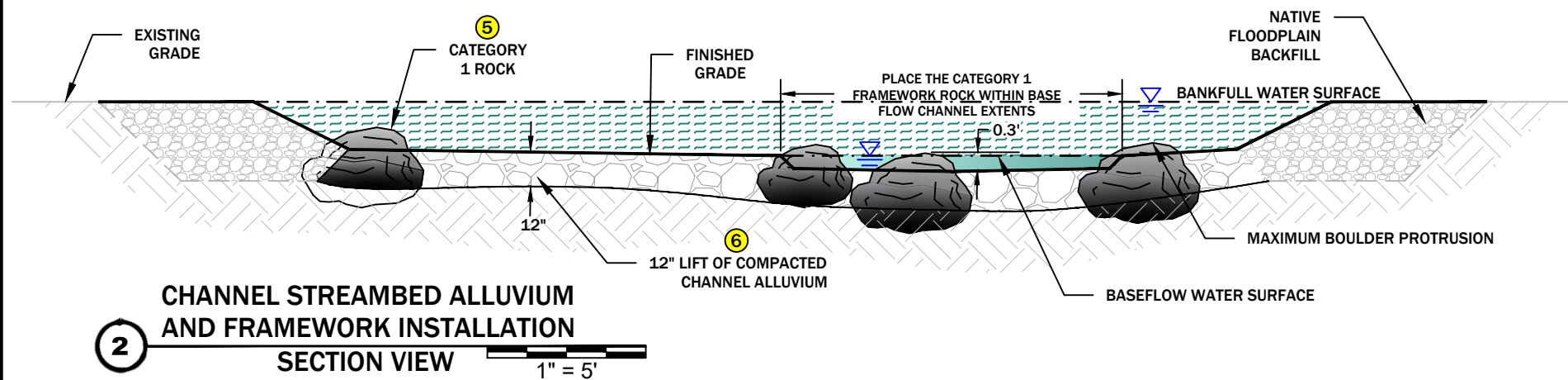
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INSTALL CATEGORY 1 ROCK SPANNING THE CHANNEL EVERY 25 FT. AND STAGGERED AS SHOWN. ROCK SHALL BE PARTILLY EMBED INTO BANKLINE AND CHANNEL STREAMBED.



1 CHANNEL STREAMBED ALLUVIUM AND FRAMEWORK INSTALLATION
3D VIEW
1" = 6'



2 CHANNEL STREAMBED ALLUVIUM AND FRAMEWORK INSTALLATION
SECTION VIEW
1" = 5'



TYPICAL CONSTRUCTED STREAMBED THROUGH A RIFFLE FEATURE

GENERAL NOTES

1. CONSTRUCTION OF THE CHANNEL STREAMBED WILL OCCUR AFTER THE CHANNEL SUBGRADE IS PREPARED.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE CONSTRUCTION MANAGER.
3. IT IS THE CONTRACTORS RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
4. CONTRACTOR SHALL MARK THE UPSTREAM AND DOWNSTREAM EXTENTS OF THE LOCATIONS OF THE CONSTRUCTED CHANNEL STREAMBED STRUCTURES.

NOTES ON CONSTRUCTED CHANNEL STREAMBED INSTALLATION

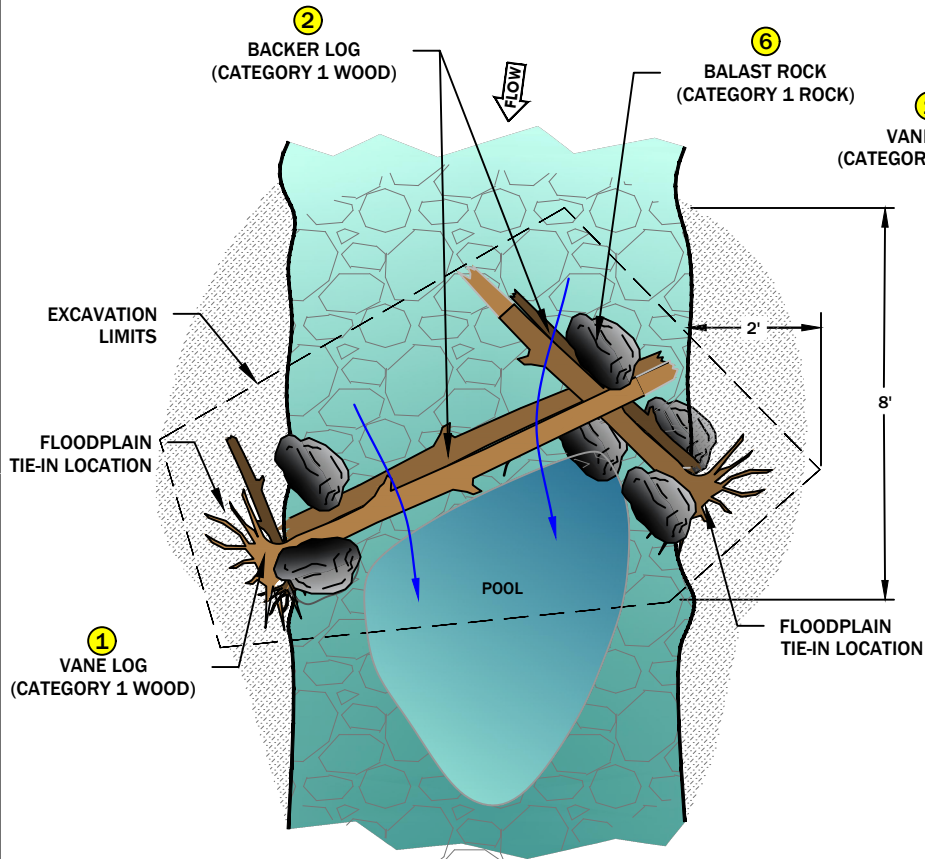
1. PRIOR TO CONSTRUCTION OF THE CHANNEL STREAMBED, CONSTRUCTION MANAGER SHALL VERIFY CHANNEL SUBGRADE ELEVATIONS. CHANNEL SUBGRADE SERVES AS THE FOUNDATION FOR THE CONSTRUCTED CHANNEL STREAMBED.
2. CONTRACTOR SHALL STOCKPILE CHANNEL ALLUVIUM PER SPECIFICATIONS NOTED ON THE DRAWING.
3. PREPARE THE FRAMEWORK. CONTRACTOR SHALL PLACE 10-INCH TO 12-INCH BOULDER SILLS (CATEGORY 1 ROCK) ON THE SURFACE OF THE CHANNEL SUBGRADE PRIMARILY WITHIN THE LOW FLOW CHANNEL AS INDICATED ON THE DRAWING. DUE TO THE INHERENT VARIABILITY IN MATERIALS, BOULDER ELEVATIONS SHALL BE ADJUSTED TO ASSURE BOULDER PROTRUSION ABOVE FINISH GRADE WILL BE NO GREATER THAN 0.5-FT.
4. PREPARE THE MATRIX. AFTER THE FRAMEWORK BOULDER RIBS ARE INSTALLED AND INSPECTED BY CONSTRUCTION MANAGER, PLACE APPROPRIATE CHANNEL STREAMBED ALLUVIUM GRADATION AND WASH FINES INTO STREAMBED. CHANNEL STREAMED ALLUVIUM SHALL BE PLACED TO THE FULL COURSE THICKNESS OF 12-INCHES TO FINISHED GRADE.

STREAMBED ALLUVIUM GRADATION

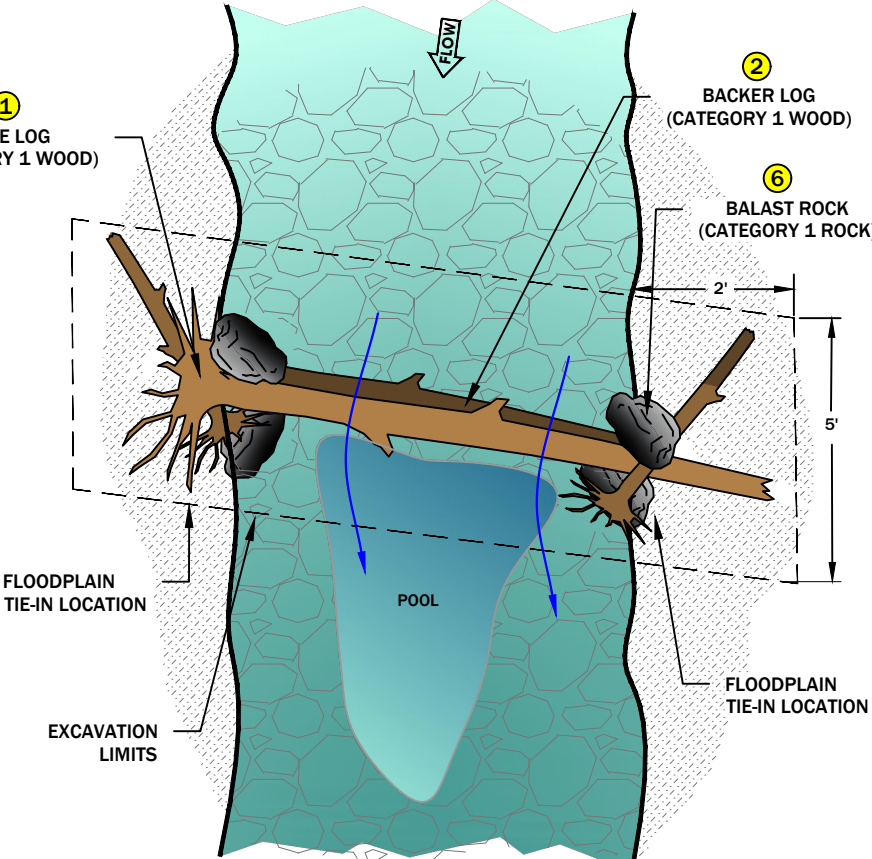
SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
10	95	D100
8	90-95	D95
5	85-90	D84
3	65 - 85	D65
2	50 - 65	D50
1	30 - 50	D35
0.5	10 - 30	D15
FINES	0-10	

MATERIAL SCHEDULE (PER LINEAR FOOT)

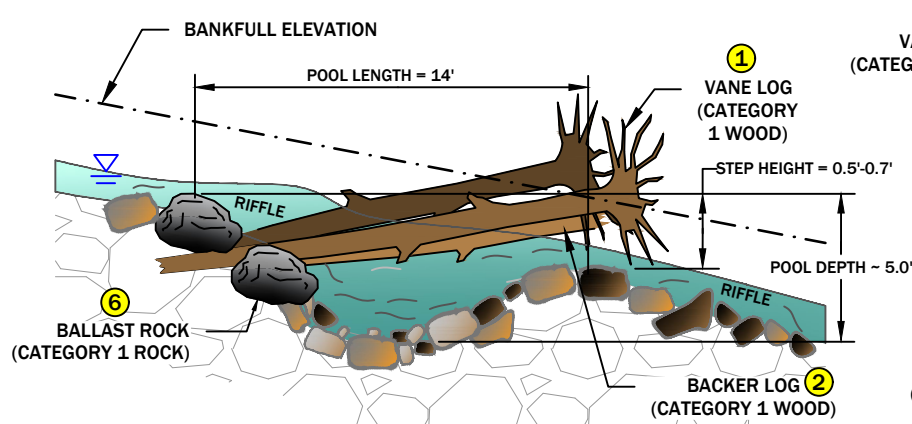
NO.	DATE	BY	DESCRIPTION	ITEM	DIA.	QUANTITY
1	1/12/22	LS	DESIGN	CATEGORY 1 ROCK	10" - 12"	0.2 EA
2	1/26/22	LS	DESIGN REVISION	CHANNEL STREAMBED ALLUVIUM	10" MINUS	0.35 CY



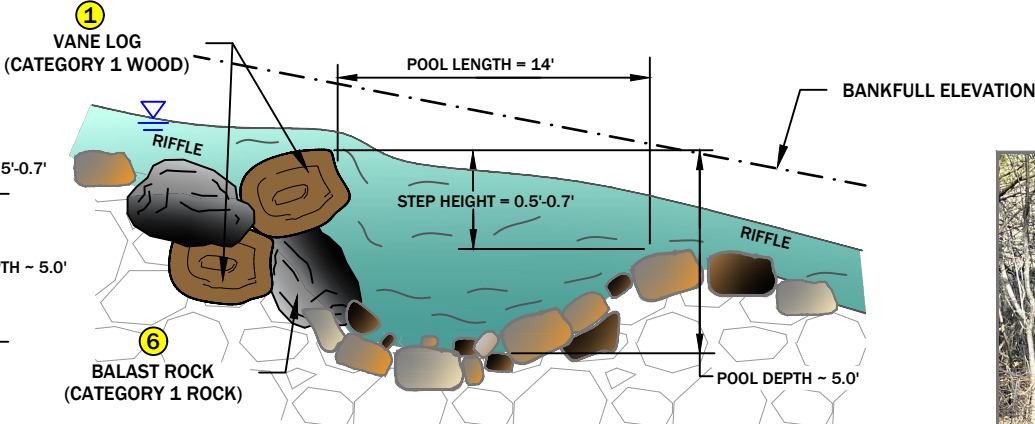
1 **TYPICAL LOG STEP POOL**
PLAN VIEW NTS



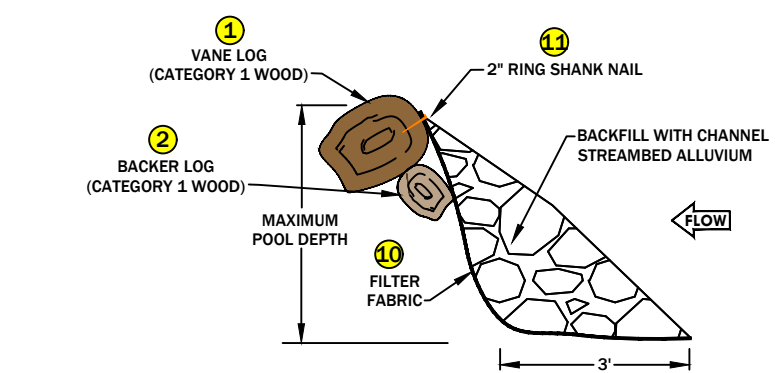
3 **TYPICAL LOG STEP POOL**
PLAN VIEW NTS



2 **TYPICAL LOG STEP POOL**
PROFILE VIEW NTS



4 **TYPICAL LOG STEP POOL**
PROFILE VIEW NTS



5 **FILTER FABRIC DETAIL**
SECTION VIEW NTS

MATERIAL SCHEDULE
(PER STRUCTURE)

ITEM	QUANTITY
1 CATEGORY 1 WOOD	2
2 CATEGORY 2 WOOD	3
6 CATEGORY 1 ROCK	6
10 LF OF FILTER FABRIC	17
11 2" RING SHANK NAILS	20

GENERAL NOTES

1. CONSTRUCTION OF THE CHANNEL LOG STEP POOL WILL OCCUR PRIOR TO THE CONSTRUCTED CHANNEL.
2. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
3. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY ENGINEER.
4. CONTRACTOR SHALL MARK AND ENGINEER SHALL APPROVE THE FLOODPLAIN AND CHANNEL STREAMBED TIE-IN LOCATIONS.

NOTES ON CONSTRUCTED CHANNEL LOG STEP POOL INSTALLATION

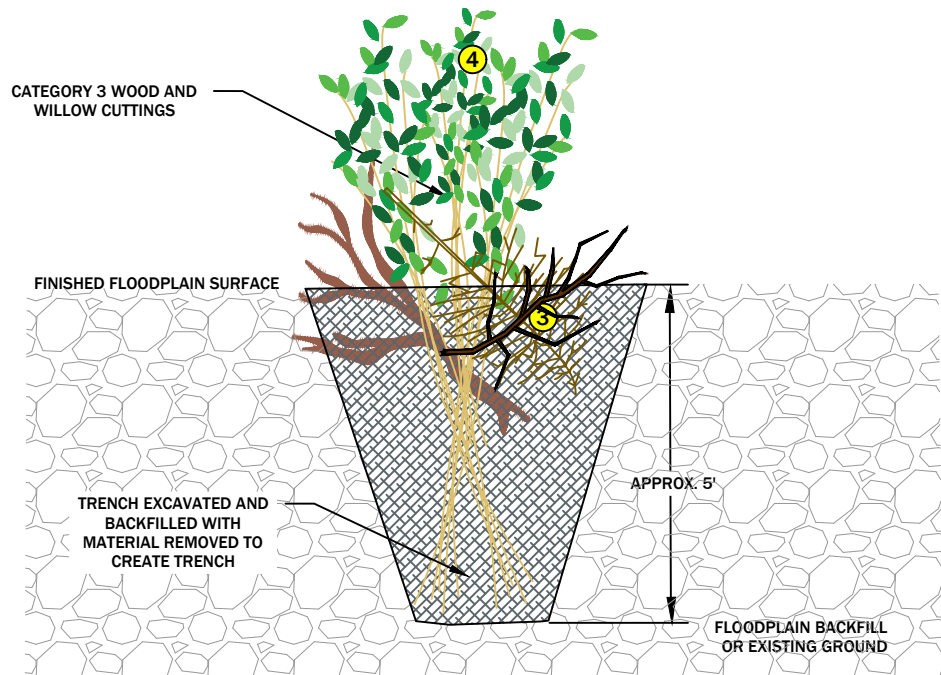
1. PRIOR TO CONSTRUCTION OF THE CHANNEL LOG STEP POOL, ENGINEER SHALL VERIFY CHANNEL SUBGRADE ELEVATIONS.
2. CONTRACTOR SHALL STOCKPILE WOOD AND ROCK PER SPECIFICATIONS NOTED ON THE DRAWINGS.
3. EXCAVATE TO THE EXCAVATION LIMITS. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
4. INSTALL VANE LOGS (CATEGORY 1 WOOD) AT THE FLOODPLAIN TIE-IN LOCATIONS AND TO THE ORIENTATIONS NOTED ON THE DRAWING. VANE LOGS SHALL BE PLACED ON CHANNEL ALLUVIUM AND THE ROOTWADS SHALL BE EMBEDDED INTO THE STREAMBANK A MINIMUM OF 2-FT. RELATIVE TO FINISHED BANK LINE.
5. ORIENT VANE LOGS IN CONTACT WITH THE CHANNEL STREAMBED AS SHOWN ON THE DRAWING. EMBED VANE LOG TIPS INTO THE CHANNEL STREAMBED A MINIMUM OF 3-FT. SLOPING AT AN ANGLE NO GREATER THAN 6% RELATIVE TO FLOODPLAIN ELEVATION. VANE LOG TIPS SHALL BE A MINIMUM OF 1-FT. BELOW THE CHANNEL STREAMBED FINISHED GRADE.
6. INSTALL BACKER LOGS (CATEGORY 1 WOOD) ON THE UPSTREAM SIDE OF THE VANE LOGS AS SHOWN ON THE DRAWINGS. BACKER LOGS SHALL BE FLUSH WITH THE VANE LOGS AND EXTEND FROM THE FLOODPLAIN TIE-IN LOCATIONS TO THE TIPS OF THE VANE LOGS.
7. INSTALL CATEGORY 1 ROCK UPSTREAM AND DOWNSTREAM OF THE STREAMBANK TIE-IN LOCATIONS AND VANE LOG TIPS. ROCK SHALL BE IN CONTACT WITH VANE LOGS AND BACKER LOGS TO PROVIDE BALLAST AND TO PREVENT THE STRUCTURE FROM SHIFTING WHILE THE STRUCTURE IS BACKFILLED.
8. ATTACH NON-WOVEN GEOTEXTILE FABRIC TO VANE LOGS AND EXTEND VERTICALLY TO THE MAXIMUM DEPTH OF THE POOL CHANNEL CROSS-SECTION ON THE UPSTREAM SIDE OF THE STRUCTURE, AS SHOWN ON DRAWING. BACKFILL VANE LOGS WITH EXCAVATED CHANNEL STREAMBED ALLUVIUM TO CHANNEL STREAMBED FINISHED GRADE.
9. REGRADE UPSTREAM AND DOWNSTREAM CHANNEL STREAMBED FINISHED GRADE ELEVATIONS. IF EXCESS MATERIAL IS SIDECAST IN POOL DURING CONSTRUCTION, CONTRACTOR SHALL RE-EXCAVATE POOL TO THE DESIGN DIMENSIONS AS APPROVED BY ENGINEER.



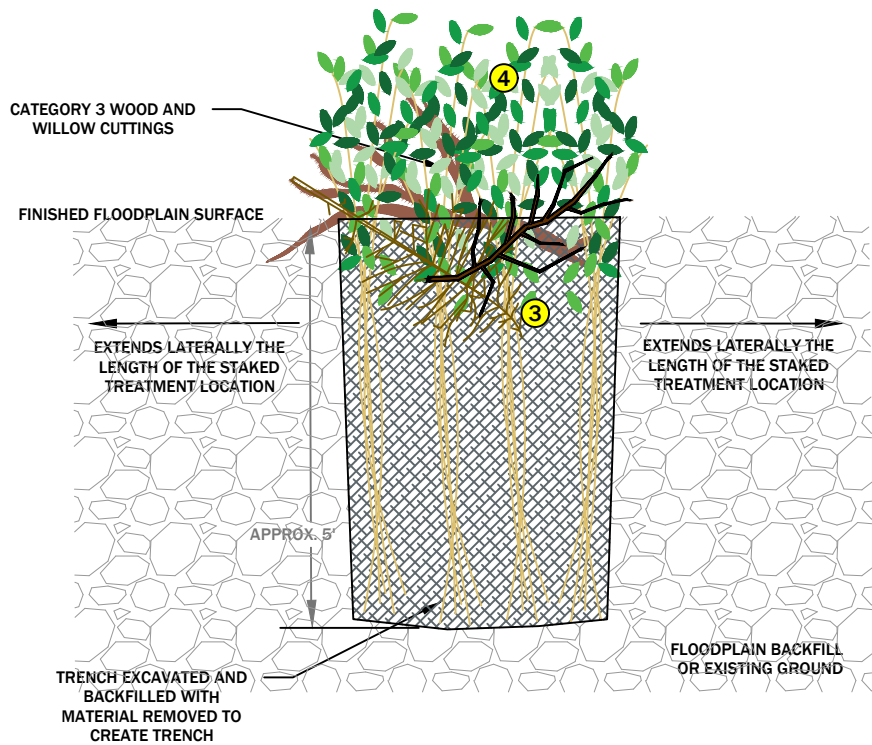
EXAMPLE OF A CONSTRUCTED LOG STEP POOL

CHANNEL LOG STEP POOL
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

CHK	DESCRIPTION	BY	DATE	NO.
NW	DESIGN	LS	1/12/22	1
JM	DESIGN REVISION	LS	1/26/22	2



1 VEGETATED BRUSH TRENCH
PROFILE VIEW NTS



2 VEGETATED BRUSH TRENCH
SECTION VIEW NTS

MATERIAL SCHEDULE (PER LINEAR FOOT)

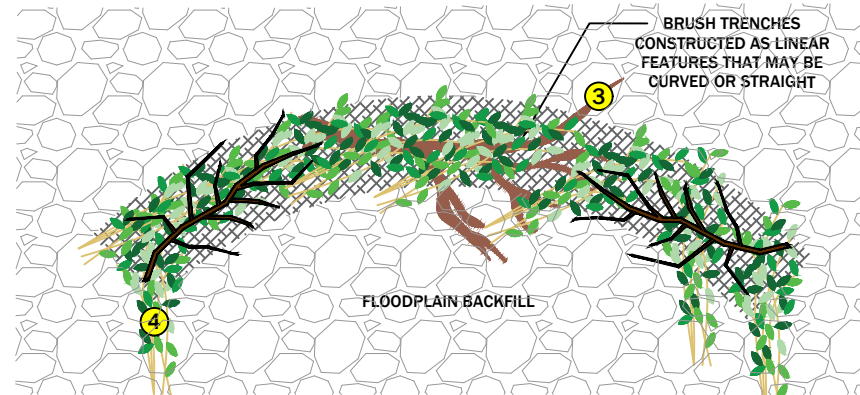
	ITEM	DIA.	QUANTITY
3	CATEGORY 3 WOOD	< 3"	2
4	WILLOW CUTTINGS	0.25" - 1"	5

GENERAL NOTES

1. VEGETATED BRUSH TRENCHES WILL BE CONSTRUCTED TO INCREASE FLOODPLAIN CONNECTIVITY, DISPERSE SURFACE FLOWS AND PROMOTE REVEGETATION. CONSTRUCTION OF VEGETATED BRUSH TRENCHES WILL OCCUR AFTER SEPTEMBER 15TH AND BEFORE THE END OF THE CONSTRUCTION SEASON.
2. CONTRACTOR SHALL MARK AND ENGINEER SHALL APPROVE THE GENERAL CONSTRUCTION LOCATION FOR EACH VEGETATED BRUSH TRENCH PRIOR TO CONSTRUCTION.

NOTES ON VEGETATED BRUSH TRENCH INSTALLATION

1. VEGETATED BRUSH TRENCHES WILL BE CONSTRUCTED WITHIN THE FLOODPLAIN AT THE DIRECTION OF THE CONSTRUCTION MANAGER.
2. A TRENCH WILL BE CONSTRUCTED APPROXIMATELY 5' DEEP AND EXTEND THE LENGTH OF THE STAKED TREATMENT LOCATION. LIVE WILLOW CUTTINGS AND CATEGORY 3 WOOD WILL BE PLACED IN THE TRENCH SUCH THAT THEY ARE INTERMIXED AND ORIENTED AT A NEAR VERTICAL ANGLE.
3. THE TRENCH WILL THEN BE BACKFILLED WITH THE SAME MATERIAL REMOVED TO CREATE THE TRENCH AND SHOULD MATCH THE ELEVATION OF THE SURROUNDING FLOODPLAIN GRADE.



3 VEGETATED BRUSH TRENCH
PLAN VIEW NTS



EXAMPLE OF A VEGETATED BRUSH TRENCH INSTALLATION



EXAMPLE OF A CONSTRUCTED VEGETATED BRUSH TRENCH

NO.	DATE	BY	DESCRIPTION	CHK
1	1/12/22	LS	DESIGN	NW
2	1/26/22	LS	DESIGN REVISION	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER


8.4


Drawing 20 of 22


PLANTING NOTES


- 1. STOCKPILE ALL WOODY MATERIAL, NATIVE VEGETATION, TOPSOIL, AND NATURAL RIVER MATERIAL DISPLACED DURING CONSTRUCTION AND USE FOR SITE RESTORATION. THE STOCKPILED MATERIALS SHALL BE INCORPORATED INTO COVER OF DISTURBED AREAS TO RESTORE THE SITE TO NATURAL CONDITIONS WHILE MINIMIZING THE POTENTIAL FOR EROSION.
- 2. LONG-TERM, PERMANENT REVEGETATION SHALL BE INSTALLED IN ACCORDANCE WITH REVEGETATION SCHEDULE INCORPORATED IN THIS DRAWING SET. PLANTINGS WILL BE FIELD FIT BETWEEN WILLOW TRENCHES AND FINAL PLACEMENT WILL CONSIDER FLOODPLAIN ROUGHNESS AND FIELD CONDITIONS.
- 3. WILDLIFE BROWSE PROTECTION AROUND PLANTINGS WILL BE COMPRISED OF WILDLIFE EXCLOSURE FENCING UNITS. EXCLOSURE FENCING UNITS CAN BE INSTALLED PRIOR TO PLANTING. FINAL PLACEMENT OF EXCLOSURE UNITS WILL VARY BASED ON FLOODPLAIN ROUGHNESS AND FIELD CONDITIONS.

LEGEND

 FLOODPLAIN PLANTING UNIT

 RIPARIAN PROTECTION FENCE

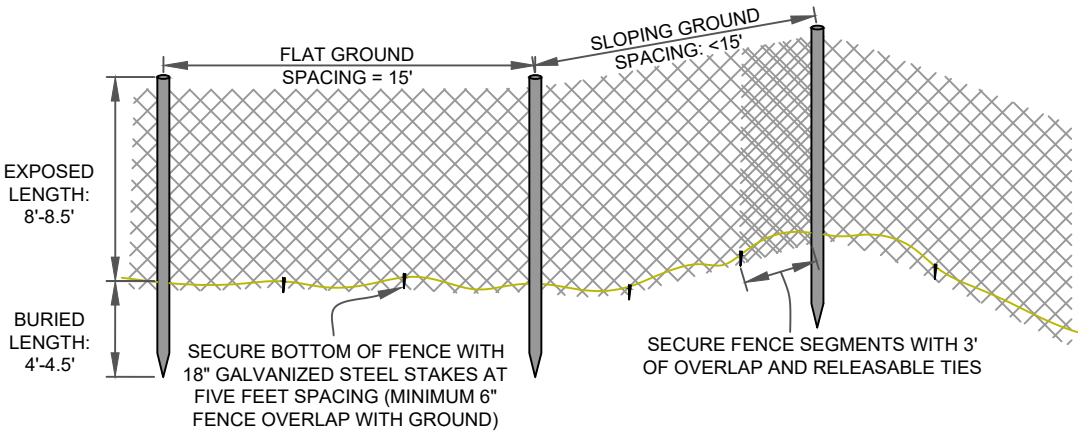
 TEMPORARY ACCESS ROAD

 STAGING AREA

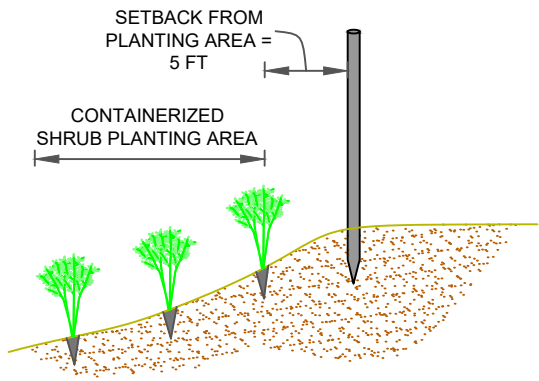
PLANTING SCHEDULE				
COMMON NAME	SCIENTIFIC NAME	CONTAINER SIZE (GALLON)	MINIMUM SPACING (FT)	TOTAL NUMBER
BLACK COTTONWOOD	POPULUS TRICHOCARPA	TALL 1	15	15
		5 GAL	15	8
		25 GAL	15	5
WATER BIRCH	BETULA OCCIDENTALIS	TALL 1	10	17
SERVICE BERRY	AMELANCHIER ALNIFOLIA	TALL 1	10	17
GOLDEN CURRANT	RIBES AUREUM	TALL 1	8	54
WESTERN SNOWBERRY	SYMPHORICARPOS OCCIDENTALIS	TALL 1	8	54
RED-OSIER DOGWOOD	CORNUS SERICEA	TALL 1	8	82
			TOTAL	254



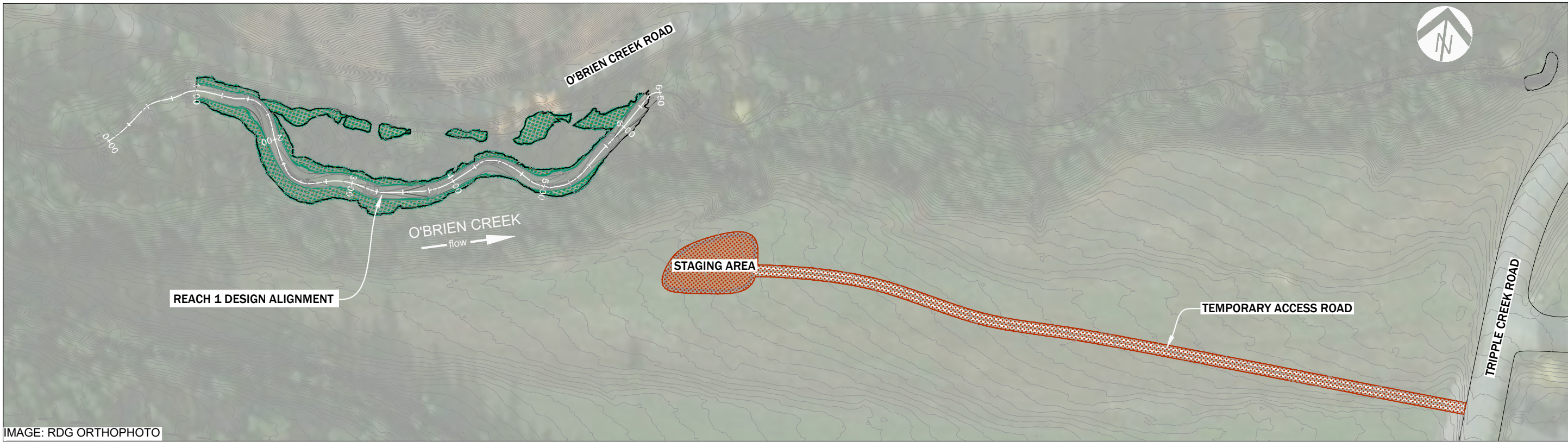
1 PLANTING PLAN
REACH 2 AND 3
1" = 60'



1 RIPARIAN PROTECTION FENCE
SIDE VIEW
1" = 6'

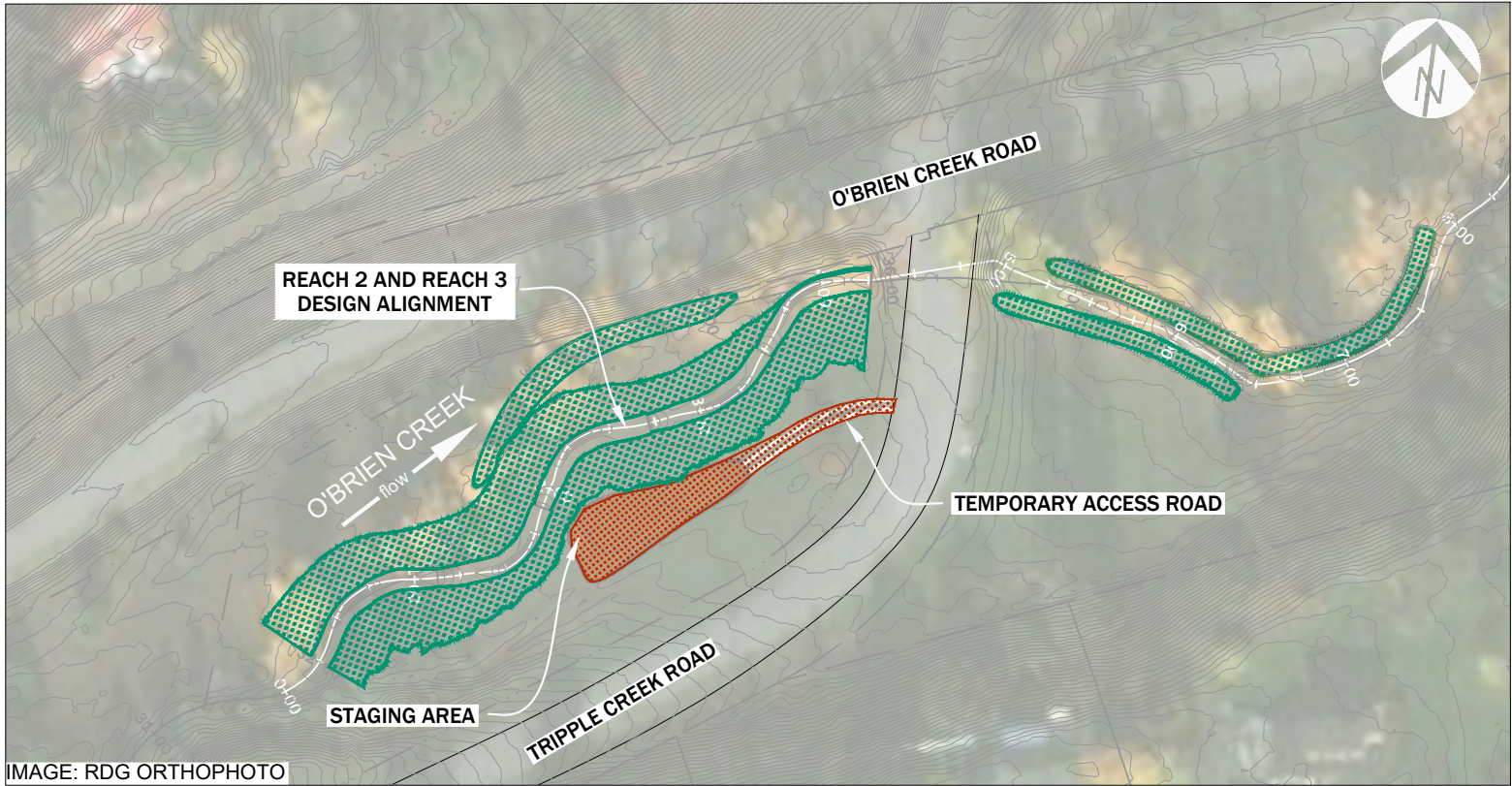


2 RIPARIAN PROTECTION FENCE
SECTION VIEW
1" = 6'



1 O'BRIEN CREEK PLAN VIEW
REACH 1

1" = 100'



2 O'BRIEN CREEK PLAN VIEW
REACH 2 AND 3

1" = 100'

LEGEND

UPLAND SEEDING UNIT

FLOODPLAIN SEEDING UNIT

TEMPORARY ACCESS ROAD

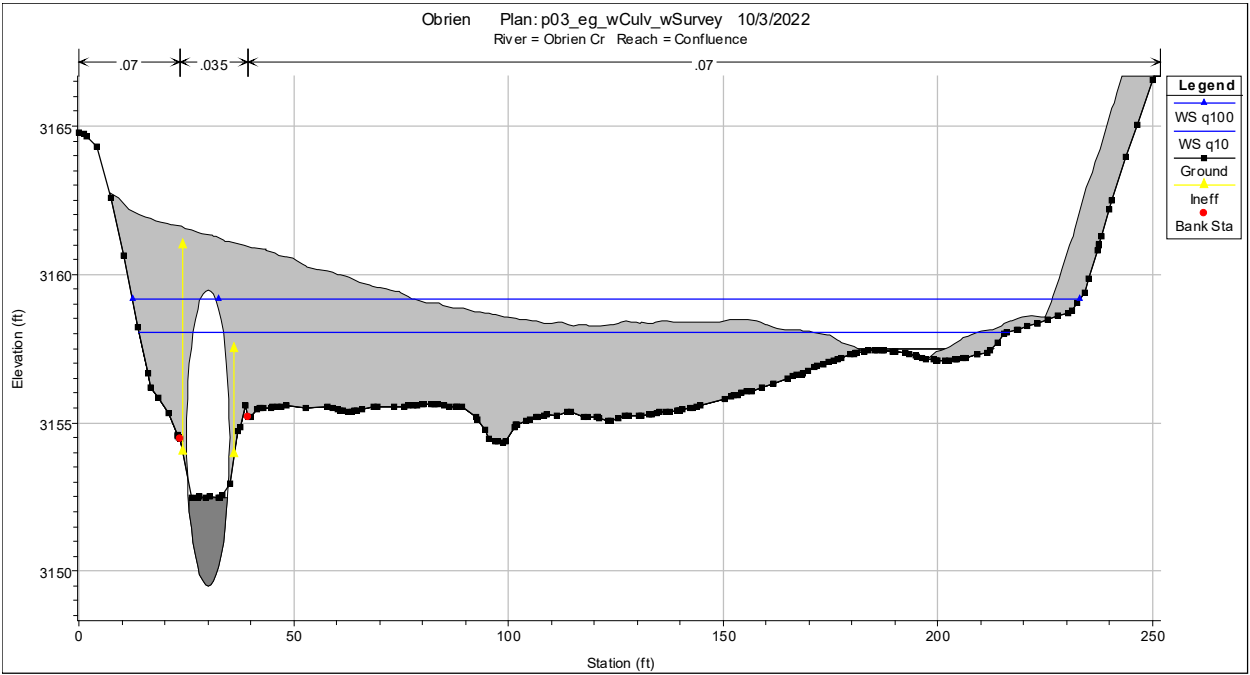
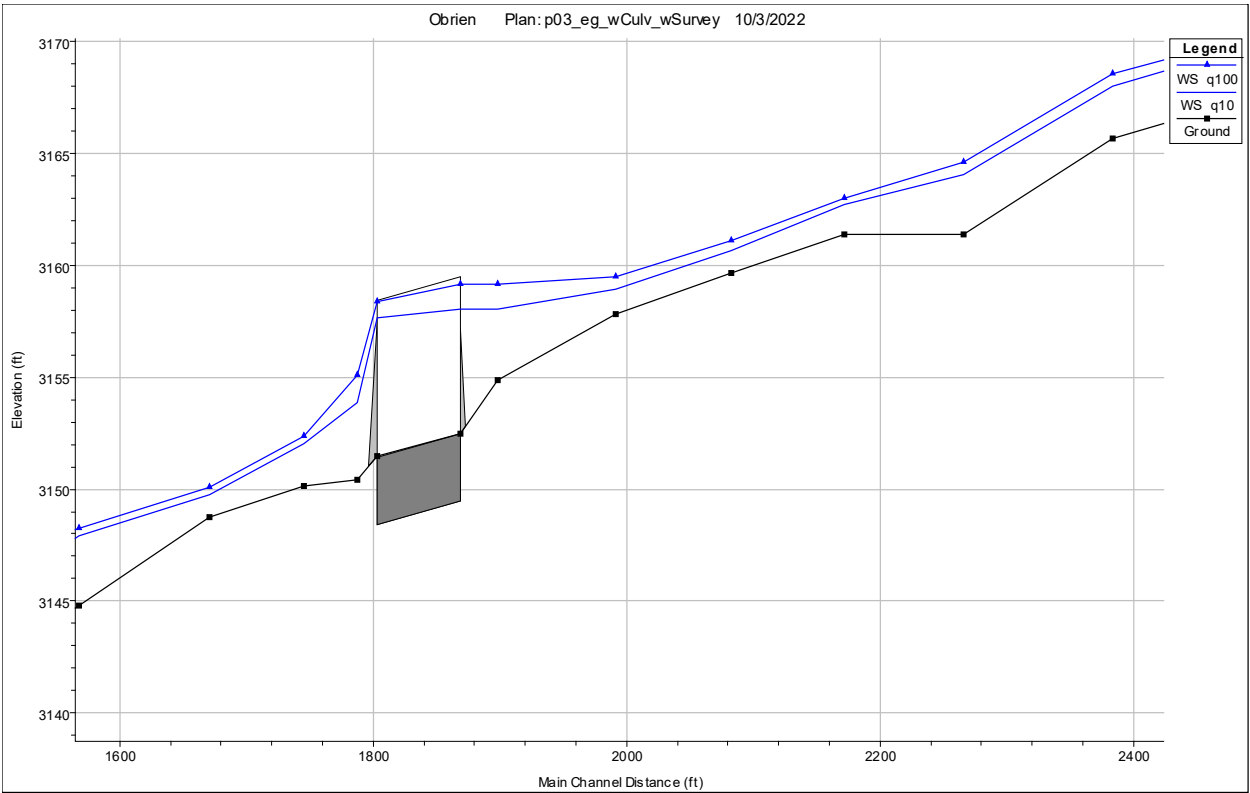
STAGING AREA

FLOODPLAIN SEEDING SCHEDULE			
COMMON NAME	SCIENTIFIC NAME	LBS/ACRE (PLS)	TOTAL PLS LBS
SLENDER WHEATGRASS	ELYMUS TRACHYCAULUS	5.88	4.11
WESTERN WHEATGRASS	PASCOPYRUM SMITHII	10.45	7.31
BLUEJOINT	CALAMAGROSTIS CANADENSIS	0.65	0.46
MOUNTAIN BROME	BROMUS MARGINATUS	9.18	6.43
PRAIRIE FLAX	LINUM LEWISII	0.16	0.11
TOTAL			18.43

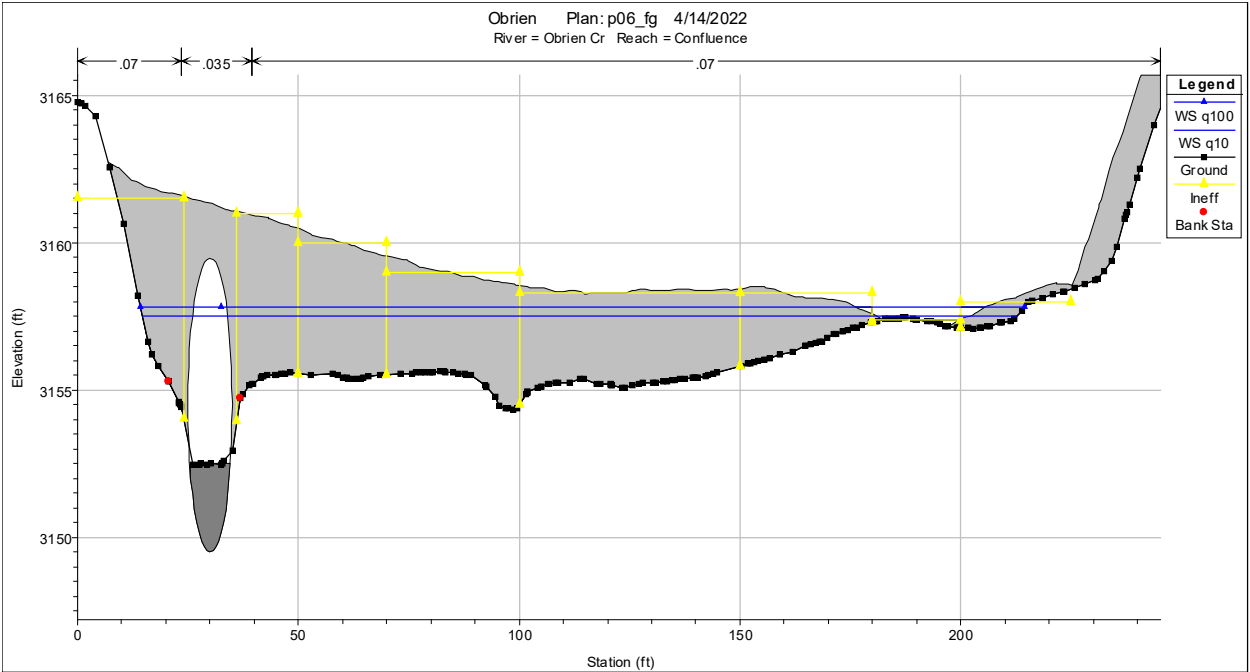
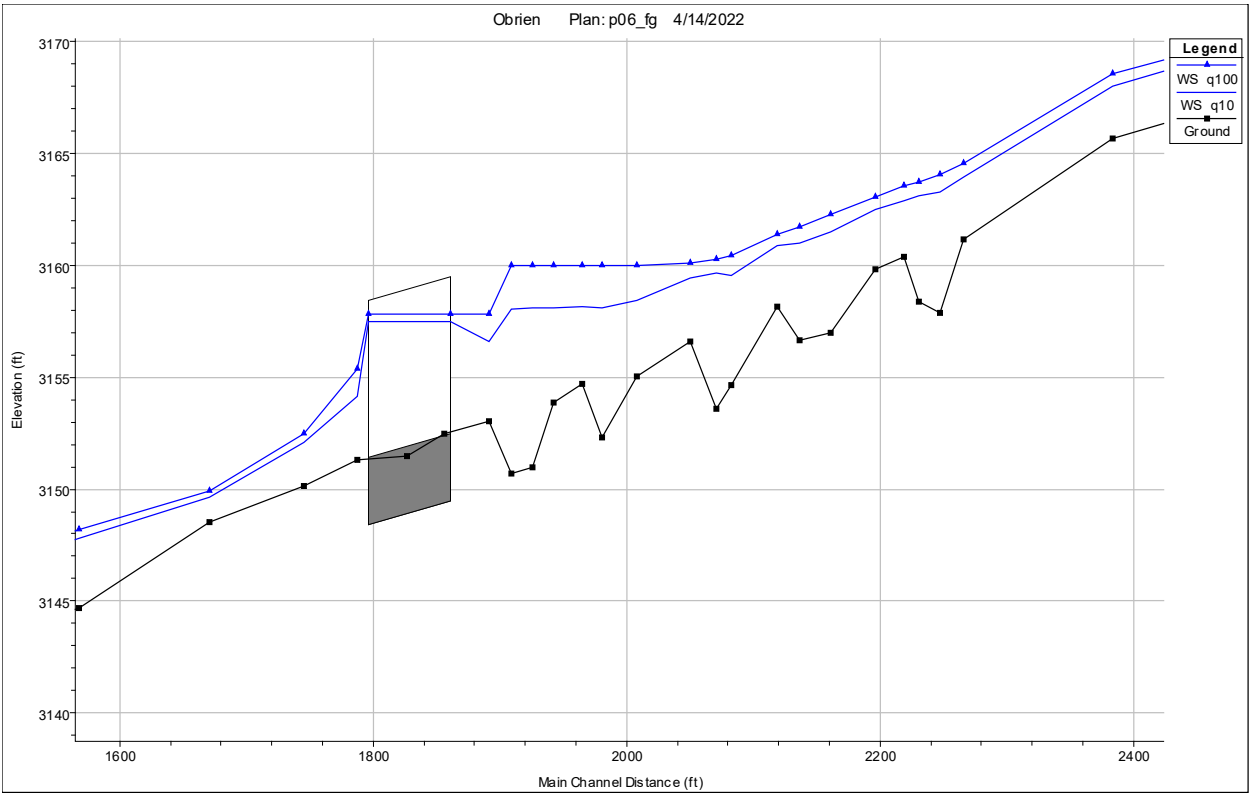
UPLAND SEEDING SCHEDULE			
COMMON NAME	SCIENTIFIC NAME	LBS/ACRE (PLS)	TOTAL PLS LBS
INDIAN RICEGRASS	ACHNATHERUM HYMENOIDES	6.13	1.41
BEARDLESS WILDRYE	LEYMUS TRITICOIDES	17.02	3.91
BASIN WILDRYE	LEYMUS CINEREUS	5.15	1.18
SANDBERG BLUEGRASS	POA SECUNDA	0.68	0.16
TOTAL			6.67

- SEEDING NOTES
1. SEEDING SHALL TAKE PLACE AFTER ACCESS AND STAGING AREAS ARE RECLAIMED.
- CONSTRUCTION NOTES
- 1 BROADCAST SEED DESIGNATED AREAS USING FLOODPLAIN SEED MIX (GIVEN BY SCHEDULE SPECIFIED IN DRAWING SET).
- 2 BROADCAST SEED DESIGNATED AREAS USING UPLAND SEED MIX (GIVEN BY SCHEDULE SPECIFIED IN DRAWING SET).

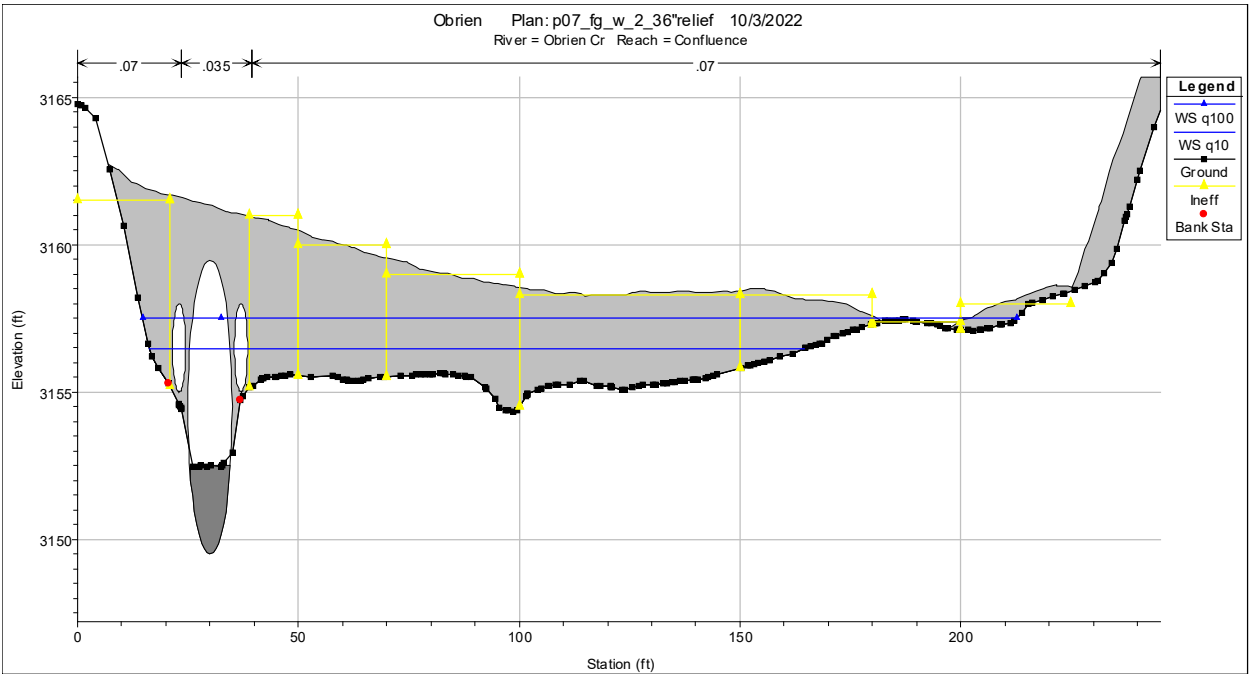
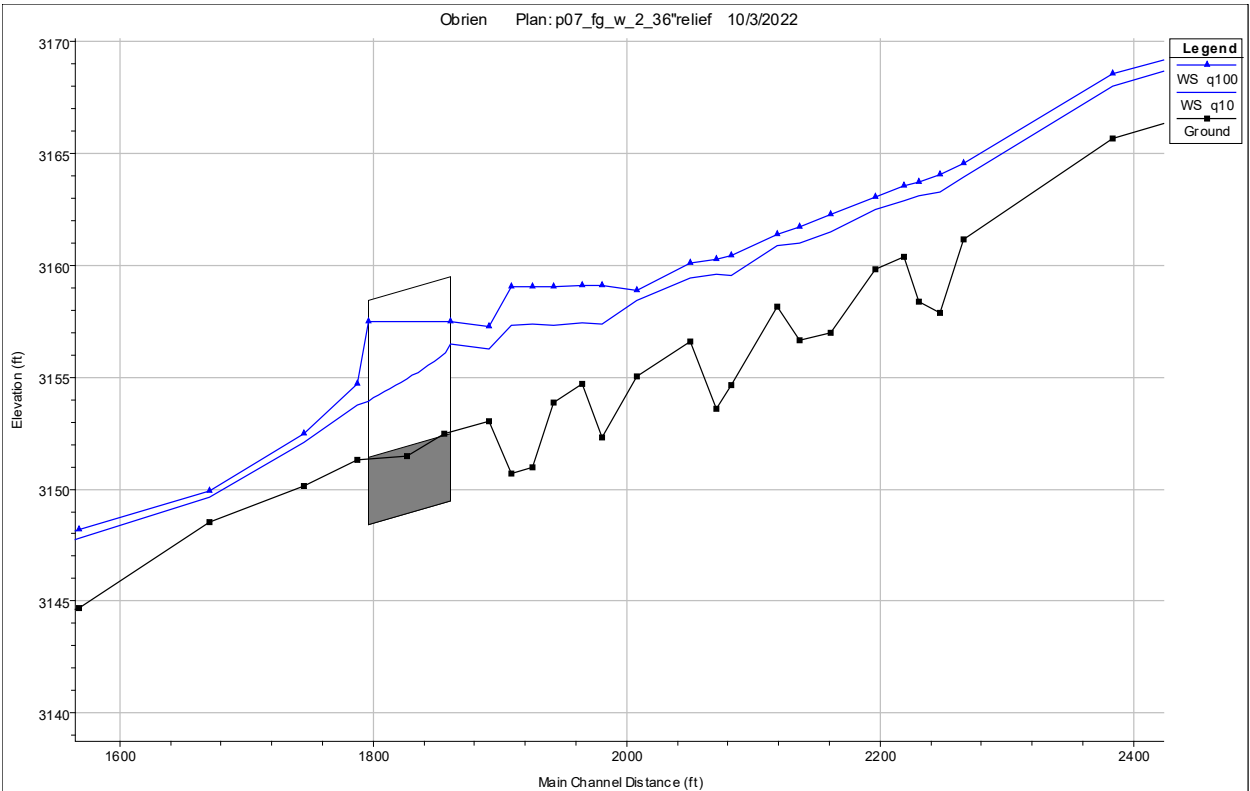
Pre-project Conditions



Post-project Conditions with existing 10-ft CMP



Post-project Conditions with existing 10-ft CMP and 2 36" CMP's



Letters of Support

Carolyn Diddel
Hillsdale Estates Property Owners Association
8419 Hollister Ter
Missoula, MT 59804

To whom it may concern:

Please accept this letter as the Hillsdale Estates Property Owners Association's endorsement of the proposed stream repair project on our reach of O'Brien Creek with the extremely high eroding bank. We have worked with the Clark Fork Coalition in the past to restore instream flow to O'Brien Creek and support the Clark Fork Coalition's ongoing efforts to reduce sediment and restore fish habitat on the creek. We appreciate the work that the Clark Fork Coalition is doing to assist with project development and funding. Once a final design is done, we'll be supportive of signing a landowner agreement that allows the work to occur on our property to repair the eroding bank. We are supportive of this work that helps the fish and the stream. Thank you for all assistance.

Sincerely,


Carolyn Diddel
Hillsdale Estates Property Owners Association

COOPERATIVE AGREEMENT
between
Clark Fork Coalition
and
O'Brien Creek Meadows HOA (Landowner)

This Cooperative AGREEMENT, dated as of August 4, 2021 (the "Effective Date") is entered into between the Clark Fork Coalition, a Montana nonprofit corporation, at 140 S. 4th Street West, Unit 1, Missoula, MT 59801 ("CFC"), and the O'Brien Creek Meadows Home Owners Association, PO Box 3502, Missoula, MT 59806 ("Landowner"). CFC and Landowner are sometimes referred to collectively herein as the "PARTIES." In consideration of the mutual covenants and stipulations described below, CFC and the Landowner agree as follows:

1. PURPOSE AND GENERAL PROJECT DESCRIPTION: The purpose of this Agreement is for the Clark Fork Coalition and the Landowner to agree on restoration work to be performed by the Coalition on O'Brien Creek on Landowner's property (the "Project"). The Project will include work on or near Landowner's communal property, located generally south of O'Brien Creek Road, in the S2S2 of Section 27, and the N2N2 of Section 34, both in Twp 13N, Rge 20W in Missoula County. CFC and Landowner have the mutual desire to cooperate in carrying out the activities contemplated herein and this Agreement sets forth the obligations of both CFC and Landowner.

2. BACKGROUND AND SCOPE OF WORK: In 2019, a stream bank failure into O'Brien Creek resulted in deposition of sediment into the channel and floodplain of the O'Brien Creek Meadows HOA's common area (i.e. the Project area). In 2019, CFC oversaw emergency actions taken to remove the substrate deposition in the main channel and return wood into the stream channel (Phase 1). This Agreement will allow CFC to implement Phase 2 of the Project to rehabilitate the stream channel, improve stream function and enhance the ecological function of the stream and adjacent riparian area. Phase 2 will include increasing stream sinuosity, raising channel profile access to the floodplain, adding log step pools, re-aligning the channel into existing channels to avoid road fill erosion, and revegetating the riparian area. The Scope of Work for CFC is further described in the Project Plan Set attached as Exh. A.

3. PERIOD OF PERFORMANCE: This Agreement shall begin on the Signing Date of this Agreement and terminate on December 31, 2041. All work described in the Scope of Work except for post-project monitoring will take place between July, 2022 and December, 2022.

4. COST OF THE PROJECT: As consideration for Landowner's consent under this Agreement, the CFC will raise funds and pay for all costs for the Project. Landowner may contribute funding toward the Project, but CFC's responsibilities under this Agreement are not contingent upon the receipt of such funds from the Landowner.

5. CFC'S RESPONSIBILITIES: CFC, its employees, agents, and agency partners shall:

- a. Provide technical support, all monetary funding and in-kind support for the Project (as described in Scope of Work and Cost of Project);

- b. Provide oversight of the Project, including but not limited to grant writing, acquisition of necessary permits, Project coordination, management and oversight of construction activities and all other activities related to the Project;
- c. Perform long-term monitoring of the Project;
- d. Provide prompt notice to Landowner of any specific areas of concern related to the Project, and repair or replace Project improvements should they become endangered, change or destroyed through natural means; and
- e. Prepare any and all reports.

6. LANDOWNER'S RESPONSIBILITIES: Landowner, its employees, and agents shall:

- f. Guarantee ownership of the above-described lands and warrant that there are no outstanding rights that will interfere with this cooperative Agreement;
- g. Allow for and maintain a minimum riparian buffer of 25-feet as measured horizontally from the ordinary high-water mark;
- h. Use reasonable efforts to protect the restoration improvements and, except in cases of emergency or Force Majeure as described in paragraph 10, refrain from removing or impeding the restoration investments for a minimum of 20 years following completion of the Project.
- i. Allow access for post-treatment monitoring for the life of the agreement.

7. AGREEMENT CONDITIONED ON FUNDING: Landowner acknowledges that funding for the Project is dependent upon availability of state, federal, and non-federal funds subject to circumstances beyond the control of CFC. CFC shall not be liable for failure to provide funds committed to the Project if those funds have been withheld for events or circumstances beyond the control of CFC. However, if funding fails, CFC shall release Landowner from its obligations under this Agreement.

8. COOPERATION AND ACCESS: The Parties shall cooperate as needed in the performance of the Scope of Work. Landowner shall give unrestricted access to CFC for the Project site as needed for CFC to perform its obligations under this Agreement, including any required inspections. CFC will give 24-hour notice to Landowner of any required visits.

9. FORCES BEYOND THE CONTROL OF THE PARTIES: Neither party shall be liable to the other party, nor deemed to be in breach of this Agreement, for failure or delay in performance arising from a Force Majeure. Force Majeure means an event beyond the reasonable control of the affected party, and which the party is unable to prevent or provide against by exercising reasonable diligence. If Landowner fails to meet terms of the Agreement due to circumstances beyond its control, Landowner shall release CFC from its obligations under this Agreement. If CFC fails to meet terms of the Agreement due to circumstances beyond its control, CFC shall release Landowner from its obligations under this Agreement.

10. INDEMNITY: CFC agrees to indemnify and hold harmless the Landowner for any damages, loss or injuries incurred during the Project, except for damages and injuries caused by willful misconduct or gross negligence of the Landowner. CFC shall maintain its general liability policy for bodily injury, death or loss, or damage to property of third persons or other liability in the minimum amount of \$1,000,000 per occurrence and \$2,000,000 in the aggregate. In addition, both CFC and Landowner shall be named as additional insured parties on the Project Contractor's general liability policy bodily injury, death or loss, or damage to property of third persons or other liability in the minimum amount of \$1,000,000 per occurrence and \$2,000,000 in the aggregate.

11. ASSIGNMENT AND DELEGATION: The provisions of this Agreement shall be binding upon the heirs, personal representatives, administrators, successors and assigns of the parties in like manner as upon the original parties. This Agreement may not be assigned without the express, written consent of the parties.

12. AMENDMENT: This Agreement may be modified at any time by mutual written consent of Landowner and CFC. No other communication between the parties shall modify or be part of this Agreement except by express written consent. This Agreement may be terminated in writing by either party with thirty (30) days notice.

13. TERMINATION: This Agreement may be terminated in writing by either party by providing thirty (30) days advance notice. If Landowner terminates this Agreement, fails to comply with terms and conditions of this Agreement, fails to respond to reasonable requests from CFC to take corrective actions, or the restoration site is degraded due to purposeful or negligent activities of the Landowner, Landowner shall reimburse CFC for the cost of the habitat developments on a pro rata basis.

14. GOVERNING LAW: The law of the State of Montana governs this Agreement.

15. ATTORNEY'S FEES AND COSTS: If a suit, action or arbitration is instituted in connection with any controversy arising out of this Agreement or to enforce any rights hereunder, the prevailing party shall be entitled to recover such amount as the court may adjudge reasonable as attorneys' or paralegals' fees at trial or on any appeal or review, in addition to all other amounts provided by law.

16. PRINCIPAL CONTACTS:

CFC is exclusively responsible for all management aspects of this Project. The principal contacts for this Agreement are:

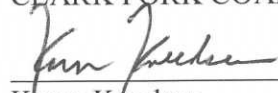
CFC Project/Contract Officer:

Adam Switalski
Clark Fork Coalition
PO Box 7593
Missoula, MT 59807
Tel. 406-396-1941
Email: Adam@clarkfork.org

Landowner

Bill Darling, HOA President
O'Brien Creek Meadows HOA
PO Box 3502
Missoula, MT 59806
Tel. 406-360-3327
Email: w.r.darling@hotmail.com

CLARK FORK COALITION



Karen Knudsen

Date:

Executive Director

O'BRIEN CREEK MEADOWS HOA



8.4.21

Bill Darling

Date:

HOA President



Missoula City-County Health Department

WATER QUALITY DISTRICT

301 W Alder | Missoula MT 59802-4123

www.missoulacounty.us/wqd

Phone | 406.258.4890

Fax | 406.258.4781

October 26, 2021

319 Review Committee

Montana Department of Environmental Quality

P.O. Box 200901

Helena, MT 59620

RE: Clark Fork Coalition 319 Grant Application

Dear 319 Review Committee,

The Missoula Valley Water Quality District would like to extend our support for the Clark Fork Coalition 319 application to reduce pollutant loading to Miller and O'Brien Creeks. This project aligns with the goals of the Missoula Valley Water Quality District to improve water quality across the district and within the watershed that supplies our sole source aquifer.

Thank you for the opportunity to demonstrate our support for this project.

Sincerely,

A handwritten signature in cursive script, appearing to read "Elena Evans".

Elena Evans

Hydrogeologist

Missoula Valley Water Quality District



October 28, 2021

To Whom it may concern,

The WestSlope Chapter of Trout Unlimited (WSCTU) works to preserve, protect and restore cold water fisheries in the Missoula area. Collectively, the chapter represents over 900 passionate anglers that care deeply about our mission. We write to express our support for three different projects being proposed by the Clark Fork Coalition on tributaries of the lower Bitterroot River:

- **O'Brien Creek Meadows Stream Restoration:** This project aims to use a variety of treatments to reduce sediment loading, restore stream and floodplain function, improve riparian and in-stream wildlife habitat, and dissipate flood energy on a 2500 foot section of O'Brien Creek.
- **Upper O'Brien Creek Stream Restoration:** This project proposes to address non-point sediment issues and fish habitat on upper O'Brien Creek by working with the Forest Service to reduce sediment loading, restore stream and floodplain function, and improve in-stream wildlife habitat. The project is focused on a 1.5 mile section of the creek where the stream is entrenched, has little in-stream wood, and is encroaching into road fills.
- **Miller Creek Mile 7 Project:** This project proposes to address sedimentation issues and degraded habitat on a section of Miller Creek. Treatments such as floodplain grading, woody debris matrix, riparian shrub plantings with enclosure fences, a hardened crossing for livestock, and other treatments to re-connect the creek to its floodplain, slow and disperse high flows, and increase riparian habitat will be used.

Given the benefits these projects will have for cold-water fisheries and watershed health, WSCTU supports their implementation. Thank you for the opportunity to comment.

Sincerely,

Mark Kuipers President

Supplemental Attachment 1

**River Design Group Email
Regarding Modeling**

From: [Chris Nelson](#)
To: [Jed Whiteley](#)
Cc: [Adam Switalski](#); [John Muhlfeld](#)
Subject: RE: [External Email]O'Brien Cr q100
Date: Monday, October 3, 2022 1:35:22 PM
Attachments: [image001.png](#)
[image002.png](#)
[image003.png](#)
[image004.png](#)
[image005.png](#)
[image006.png](#)
[2022-10-03 Tripple Creek Road Culvert plots.pdf](#)

Hi Jed,

Thanks for the update on the flows. The 10-year flow estimated using Streamstats (304 cfs) is about the same as the 100-year flow (307 cfs) that Nolan estimated using field data and the bankfull width regressions. Profiles and plots of the upstream side of the Tripple Creek Road crossing for the pre-project condition and post-project condition with and without the 36" relief culverts are attached. Adding the two 36" relief culverts reduces the water surface elevation upstream of the road for the post-project condition by about 1.5 feet at the new 100-year flow of 307 cfs. This is a substantial reduction that eliminates overtopping of the road at the low point to the right of the culvert and nearly eliminates the backwater profile through the crossing.

Please let me know if you have any questions or need any additional information for your grant submittal.

Thanks,
Chris

Chris Nelson, PE, CFM
Water Resources Engineer
406.862.4927 office
[River Design Group, Inc.](#)

From: Jed Whiteley <jed@clarkfork.org>
Sent: Monday, October 3, 2022 11:24 AM
To: John Muhlfeld <jmuhlfeld@riverdesigngroup.net>; Chris Nelson <cnelson@riverdesigngroup.net>
Cc: Adam Switalski <adam@clarkfork.org>
Subject: FW: [External Email]O'Brien Cr q100

Hi John and Chris,

Please see below for the updated q100 flow for O'Brien Creek Nolan at the Lolo NF ran for us. Looking through the hydraulic analysis of the crossing at Tripple Creek you ran for us the new q100 puts us close to the q10 of 304 cfs Streamstats projected. Which looks like from the additional modeling you completed adding two 36" relief culverts should do the trick. I talked with the DEQ 319 program and they are up for us applying for additional project funding this round of proposals to add

the relief culverts. Before I write and submit the grant I wanted to double check with you guys that the two 36" relief culverts would truly do the job. And of course the grant is due Friday and I have to have it written by end of Wednesday due to other work conflicts. Love the fall work season.

Thanks-

Jed

From: Platt, Nolan - FS, MISSOULA, MT <Nolan.Platt@usda.gov>

Sent: Friday, September 30, 2022 12:45 PM

To: Jed Whiteley <jed@clarkfork.org>

Cc: Walters, Dustin -FS <dustin.walters@usda.gov>; Sylte, Traci -FS <traci.sylte@usda.gov>; Adam Switalski <adam@clarkfork.org>

Subject: RE: [External Email]O'Brien Cr q100

Jed and others,

I just finished crunching some numbers for a Q100 estimate for Obrien Creek at the Triple Creek Rd crossing. See below table:

Method			
	Streamstats	Field Data & Model Adjusted	Bankfull Width Regression*
Q2 (cfs)	144	91	85
Q100 (cfs)	528	307	318

*per Lawlor 2004, USGS, Determination of Channel-Morphology Characteristics, Bankfull Discharge, and Various Design-Peak Discharges in Western MT

Based on the two analyses I ran I think that the Streamstats (i.e. regression equation) estimates seem high. I was pleased to see the "Field Data & Model Adjusted" and "Bankfull Width Regression" estimates matched each other pretty well.

Bear in mind that Streamstats estimates for small drainage areas like this (25.3sqmi) are associated with large prediction intervals. For example, the Streamstats report states that the Q100 = 528 cfs with the lower prediction interval of 225cfs and upper prediction interval of 1240 cfs (at the crossing site).

I am happy to elaborate on my methods if you are curious. Also, I would be interested in reviewing designs and reports prepared by design engineers as this project progresses, if you are OK with sharing.

Have a good weekend!

Nolan Platt
Hydrologist
Forest Service

Supplemental Attachment 2

**United States Forest Service
Email Regarding O'Brien
Creek q100**



Lolo National Forest

p: 303-731-9110

Nolan.Platt@usda.gov

24 Fort Missoula Road

Missoula, MT 59804

www.fs.fed.us



**Caring for the land and
serving people**

From: [Jed Whiteley](#)

Sent: Thursday, September 29, 2022 8:45 AM

To: [Platt, Nolan - FS, MISSOULA, MT](#)

Cc: [Walters, Dustin -FS](#)

Subject: Re: [External Email]O'Brien Cr q100

Thanks Nolan, really appreciate you working up some numbers.

From: Platt, Nolan - FS, MISSOULA, MT <Nolan.Platt@usda.gov>

Sent: Wednesday, September 28, 2022 5:00:11 PM

To: Jed Whiteley <jed@clarkfork.org>

Cc: Walters, Dustin -FS <dustin.walters@usda.gov>

Subject: RE: [External Email]O'Brien Cr q100

Hey Jed,

I plan on working at the office the next two days, so I can get you a Q100 estimate and brief explanation by the end of the week.

Thanks for the patience,



S

Nolan Platt

Hydrologist

Forest Service

Lolo National Forest

p: 303-731-9110

Nolan.Platt@usda.gov

24 Fort Missoula Road

Missoula, MT 59804

www.fs.fed.us



Caring for the land and
serving people

From: Jed Whiteley <jed@clarkfork.org>
Sent: Wednesday, September 28, 2022 12:17:38 PM
To: Platt, Nolan - FS, MISSOULA, MT <Nolan.Platt@usda.gov>
Subject: [External Email]O'Brien Cr q100

[External Email]

If this message comes from an **unexpected sender** or references a **vague/unexpected topic**;
Use caution before clicking links or opening attachments.
Please send any concerns or suspicious messages to: Spam.Abuse@usda.gov

Hey Nolan,

Just checking in to see if you had a chance to dial in the q100 for O'Brien Creek. I know you're probably slammed trying to get ready to leave town for your detail but I'm hoping to turn in a grant by next Friday to get that culvert upgraded.

Thanks!

Jed

Project Manager
(406) 531-0256



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From: [Platt, Nolan - FS, MISSOULA, MT](#)
To: [Jed Whiteley](#)
Cc: [Walters, Dustin -FS](#); [Sylte, Traci -FS](#); [Adam Switalski](#)
Subject: RE: [External Email]O'Brien Cr q100
Date: Friday, September 30, 2022 12:44:46 PM
Attachments: [5CE1B62DC7314DF59BF8AF2805D72229F1089763251.png](#)
[6835474EFC504E70AA23F1FFEF096F381089763261.png](#)
[1FFCE43ED65F427B83E59BE64C2200521089763271.png](#)
[5D8977DE57A748EFA9D38257DC711FFB1089763281.png](#)
[A16CD30712184B6788C44026A910FBEA.png](#)
[C6E3811D55A1406B908DA1ECF6308628.png](#)

Jed and others,

I just finished crunching some numbers for a Q100 estimate for Obrien Creek at the Triple Creek Rd crossing. See below table:

Method			
	Streamstats	Field Data & Model Adjusted	Bankfull Width Regression*
Q2 (cfs)	144	91	85
Q100 (cfs)	528	307	318

*per Lawlor 2004, USGS, Determination of Channel-Morphology Characteristics, Bankfull Discharge, and Various Design-Peak Discharges in Western MT

Based on the two analyses I ran I think that the Streamstats (i.e. regression equation) estimates seem high. I was pleased to see the "Field Data & Model Adjusted" and "Bankfull Width Regression" estimates matched each other pretty well.

Bear in mind that Streamstats estimates for small drainage areas like this (25.3sqmi) are associated with large prediction intervals. For example, the Streamstats report states that the Q100 = 528 cfs with the lower prediction interval of 225cfs and upper prediction interval of 1240 cfs (at the crossing site).

I am happy to elaborate on my methods if you are curious. Also, I would be interested in reviewing designs and reports prepared by design engineers as this project progresses, if you are OK with sharing.

Have a good weekend!



Nolan Platt
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Missoula, MT 59804

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Caring for the land and
serving people

From: [Jed Whiteley](#)

Sent: Thursday, September 29, 2022 8:45 AM

To: [Platt, Nolan - FS, MISSOULA, MT](#)

Cc: [Walters, Dustin -FS](#)

Subject: Re: [External Email]O'Brien Cr q100

Thanks Nolan, really appreciate you working up some numbers.

From: Platt, Nolan - FS, MISSOULA, MT <Nolan.Platt@usda.gov>

Sent: Wednesday, September 28, 2022 5:00:11 PM

To: Jed Whiteley <jed@clarkfork.org>

Cc: Walters, Dustin -FS <dustin.walters@usda.gov>

Subject: RE: [External Email]O'Brien Cr q100

Hey Jed,

I plan on working at the office the next two days, so I can get you a Q100 estimate and brief explanation by the end of the week.

Thanks for the patience,



S

Nolan Platt
Hydrologist
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Caring for the land and
serving people

From: Jed Whiteley <jed@clarkfork.org>

Sent: Wednesday, September 28, 2022 12:17:38 PM

To: Platt, Nolan - FS, MISSOULA, MT <Nolan.Platt@usda.gov>

Subject: [External Email]O'Brien Cr q100

[External Email]

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Hey Nolan,

Just checking in to see if you had a chance to dial in the q100 for O'Brien Creek. I know you're probably slammed trying to get ready to leave town for your detail but I'm hoping to turn in a grant by next Friday to get that culvert upgraded.

Thanks!

Jed

Project Manager

(406) 531-0256



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Supplemental Attachment 3

Cost Estimates

Project: O'Brien Creek Relief Culverts
Title: Construction Cost Estimate for Grant Funding
Client: MTU
Description: Opinion of Probable Construction Costs
Date: October 4, 2022



		2 x 36" Relief Culverts			
		Quantity	Unit Cost	Cost	
1	Construction Administration / Layout / Inspection			\$	7,175
1.1	Project Engineer	30 hrs	\$135 /hr	\$	4,050
1.2	Survey Crew	12 hrs	\$185 /hr	\$	2,220
1.3	Direct Costs (mileage, lodging, per diem)	1 ls		\$	905
2	Construction Costs			\$	39,957
2.1	Mobilization / Demobilization			\$	2,000
	Each piece of equipment	2 each	\$1000 /ea	\$	2,000
	Crane	0 each	\$8000 /ea	\$	-
2.2	Site Prep & Access			\$	2,033
	Develop access and work pad	1 each	\$1500 /job	\$	1,500
	Remove asphalt	107 sy	\$5 /sy	\$	533
2.3	Dewatering / Work Area Isolation / Erosion Control			\$	400
	Work site dewatering/pump/piping during construction	0 job	\$2000 /job	\$	-
	Defish work site	0 job	\$1200 /job	\$	-
	Temporary Erosion Control	1 job	\$400 /job	\$	400
2.4	Excavation and Disposal / Hauling			\$	7,420
	Bulk Excavation	400 cy	\$12 /cy	\$	4,800
	Stockpiling	290 cy	\$6 /cy	\$	1,740
	Disposal / Hauling	110 cy	\$8 /cy	\$	880
2.5	Install New Culverts			\$	19,280
	3' dia (CMP or PE)	160 lf	\$60 /lf	\$	9,600
	squash pipe	-	-	\$	-
	concrete box	-	-	\$	-
	Bedding / Foundation preparation (Leveling Pad)	12 cy	\$35 /cy	\$	420
	Structure Assembly and Installation	16 hrs	\$285 /hr	\$	4,560
	Select granular backfill	90 cy	\$35 /cy	\$	3,150
	Native backfill	200 cy	\$6 /cy	\$	1,200
	Scour Protection at Structure/Road Interface	10 cy	\$35 /cy	\$	350
2.6	Simulated Streambed / Inlet & Outlet Apron			\$	350
	Simulated Streambed	0 cy	\$70 /cy	\$	-
	Inlet/Outlet Apron	10 cy	\$35 /cy	\$	350
2.7	Road Restoration			\$	2,542
	Road subgrade - 6" Crushed Aggregate (3/4")	18 sy	\$35 /cy	\$	622
	Road top course - Asphalt Surfacing	960 sf	\$2 /sf	\$	1,920
2.8	Site Cleanup / Erosion Control / Planting			\$	720
	Erosion control seeding	0.25 acre	\$800 per acre	\$	200
	Mulching	0.25 acre	\$800 per acre	\$	200
	Laborer 1	8 hrs	\$40 /hr	\$	320
	Upland trees	0 acre	\$2000 per acre	\$	-
	Riparian planting	0 acre	\$2000 per acre	\$	-
2.9	Risk /Uncertainty				
	Contingency based on variables	15%		\$	5,212
Total				\$	47,132