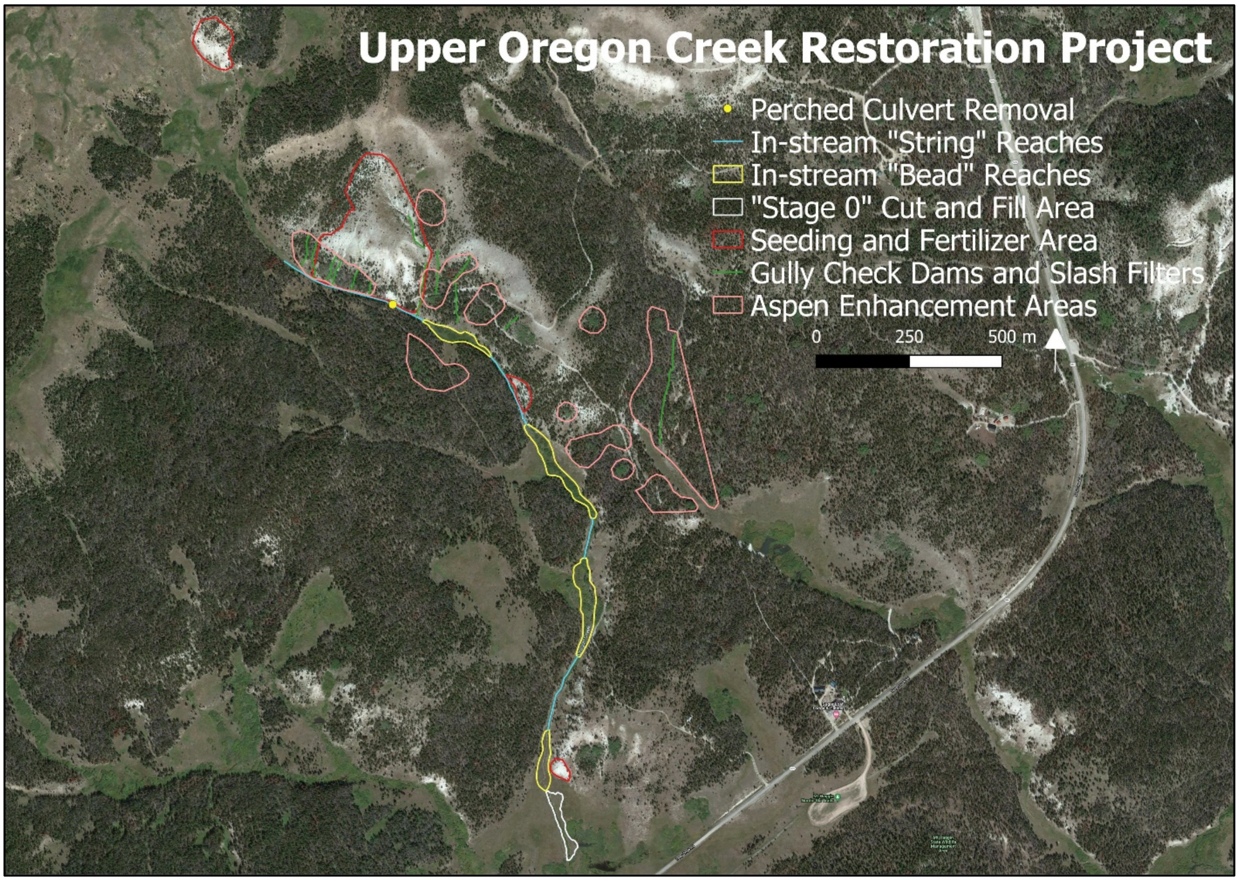
UPPER OREGON CREEK RESTORATION PROJECT
IMPLEMENTATION PLAN

March 2022



Prepared for:

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

Prepared by:

BIG HOLE WATERSHED COMMITTEE

Conservation Through Consensus.

APPROVALS

Vanna Boccadori (Fish Wildlife and Parks) — 11 March 2022 (Date)

Eric Trum — 3/14/2022

Eric Trum (Department of Environmental Quality) — (Date)

3/8/2022

Pedro Marques (Big Hole Watershed Committee) — (Date)

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Background

Oregon Creek is a headwater tributary to the Big Hole River on the Continental Divide (Big Hole River< Deep Creek<French Creek<California Creek<Oregon Creek) and is within the state-owned Mount Haggin Wildlife Management Area (WMA). The area has an extensive history of mining related disturbance. Aerial emissions from smelting activities in Anaconda deposited heavy metals (e.g. Copper, Arsenic, Cadmium, Lead and Zinc) on nearby mountains that killed upland vegetation and, together with intensive logging to fuel the smelters, removed a vast majority of the vegetation community from the upper extents of the WMA. Devoid of vegetation, large areas developed extensive networks of rills and large gullies during heavy rain events, most severely in areas with geologic parent material of highly erodible volcanic tuff. These erosive processes persist on 25 acres of uplands in the upper reaches of Oregon Creek, contributing annual plumes of fine sediment into the creek and eventually into the Big Hole River. These acres were purchased by Montana Fish Wildlife and Parks (MFWP) in 2020 and added to the WMA.

The Upper Oregon Creek Restoration Project was developed to address both upland sediment sources and enhancement of riparian areas impacted by upland sediment plumes.

The Big Hole Watershed Committee (BHWC) was awarded 319 project funding by the Montana Department of Environmental Quality to address both upland erosion and improve riparian habitat in the headwater reaches of Oregon Creek. MFWP and The Natural Resource Damage Program (NRDP) are active partners and funders of this project.

This Implementation Plan will be executed in conjunction with the *Upper Oregon Creek Monitoring Plan*, approved by the Montana Department of Environmental Quality on 3/4/21.

Regulatory Framework

Oregon Creek (MT41D003_080) is listed by the Montana Department of Environmental Quality as impaired for sedimentation/siltation, Arsenic, Copper, Lead, anthropogenic/physical substrate alterations, and alterations in streamside cover. This area is the highest priority watershed in the BHWC Middle/Lower Big Hole WRP, and this upper Oregon Creek sediment source is the last known major source of sediment to the system. The BHWC and partners have invested significant effort in restoring this basin, successfully completing projects on 5 creeks of the French Creek drainage.

This project addresses the sediment priority concerns identified in the TMDL and other guiding documents for this area. The project will reduce metals loading to Oregon Creek by stabilizing the sediment delivery balance in the drainage, though reduction in metals is not a primary objective of this project. Ongoing water sampling is being conducted by Pioneer Technical Services under contract with the NRDP at a location on California Creek downstream of the confluence with Oregon Creek. Since 2019, no water samples have exceeded chronic water quality standards for metals. Monitoring at this location will be ongoing and overseen by the EPA, with sampling contract held by the NRDP.

Superfund Jurisdiction

With the acquisition of this parcel in 2020, management responsibilities for the area containing the Upper Oregon Creek project transferred to the State of Montana. Exhibiting degraded conditions similar to those being addressed under existing Superfund responsibilities and work plans, this Upper Oregon

Creek project area was added to the purview of NRDP remedy and restoration activities in January, 2022. This transfer of responsibility was accomplished after consultation with EPA and with the submission of an Addendum to the NRDPs 2018 Remedy and Restoration Work Plan, the EPA-sanctioned document outlining the scope of activities under this Superfund unit.

A Consent Decree (CD) was filed in federal court between the State of Montana, the United States, and Atlantic Richfield company in 2008. As part of the CD settlement, the Natural Resource Damage Program agreed to perform remedy and restoration actions on State-owned properties, including the WMA. From 2010 to the present, NRDP has performed remedial and restoration actions throughout the WMA, which is included in EPA's designated Surface Water Evaluation Area. NRDP has completed work plans for the remedy in this area, which have been approved by EPA in consultation with DEQ. EPA has agreed that the work NRDP will perform in Oregon Creek is remedial action. Therefore, the work planned for this Upper Oregon Creek project will adhere to CERCLA cleanup standards (42 U.S.C. 9621). Specifically, this means that state permits are not required as articulated in CERCLA Section 121(e) (42 U.S.C. 9621(e)):

"(e) PERMITS AND ENFORCEMENT. —(1) No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely onsite, where such remedial action is selected and carried out in compliance with this section."

Project Location

Oregon Creek is a headwater tributary of California Creek, which flows into French Creek, and then into Deep Creek, which then feeds into the Big Hole River upstream of Dickie Bridge. The Upper Oregon Creek Restoration Project is located in Deer Lodge County, Montana, approximately 12 miles southwest of the city of Anaconda (**Figure 1**). The project site is located on MFWP property within the Mount Haggin WMA, an area that experienced heavy mining and logging pressure from the mid-1800s to the mid-1900s. The area is bounded by the Beaverhead-Deer Lodge National Forests. The latitude and longitude of the upper extent of the project is 46.0180, -113.0105. The latitude and longitude of the lower extent of the project is 45.9988, -112.9980.

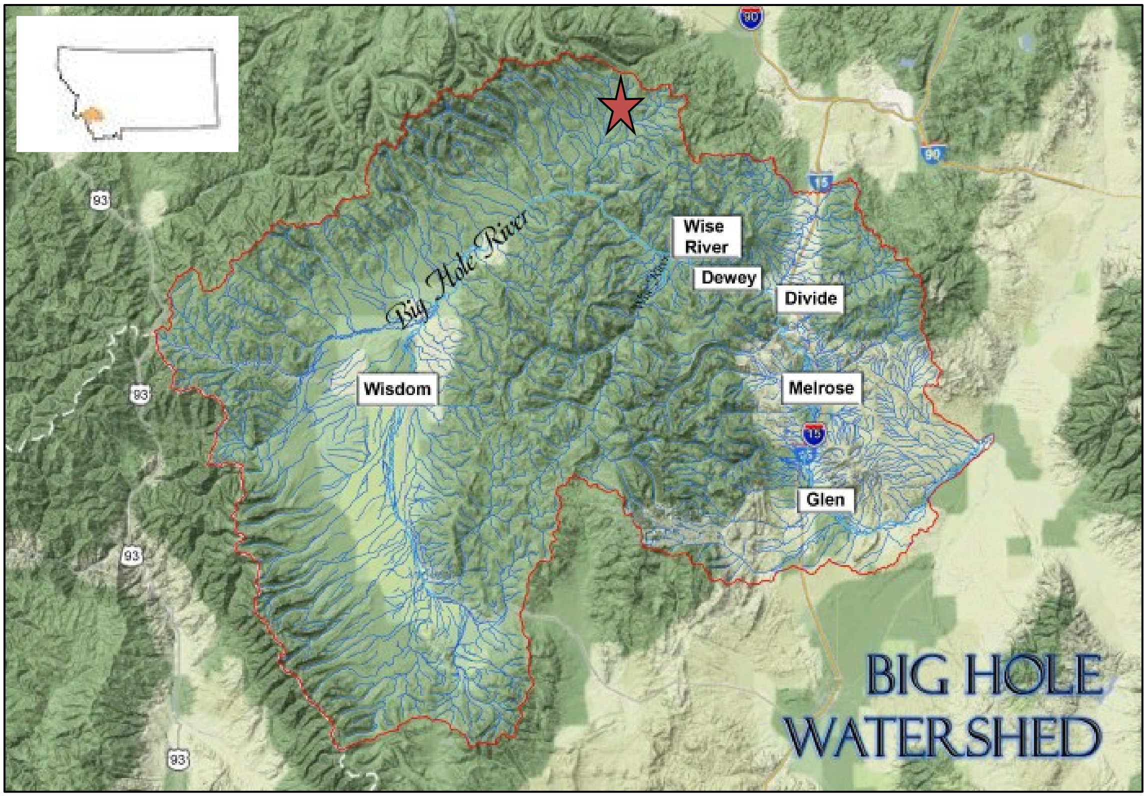

Figure 1. Project site location.

Project Scope and Restoration Design

The Upper Oregon Creek Restoration project is an extension of BHWC's many years of involvement of remedy and restoration on the Mount Haggin Injured Area (RDU 15) of the Anaconda Superfund site, under NRDP. This project is based directly on the toolbox (*2018, Anaconda Smelter NPL Site Mount Haggin Uplands (RDU 15) Remedy and Restoration Work Plan*) developed for the Injured Area (IA) under Superfund. Many of the techniques and restoration actions that will be implemented during this project are identical to these proven actions and are consistent with MFWP management objectives for the long term.

The purpose of this Implementation Plan is to identify each restoration action and describe the specific criteria and design specifications for implementation for each action. The project consists of five distinct restoration approaches and areas (**Figure 2**).

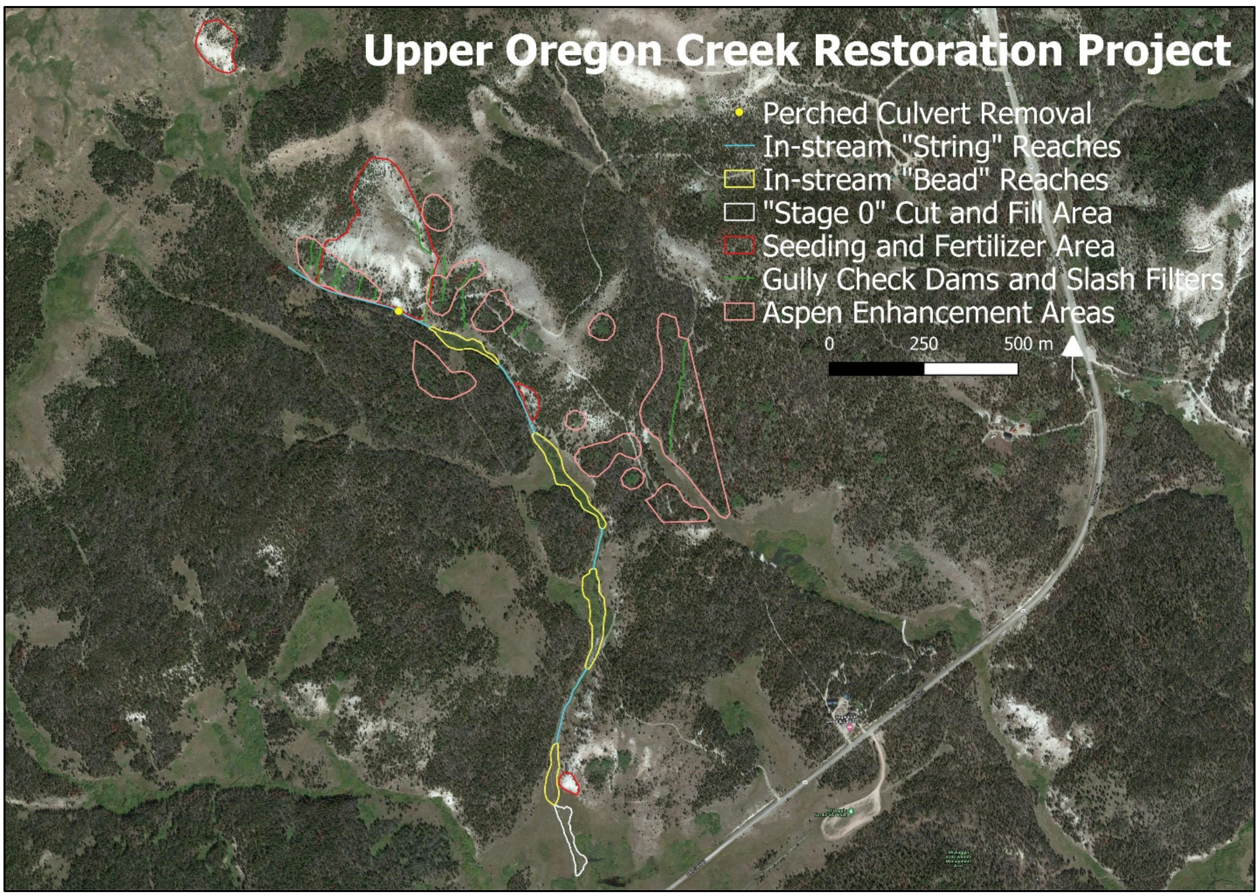

Figure 2. Upper Oregon Creek restoration approaches and project areas

This project is designed to improve water quality by reducing sediment loading from upland erosion, improve riparian habitat and vegetation conditions, and remove a fish passage barrier in the headwater reaches of Oregon Creek. The project will also improve the landscape's ability to capture and retain surface and groundwater, as well as generate and attenuate sediment more consistent with the channel type and location on the landscape. This will be accomplished by following a four-pronged strategy:

Table 1. Project Scope	
Uplands	**Riparian**
Bare upland slopes: ○ Soil scarification, fertilization, and seeding on contour (i.e., coir "band-aids") ○ Aerial fertilization and seeding ○ Rill treatments with slash and coir Gullies: ○ Gully BMPs using available log material and slash (gully check dams) ○ Fill gullies with surplus slash and log material from MFWP's Upper Oregon Creek Aspen Enhancement project.	In-stream structures: ○ Post-assisted log structures ○ Beaver Dam Analogues Road crossings: ○ Remove 1 failed culvert Stage 0: ○ Regrade existing valley surfaces (cut/fill) to allow for natural fluvial process. ○ Install large woody debris on floodplain to add surface roughness and complexity.

1. Capture sediment on the floodplain and in the stream channel (blue and yellow reaches.)
   a. Install in-stream check structures (beaver dam analog (BDA)/Post-assisted log structures (PALS)) to aggrade the stream bed and restore stream function and dynamics.

2. Detain sediment in 15 active gully networks (green lines).
   a. Install gully check dams and gully slash filters to capture eroding upland sediment.
   b. Utilize MFWP's Upper Oregon Aspen Enhancement project's (pink polygons) surplus slash material to fill gullies (mechanically and by hand).

3. Establish vegetation on 25 acres of upland slopes to prevent sheet erosion (red polygons).
   a. Apply native seed mix and slow-release organic fertilizer (Sustane 8-2-4) by helicopter and hand.
   b. Apply soil scarification and trenching techniques using coconut coir erosion fabric, fastened with stakes and nearby woody debris (i.e., coir "band-aids").

4. Reconnect 11 acres of floodplain to surface water (white polygon).
   a. Implement 1,126 feet of "stage 0" cut and fill to restore stream function and dynamics.

5. Remove a failed culvert, impeding fish passage to approximately .5 miles of Oregon Creek headwaters (yellow dot)
   a. Pull perched culvert and reconstruct stream channel

Capture sediment on the floodplain and in the stream channel

Two types of in-stream structures, post-assisted log structures (PALS) and beaver dam analogs (BDAs), will be installed in three distinct stream reaches (**Figure 3**). Approximately 50-70 in-stream structures will be installed throughout the project area. PALS are low-tech restoration structures that mimic and promote the accumulation of large woody debris and are designed to influence hydraulic, hydrologic, and geomorphic process. BDAs are man-made structures that mimic the form and function of natural beaver dams (Wheaton et al., 2019).

Definitions
- Post-Assisted Log Structures (PALS) -woody material of various sizes pinned together with untreated wooden posts driven into the substrate to mimic natural wood accumulations.

-**Beaver Dam Analogues (BDAs)**-a permeable, channel-spanning structure with a constant crest elevation, constructed with a mixture of woody debris and fill material to mimic a natural beaver dam.

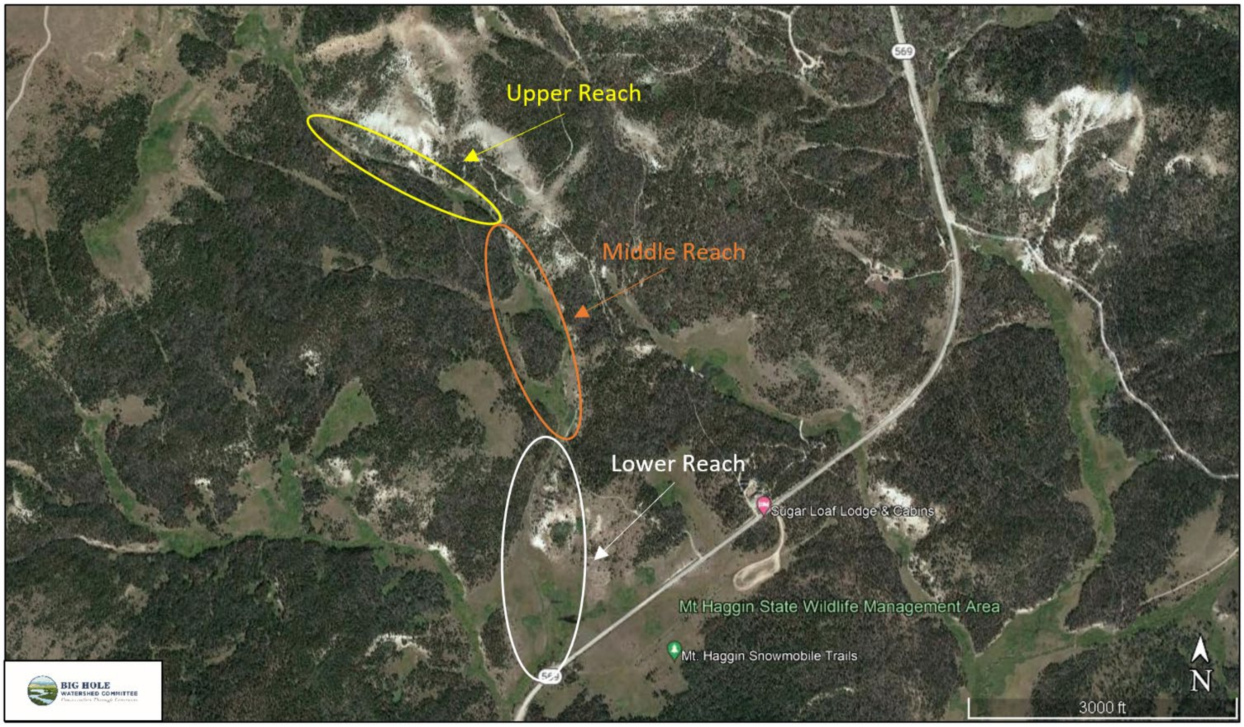

Figure 3. Upper Oregon stream/riparian reaches.

Each in-stream structure is designed to achieve specific restoration objectives and can affect different processes during different flow conditions as shown in **Figure 4** (Wheaton et al., 2019).

Type	Hydraulic	Hydrologic	Geomorphic
PALS Channel-spanning	create upstream backwater or pond, and plunge hydraulics downstream	increase frequency and magnitude of overbank flow, increase hyporheic flows	channel aggradation, channel avulsion, bank erosion, dam and plunge pool formation, bar formation
PALS Bank-attached	force convergent flow (deeper and faster), create eddy behind structure	force overbank flows*	bank erosion, scour pool formation, bar formation, sediment sorting, channel avulsion
PALS Mid-channel	force flow separation, create eddy in lee of structure	force overbank flows*	bank erosion, scour pool formation, bar formation, sediment sorting, channel avulsion
Primary BDA	create deep slow water	increase frequency and magnitude of overbank flow, increase hyporheic flows	channel aggradation upstream, bar formation, bank erosion (if breached on ends), sediment sorting
Secondary BDA	create deep slow water	increase frequency and magnitude of overbank flow, increase hyporheic flows	channel aggradation, channel avulsion, bank erosion, dam pool formation, bar formation

Figure 4. Summary of typical hydraulic, hydrologic and geomorphic effects of PALS and BDAs.

This project will utilize the “river beads and river strings” conceptual framework described by Ellen Wohl et al. (2017) as a template for structure type and location placement. PALS will be installed in “river string” reaches/transport zones to encourage overland flow, bank erosion, scour pool formation, plunge pool creation, channel widening, and sediment sorting. The main purpose of the PALS will be to create variable flow patterns and create varying flow velocities that will in turn, create channel complexity and encourage recruitment of properly sized gravels used for spawning and fish habitat. Installing the PALS in the “string reaches” will complement the natural stream channel geomorphology, as the steeper and narrower segments are not suited for lower gradient, channel spanning beaver mimicry structures.

BDA structures will be installed in “river bead” reaches/retention zones to encourage optimal sediment retention, channel aggradation, and increased floodplain connectivity. The main purpose of the BDA’s will be to capture upland sediment and increase floodplain connectivity. Installing the BDAs in the “bead” reaches, that are generally wider and lower gradient will complement the natural stream channel geomorphology and aid in optimal sediment capture and floodplain connectivity. **Figure 5** shows the “bead” and “string” reaches in the project area.

The *Anaconda Smelter NPL Site Mount Haggin Uplands (RDU 15) Remedy and Restoration Work Plan, “*SSR Remedy and Restoration Toolbox” manual will be used as a guiding document during implementation for design and application considerations (Appendix A, SSR 2b: In-Stream Check Structures).

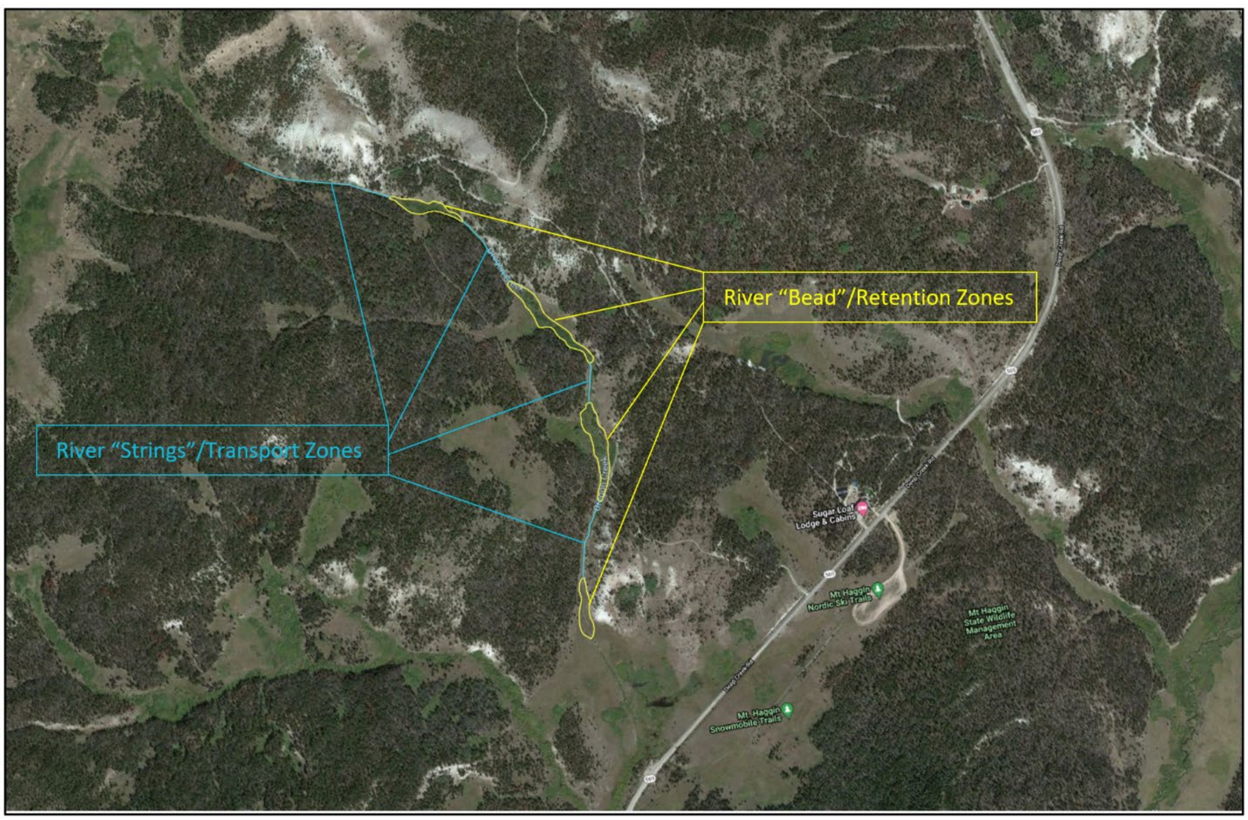

Figure 5. Upper Oregon “bead” and “string” reaches in Upper Oregon Creek. PALS will be installed in the “string” reaches and BDA’s will be installed in the “bead” reaches.

Detain sediment in 15 active gully networks

A total of 15 gullies with active sediment inputs to upper Oregon Creek have been identified in the project area. Installation of gully check dams and gully slash filter techniques will be used to capture sediment in these pathways.

Gully Check Dams

Gully check dams will be constructed in every active gully, both large and small. Check dams will be constructed using a mix of onsite logs, rock, and slash. Exact location and number of check dam structures within each gully will be determined during construction. We expect smaller less erosive gullies will require a single or multiple small dams (under 3 feet high), where larger and deeper gullies may require a greater number and large structures. Construction materials and size will vary based on these local conditions. Structures will be strategically placed where gullies meet/intersect so the greatest volume of sediment can be impounded upslope. Other appropriate locations for structures include lower gradient sections and gully reaches where sediment is already depositing. Lastly, structures will be built where construction materials are available nearby and where there is safe access to the gully bottom. **Figure 6** shows examples of completed gully check structures in small and large gullies.

The *Anaconda Smelter NPL Site Mount Haggin Uplands (RDU 15) Remedy and Restoration Work Plan, "*SSR Remedy and Restoration Toolbox" manual will be used as a guiding document during implementation for design and application considerations (Appendix A, SSR 2d: Gully Check Dams).

Figure 6. Log and Slash check dam structures in small gullies (left) and a series of structures in a large gully (right)

Gully Slash Filters

Gully slash filters will be placed in every gully in the project area, except for one or two. Those one or two gullies will only receive gully check dam structures to give a clean representation of sediment catchment for monitoring purposes (see Upper Oregon Creek Monitoring Plan). Gullies only receiving gully check dam structures will be identified by the BHWC prior to implementation. Exact location and number of gully slash filters within each gully will be determined during construction. Gully slash filters will be placed above and below the constructed gully check dams, acting as sediment retention structures between gully check dams. Gully slash filters utilize the byproducts of traditional forest thinning efforts to fill erosion channels with organic material (2018, Remedy and Restoration Workplan). The slash in the gullies acts to reduce sediment transport from both upstream and from the eroding sidewalls of the gullies. The slash also increases water retention and infiltration and helps to establish vegetation by acting as a microclimate and browse protection surface. **Figure 7** shows two examples of gully slash filter treatments in gullies.

Figure 7. Two examples of gully slash filters utilizing forestry thinning byproducts to capture sediment and fill gullies

In 2022, MFWP will implement hand and mechanical treatments to remove encroaching conifer trees on threatened aspen stands and riparian areas on 35 acres within the Upper Oregon Creek Restoration project area (**Figure 8**). Forestry treatments will remove all conifer trees (minus juniper, alpine larch, and 5 needle pines) within the interior and within a 100-foot buffer around the exterior of aspen stands and riparian areas. Disturbance to the aspen clone during restoration activities will aid in suckering (regeneration) of aspen that has been suppressed by conifers. Promoting above-ground and underground aspen growth will also generate appropriate wildlife habitat values.

This aspen enhancement project will be completed in two phases. The first phase of project work will consist of only mechanical treatments using logging equipment and will occur in the spring, 2022. Merchantable conifer > 8” DBH (diameter at breast height) will be cut and removed from the site to be sold by MFWP. The second phase of the project consists of handwork (maybe mechanical) to cut the remaining small diameter/non-merchantable conifers and install gully slash filters in adjacent gullies and will take place in the summer, 2022. The slash generated from the aspen enhancement project will be utilized for gully slash treatments and placed in the gullies.

The *Anaconda Smelter NPL Site Mount Haggin Uplands (RDU 15) Remedy and Restoration Work Plan,* “SSR Remedy and Restoration Toolbox” manual will be used as a guiding document during implementation for design and application considerations (Appendix A, SSR 2c: Gully Slash Filters).

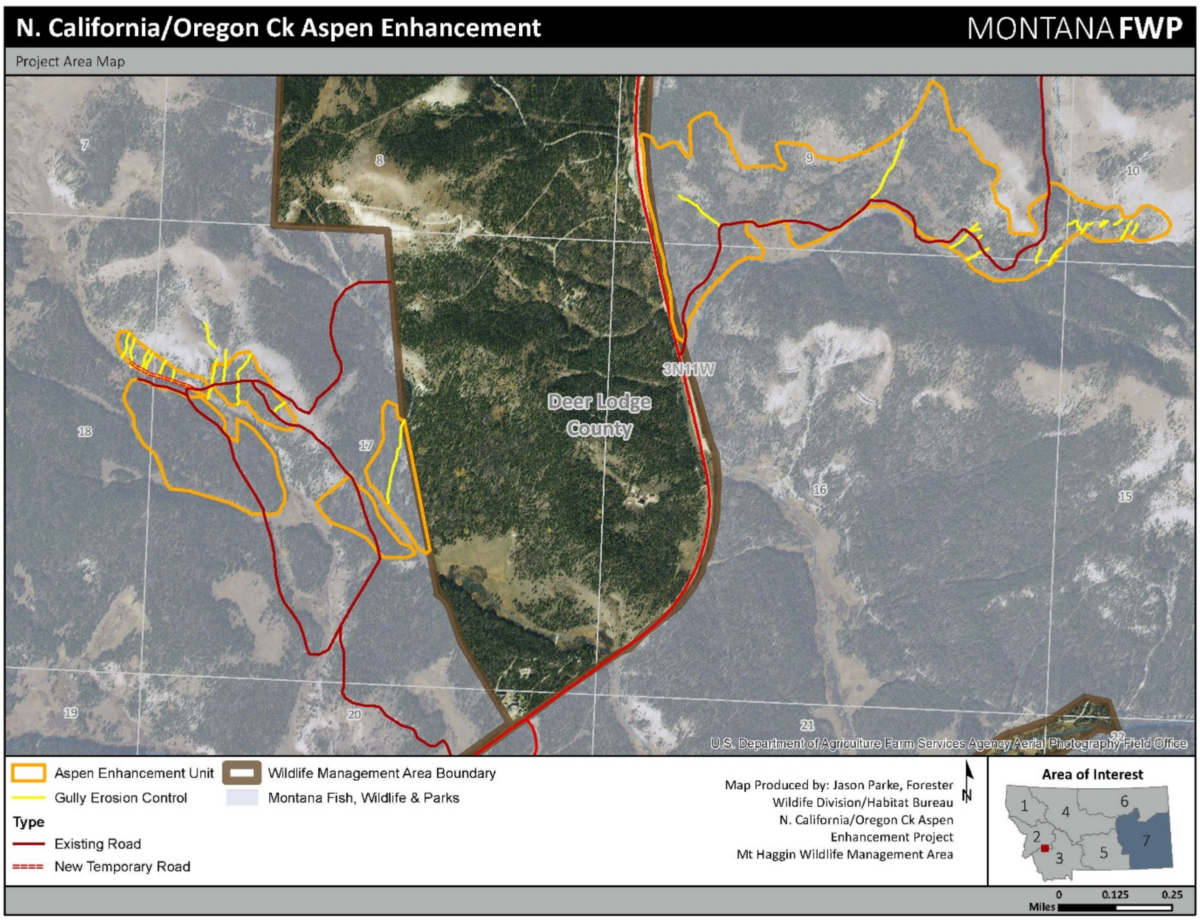

Figure 8. MFWP Aspen enhancement project.

Establish vegetation on 25 acres of upland slopes to prevent sheet erosion

The best approach to control sediment delivery for the long term is to establish vegetation on the bare, erosive upland slopes. 25 acres of upland slopes (**Figure 9**) will receive revegetation treatments. Revegetation treatments consist of broadcast seeding with fertilizer and soil scarification/trenching.

Figure 9. 25 acres of upland revegetation areas

Soil Scarification/Trenching (coir "band-aids")

Soil scarification and trenching, typically across contours, are an effective means to improving germination rates and water holding capacity on bare eroding slopes. Trenches and grade breaks in the micro-topography of a slope act as natural sinks for seed establishment and water infiltration. Trenching along contour lines promotes snowmelt infiltration, reduces sheet erosion, and provides ideal microclimates for plant establishment and success. This treatment aims to create islands of vegetation that can spread into otherwise bare areas (2018, NRDP). A total of 30 coir "band-aids" will be installed within the upland revegetation polygons.

Appropriate locations for treatment placement include slopes that exhibit a relatively uniform topography and minimal roughness. Trenching must follow contour lines to maximize water retention and reduce soil mobility.

Figure 10 shows before and after photos of coir "band-aid" treatments installed in 2018 and an example of a coir "band-aid" treatment 6 years post installation.

The *Anaconda Smelter NPL Site Mount Haggin Uplands (RDU 15) Remedy and Restoration Work Plan,* "SSR Remedy and Restoration Toolbox" manual will be used as a guiding document during implementation for design and application considerations (Appendix A, SSR 1c: Soil Scarification and Trenching).

Figure 10. Before and after photos of coir "band-aids" (left) and a coir "band-aid" treatment 6 years post installation (right)

Broadcast Seeding with Fertilizer

Broadcast seeding of grasses and forbs has been shown to successfully colonize the Mt. Haggin uplands where there is a lack of a natural seed source (2018, NRDP). Additionally, the application of slow-release organic fertilizers has proven effective in boosting the growth potential of existing and newly establishing vegetation in the low nitrogen volcanic tuff soils in the project area (2018, NRDP). 25 acres of bare upland slopes (**Figure 9**) will be aerially seeded and fertilized by helicopter. A natural organic slow release fertilizer, Sustane 8-2-4 will be applied at a rate of 1600 pounds per acre. A native seed mix (**Table 2**) will be used at a rate of 16 pounds per acre. Heli-Works LLC will apply both the seed and fertilizer.

Table 2. Upper Oregon Creek Native Upland Seed Mix

Species (Common Name)	Species (Latin name)	% of Mix
Idaho Fescue	Festuca idahoensis	33%
Rough Fescue	Festuca campestris	33%

June Grass	Koeleria macrantha	17%
Western Yarrow	Achillea millefolium	2%
Sulphur Buckwheat	Eriogonum umbellatum	4.5%
Blue Flax	Linum lewisii	4.5%
Sticky Geranium	Geranium Viscosissimum	6%

Reconnect 11 acres of floodplain to surface water

In the lower half of the lower riparian reach (**Figure 3**) the stream channel has been straightened (45.9997, -112.9983), most likely for historic agricultural purposes. This anthropogenic manipulation has resulted in head cutting and severe channel incision followed by a lowering of the shallow groundwater table and vegetation transitions from wetland to arid/upland. The stream (perennial in this reach) has begun to form a small, inset floodplain with riparian vegetation beginning to establish near the water's edge. The straight, incised stream is acting as a sediment transport reach as the broader floodplain is completely disconnected from the steam.

Applying the themes detailed in "A process-based approach to restoring depositional river valleys to Stage 0, an anastomosing channel network" (Powers et al., 2018) this project will employ a modified "Stage 0" restoration approach to reconnect 11 acres of floodplain to Oregon Creek surface water. The unique process-based restoration approach, strives to restore degraded stream, river or meadow systems to pre-manipulated conditions that exhibit a multithreaded channel configuration that has broad floodplain inundation. (Power et al., 2018).

The incised channel will be completely filled in with adjacent native materials (large wood and soil). The disturbed floodplain will be treated with large wood and microtopography to provide short-term roughness and habitat complexity until riparian vegetation can establish. **Figure 11** shows the basic design of the project. Using publicly available LiDAR data, Morison-Maierle provided BHWC estimated cut and fill quantities needed for construction estimates and bid design (**Figure 12**). Microtopography will be added to all disturbed floodplain areas. **Figure 13** shows a detail sheet and example photo used in previous projects to roughen and add microtopography to the floodplain. The same techniques will be applied for this project.

The general construction sequence will be as follows:

1. Mobilization in the fall months when the channel is dry and vegetation is dormant.
2. Harvest wood from nearby forest for floodplain roughness treatments and burial in existing stream alignment.
3. Stockpile logs and slash in approved locations for later use.
4. Strip all riparian sod, willows, and top soil material from disturbance area (pink polygon in **Figure 11**) and temporarily stockpile material in approved locations for later use.
5. Excavate borrow material from disturbance area and fill in existing incised stream.

6. Incorporate harvested wood and slash as fill material in the existing incised stream, oriented perpendicular to the valley slope.
7. Compact soil and incorporated wood in 1-foot lifts.
8. Fill to adjacent floodplain surface, working upstream to downstream.
9. All excess cut material will be placed in the downstream incised channel and graded to blend into the existing topography to look "natural". No excess material will be placed on the floodplain.
10. Create roughness and complexity to all disturbed areas on the floodplain by partially burying harvested slash and logs and adding microtopography. The floodplain finished surface is meant to prevent concentrated flow paths and encourage complex topography to aid in microsites for seed establishment and flood detention.
11. For added insurance, in the field decisions will be made by BHWC and contractor as to where to place extra wood/soils material to ensure water does not enter back into the lower portion of the incised stream. This work consists of strategical soil berming and additional floodplain roughness to direct/deflect surface water. This will be a "field fit" application.
12. Revegetate with harvested topsoil, sod mats, and willows.
13. Seed all disturbed areas with approved native riparian seed mix.
14. Demobilize

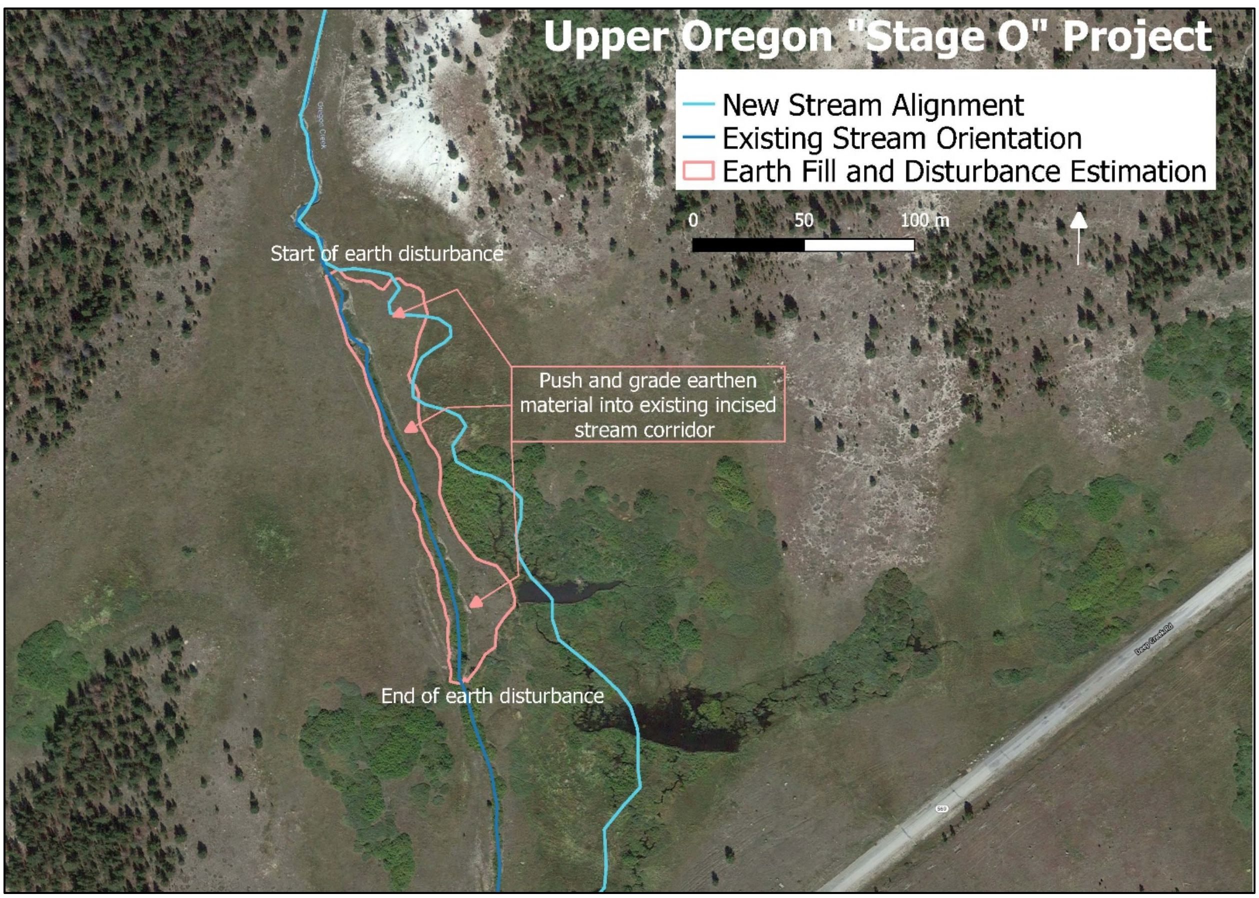

Figure 11. Upper Oregon Creek modified "Stage 0" design

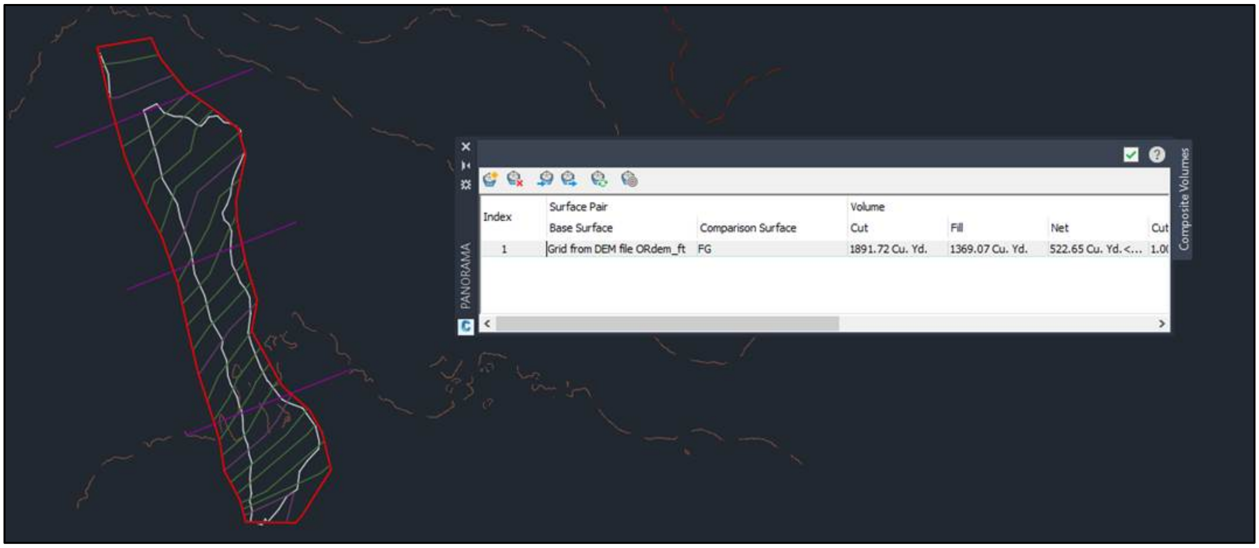

Figure 12. Cut and fill estimates generated by publicly available LiDAR data.

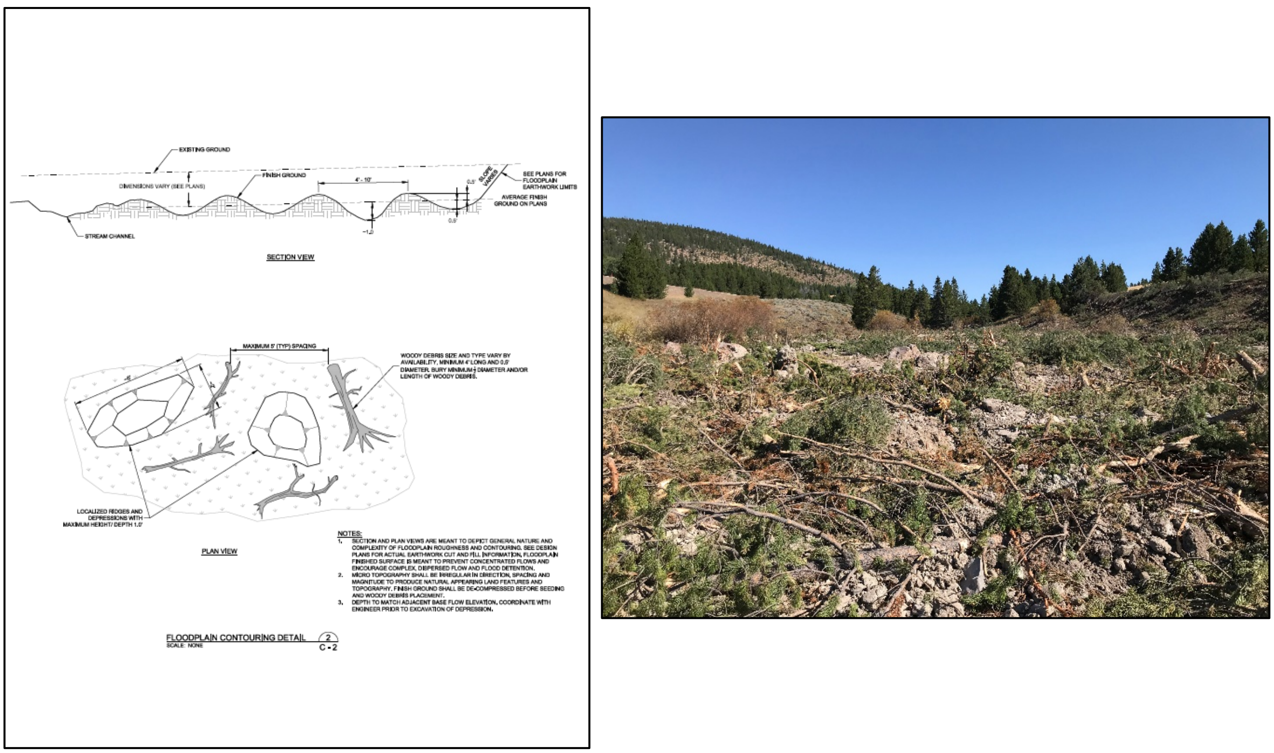

Figure 13. Floodplain roughness/microtopography specifications (left) and example of floodplain roughness treatments used in previous projects (right).

Culvert Removal

A perched, plastic culvert (46.0121, -113.0041) is located in the project area. The culvert is undersized, resulting in high rates of erosion on the outlet side of the pipe (**Figure 14**). The outlet side of the culvert is elevated approximately 1.5-2 feet above the downstream water surface. This perched culvert is impeding fish passage to .5 miles of upper Oregon Creek.

This culvert will be removed entirely from the stream. The streambed will be graded to match the existing upstream and downstream elevations. The banks will be sloped back to a minimum of 2:1 slope. If necessary, rock or log weirs will be installed in the streambed used for grade control. Grade control structures will be installed in the disturbed area (in place of the culvert). All excess material excavated during removal will be placed on the northeast side of the stream and blended into the exiting grade, out of the floodplain. If necessary, material can be placed on the access road and blended into exiting road base elevations. All disturbed areas will be seeded with the Upper Oregon Creek Native Seed Mix.

Figure 14. Perched culvert in the Upper Oregon Creek project area to be removed.

Implementation Schedule

	Spring 2022	Summer 2022	Fall 2022	Spring 2023	Summer 2023	Fall 2023
Uplands						
Gully Check Dams and Gully Slash Filters Installation						
Aspen Enhancement						
Revegetation of Uplands						
Riparian						
In-stream Structures Installation						

"Stage O" Implementation						
Culvert Removal						
Continued Monitoring and Maintenance						

Project Team

BHWC Restoration Program Manager, Ben LaPorte will lead all project implementation during the Upper Oregon Creek Restoration project. Executive Director, Pedro Marques will be leading the coordination of the work with NRDP and the ongoing Superfund work, and will be available in the field as needed. Associate Director, Tana Nulph will assist in project documentation and reporting efforts.

MFWP, as the landowners, will be watching the project closely and directly involved in implementation. Jason Park, MFWP Forester, will lead all contracting and oversight of the aspen enhancement work. Jason will work closely with Ben LaPorte to ensure all gully check dam and slash treatments are installed properly. Jim Olsen, MFWP Fisheries Biologist, will act as the lead authority on all riparian/in-stream work and will be technical support for structure placement and culvert removal activities. Vanna Bocaddori, MFWP Wildlife Biologist, and Mount Haggin WMA Manager will act as the chief authority on all project activities and will coordinate with, BHWC and NRDP throughout all phases of project work.

Greg Mullen, NRDP Environmental Science Specialist leads remedy activities on the MWA. Greg is the main contact on all documentation pertaining to Superfund and associated compliance.

References

Montana Department of Justice Natural Resource Damage Program. 2018. *Anaconda Smelter NPL Site Mount Haggin Uplands (RDU 15) Remedy and Restoration Work Plan*. Helena, Montana. Montana Department of Justice Natural Resource Damage Program

Powers P.D., Helstab M., Niezgoda S.L.. 2018. *A process-based approach to restoring depositional river valleys to Stage 0, an anastomosing channel network.* River Res Applic. 2019;35:3-13.

Wheaton J.M., Bennett S.N., Bouwes, N., Maestas J.D. and Shahverdian S.M. (Editors). 2019. *Low-Tech Process-Based Restoration of Riverscapes: Design Manual*. Version 1.0. Utah State University Restoration Consortium. Logan, UT.

Wohl E., Lininger K.B., Scott D.N.. 2017. *River Beads as a conceptual framework for building carbon storage and resilience to extreme climate events into river management*. Biogeochemistry. DOI 10.1007/s10533-017-0397-7.

Appendix A

SSR Remedy and Restoration Toolbox
(NRDP 2018 Work Plan)

Anaconda Smelter NPL Site
Mount Haggin Uplands (RDU 15)

Remedy and Restoration Work Plan

PREPARED BY:
MONTANA DEPARTMENT OF JUSTICE
NATURAL RESOURCE DAMAGE PROGRAM

SSR Remedy and Restoration Toolbox

This section describes all the SSR techniques developed in over the last 5 years by the NRD program. This section can be used as a stand-alone manual for steep slope restoration in a variety of contexts.

SSR 1a: Broadcast Seeding

Broadcast seeding of grasses and forbs has been shown to successfully colonize the Mt. Haggin uplands where there is a lack of a natural seed source. Seed can be hand-applied as well as aerially broadcast via helicopter. Seed mixes should emphasize metals and low-pH tolerant cultivars, species common to the area, and species with high wildlife forage, soil stabilization and varietal hardiness characteristics.

Broadcast seeding via hand-operated belly seeder on freshly worked soil adjacent to a gully.

Broadcast seeding is appropriate under certain conditions:

- Soil has been shown to lack natural seed source
- Slope has relatively uniform features without excessive gullying
- Grasses and forbs will aid in soil stabilization and wildlife forage

Design & Application Considerations

- In areas <5 acres, hand application via belly seeder is appropriate. Treatment areas >5 acres should be applied via helicopter to maximize distribution and efficiency
- Low pH- and metals-tolerant native seed varieties have been developed for use in this project area through the Bridger Plant Materials Center and have shown high success in the Mt. Haggin WMA under the right conditions
- Seed should be applied on calm days (low wind), in late fall or early spring to maximize germination potential
- Seed mix should consist of drought-tolerant, native perennial species with extensive root systems
- Seed mix should emphasize species with vegetative growth characteristics (i.e. tillers and runners)
- In high traffic wildlife areas, consider species that are not preferred as wildlife forage to reduce browse pressure

Cautions:

- Exceptionally exposed areas (ridgelines, high wind areas, scree fields) should be avoided
- Noxious weed-infested areas will have lower rates of success when seeded with a native mix
- Slopes of 50% (~25°) or greater should be prepped with micro-topography to improve germination rates

SSR 1b: Seeding & Fertilization

The parent material throughout the Mt. Haggin WMA has tested exceptionally low in plant available nitrogen due to the nature of the volcanic tuff that formed the soils. Inorganic and organic fertilizers provide a much-needed boost to seed establishment. Fertilizer application also boosts the growth potential of existing vegetation throughout the project area.

Broadcast seed and inorganic fertilizer visible alongside established Berberis repens in the Mt. Haggin Uplands.

Seeding & fertilization is appropriate under certain conditions:

- Slope is within appropriate parameters for seed germination success (see above)
- Fertilizer is applied 200+ feet from stream systems
- Slopes are considered unlikely to experience overland sheeting or other extensive erosion

Design & Application Considerations

- In areas <5 acres, hand application via belly seeder is appropriate. Treatment areas >5 acres should be applied via helicopter to maximize distribution and efficiency
- Slow-release organic fertilizers, such as Sustane or Biosol at 2000 lbs/acre have been proven effective.
- Fertilizers should have high N:P:K ratios – from 7:3:2 up to 42:0:0
- Compost products can be incorporated in areas where organic material is desired
- Fertilizer should be applied in early spring (after snowmelt) to maximize growth potential
- Fertilizer alone can be applied in areas with established vegetation to promote growth potential
- Seed and fertilizer can be used in combination with light earthworks, BMP structures and in between woody transplants

Cautions:

- Fertilizer should not be applied at high concentrations within 30’ of stream systems, wetlands or ponds
- Fertilizer should not be applied in noxious weed infested areas without aggressive weed treatment in those areas
- Fertilizer should not be applied in areas of extensive rilling or gullying unless check dams or other BMP structures are incorporated to reduce downslope impacts

SSR 1c: Soil Scarification & Trenching

Soil scarification and trenching, typically across contours are an effective means towards improving germination rates and water holding capacity on bare eroding slopes. Trenches and grade breaks in the micro-topography of a slope act as natural sinks for seed establishment and water infiltration. Trenching along contour lines promotes snowmelt infiltration, reduces sheet erosion, and provides ideal microclimates for plant establishment and success. This treatment aims to create islands of vegetation that can spread into otherwise bare areas.

Seeded and fertilized micro-swales (trenches) are installed before being covered by coconut coir erosion fabric and fastened with stakes and woody debris in Joyner Gulch

Soil scarification & trenching are appropriate under certain conditions:

- Slope exhibits a relatively uniform topography and minimal roughness
- Slope is exposed and subject to heavy wind erosion
- Trenching follows contour lines to maximize water retention and reduces soil mobility

Design & Application Considerations

- Contour lines are followed to maximize efficacy of water retention and infiltration
- Trenches can be effective at a variety of soil depths – from 3” for seed establishment to 18” for large sediment sources
- Excavated soils should form a berm on the downhill side of the trench to act as a barrier to seed, soil and water movement
- Consider covering trenches and scarified areas with erosion blankets, fabrics or forest byproducts (downed woody debris, slash, etc.) to improve seed and water retention, increase shade, and reduce potential blowouts

Cautions:

- Trenches that dip below contour lines and down the slope can act as channels that may funnel surface water and form new rills and gullies

SSR 1d: Woody Vegetation Establishment

Woody vegetation establishment is the ultimate goal of the restoration efforts in the Mt. Haggin WMA due to its ability to stabilize eroding soils, build soil complexity and health, and provide wildlife habitat. While much of the surrounding area has been reclaimed by *Pinus* and *Populus* stands, many steep slopes have yet to establish woody plant communities.

Woody vegetation establishment is a crucial step towards the end goal of the Mt. Haggin restoration efforts. Above,* Pinus contorta *saplings being planted at the Stucky Ridge site.

Woody vegetation establishment is appropriate under certain conditions:

- Species are selected based on site specific tolerances to elevation, aspect and soil conditions
- Costs to mobilize materials are low, i.e., planting location is near existing roads or live stakes are used from local sources
- Woody transplants respond best on North and East aspects

Design & Application Considerations

- Woody vegetation establishment can be approached in several ways:
    - Live (dormant) transplants of nearby individuals
        - Transplant live rootwads and clumps of young *Populus tremuloides*, *Rosa woodsii*, *Prunus virginiana* and *Salix scouleriana*, among others
        - *Salix spp.* cuttings installed along ephemeral streams and draws
    - Nursery-raised containerized plants should be installed with browse protection nets
    - Install wildlife exclosures around existing woody vegetation to promote faster development and colonization – particularly aspen colonies
- Locate favorable planting areas in drainage areas and draws to maximize water availability and soil stability benefits

Cautions:

- Exceptionally exposed areas (ridgelines, high wind areas, scree fields) should be avoided due to difficulty of plant establishment
- Wildlife browse pressure can drastically impact plantings – protect with fencing as needed
- Use of plant protection should be limited to avoid maintenance issues, particularly in remote locations
- Water is the limiting factor on these slopes. Locate plantings where they will have the best chance of accessing ground water or areas of higher soil moisture

SSR 1e: Additional Soil Amendments

Due to the denuded nature of the soils in the Mt. Haggin WMA, additional amendments may be considered necessary for site specific applications. While nitrogen is typically the limiting nutrient, organic matter, soil biological components and micronutrients are highly desired. Lime in generally considered unnecessary for plant establishment but may be considered for some applications where soil pH is below 5.0.

Two forms of bagged fertilizer, – one organic, the other inorganic – are staged on a ridgeline via helicopter or ATV

Possible alternative soil amendments include:

- Compost
- Lime
- Borrow material
- Mycorrhizae
- Woody debris- from shredded bark to large trees

Design & Application Considerations

- Compost will greatly improve local soil biota if applied by tilling into the A and B horizons of the soil column
- Lime will help to neutralize acidic soils to provide better seed germination conditions
- Borrow material, such as sod mats from sources within the Mt. Haggin WMA will introduce local soil biota, seed sources and organic matter as well as provide erosion control
- Mycorrhizae, when applied through containerized plantings, can improve survival
- Woody debris adds organic matter over time, can improve water holding capacity, add stability to soils, and provide microclimates for plant establishment

Cautions:

- Compost and other soil amendments will readily blow away unless tilled into the soil or covered with erosion fabric or woody debris
- Over-application of lime can make a soil too basic for plant establishment
- Borrow pits disturb established vegetation and promote noxious weeds – seed as necessary
- Mycorrhizae is best applied during the early stages of plant establishment

SSR 2a: Slope Stabilization

Initial efforts to stabilize upland slopes focused on installing low-cost, low-tech check structures where rill formation begins to slow sediment transport and overland sheeting. These structures are made from available forest resources, rocks or biodegradable materials and placed in rills, or scattered on the soil surface to increase roughness, slow water and promote natural vegetation establishment.

Woody debris from nearby slopes can be re-located to eroding rills to capture sediment and promote regeneration

Appropriate conditions for steep slope stabilization:

- Active or historic rills no deeper than 2 feet are best locations for these structures
- Slash filter windrows and straw wattles are appropriate treatments for many SSR-3 activities to stabilize disturbed soils.

Design & Application Considerations

- Forest slash (branches, limbs and trunks) can be processed and laid throughout channelized gullies to aid in sediment retention or on bare slopes to add roughness, micro-site locations
- Burlap coffee bags are filled with parent material from on site, amended with fertilizer and seed, and placed as a series of check dams in rills and small gullies to act stop sediment transport, promote water infiltration and encourage vegetation establishment
- Coir and straw wattles should be utilized in lower-elevation settings where sediment delivery is less significant and the opportunity to spread surface water horizontally across floodplains is more easily achieved
- Revegetation – in the form of seed, *Salix* cuttings, or transplants – should be incorporated into this approach

Cautions:

- Coffee bag material readily decomposes within two years in exposed areas of the steep slopes
- On steeper areas, wattles can fill and overtop in a single rain event. Caution needs to be taken when placing wattles to prevent significant blowouts and subsequent headcuts
- Forest slash is not always readily available and should not be transported long distances by hand
- Revegetation should be incorporated into these structures to support long term success of structures

SSR 2b: In-Stream Check Structures

In-stream structures are assembled in incised channels using local materials. The structures are placed in the stream channel to capture sediment and aggrade the channel bed. Installed in series, structures promote overbank flows during high water that slows water and deposits its bedload on the landscape. The increased floodplain connectivity and groundwater recharge support desired riparian plant communities.

In-stream beaver dam analogues (BDAs) successfully stopping sediment transport and reactivating floodplain in previously incised creek system in the Mt. Haggin WMA

Appropriate conditions for In-Stream Check Structures:

- In incised channels where bank-full stage does not spill out of the channel
- In high- and low- turbidity settings to reduce sediment loading
- In perennial or intermittent channels, typically no more than 2% grade

Design & Application Considerations

- Ideal locations are in lower gradient breaks in slope, where floodplain can be accessed and a series of 3 structures can be built to slow and spread water over a large area
- Begin by driving ~30” wooden posts into the stream channel, perpendicularly, on 12” centers
- Pine boughs and willow whips are then tightly woven through the posts and pressed into placed to form a leaky dam
- Stream aggregate can be backfilled along the bottom of the structure to prevent under scour, and transplanted clumps of sedge are placed along the banks to seal the edges and prevent lateral channel migration cuts
- Hydrologic function can be restored to deeply incised systems with annual maintenance and building of new structures on top of filled structures
- In areas being constructed with heavy equipment, large straw bales can be installed with 6-foot willow stakes driven through them into native earth

Cautions:

- The use of solid wood or large rock in these structures promotes lateral cutting and should be carefully considered
- Preventing scour under the structures is crucial. Ensure the bottom of the structure is flush with the channel bottom by backfilling with sediment, sod or mud
- Headcuts can be created if structures overtop and create a ‘waterfall’ effect. Prevent this by padding the downstream side of the structure with slash or large cobble
- When a structure fills up with sediment, the stream will create a new channel. Consider directing the high water into older channels or into vegetated areas to reduce the risk of additional headcuts

SSR 2c: Gully Slash Filters

Gully slash filters utilize the byproducts of traditional forest thinning efforts to fill erosion channels with organic material. Placing this material in the channels helps to reduce sediment transport, increase water retention and infiltration, and establish vegetation by acting as a microclimate and browse protection structure.

Appropriate conditions for Gully Slash Filters:

- Nearly all gullies in the RRA are appropriate settings for slash filters
- Materials should be close by or easily mobilized (road or skid trail accessible)

Two examples of slash filters utilizing forest thinning byproducts to capture sediment and fill erosion gullies.

Design & Application Considerations

- Construction of gully slash filters is cost-effective as long as conifer material is growing along the edge of the gully
- Adjacent timber stands are thinned – removing standing dead trees, non-merchantable trees and small-diameter slash and diseased or damaged trees can be targeted, adding a forest health component
- Stands of aspen are ideal locations for harvesting log material, promoting underground vegetative growth and promoting appropriate wildlife habitat values.
- Several feet of limbs, slash and immature trees are laid lengthwise along the bottom of the channel to maximize contact with the ground and minimize porosity of structure (water & sediment mobility)
- Large stems and logs are piled on top to weigh the structure down and increase structural integrity
- Incorporate additional SSR treatments to promote vegetation establishment and soil stabilization

Cautions:

- Do not thin trees that are directly adjacent to gully walls or whose root structures act as structural support for surrounding soil
- Do not allow large air gaps or spaces between the bottom of the channel and the slash filter
- Living limbs and slash are preferred materials for lining the bottom of the gully
- Trained professionals should oversee forest thinning to avoid over harvesting

SSR 2d: Gully Check Dams

Check dams are strategically placed and carefully constructed Best Management Practices consisting of a mix of logs, rock and sometimes erosion control fabric. Structures are positioned across the gully bottom to capture eroding sediment, raising the gully base height and decreasing gully slope length. Like in-stream structures, these are monitored annually and new structures built on top of captured sediment. Where possible, structures are built up until overland flows can be directed out of gully and spread across vegetated landscape.

A log and slash check dam that filled with sediment over the course of one year in the Mt. Haggin WMA

Appropriate conditions for Gully Check Dams:

- Large and small gullies, active or not, in volcanic welded tuff soils
- Where construction materials are available nearby
- Where there is safe access to the gully bottom

Design & Application Considerations

- Check dams should be located in areas where large volumes of sediment can be impounded upslope with the aim of bringing the gully back up to grade
- Check dams should be built in series – 3 to 5 per 300 linear feet – to add resiliency and a 'step pool' effect to channelized gully
- For log and slash check dams, pack slash along the bottom of the channel and secure logs across the channel with posts and backfill. Align logs to provide a spillway on the downhill side
- Rock check dams should be backfilled during construction to fill pore space and prevent under scour. Pad with slash or cobble immediately below structure to prevent additional channel incising
- Forest slash or erosion fabric (coir) can be laid across the bottom of the channel and underneath check dams to aid in fine sediment capture and bank stabilization
- Incorporate additional SSR treatments with each structure to provide further stabilization and improve revegetation potential

Cautions:

- Check dams can fill with sediment during a single rain event. Monitor annually
- Do not place check dams where significant 'waterfall effects' may occur to reduce the risk of under scour and headcuts
- As structures fill, impounded sediment should be stabilized with vegetation or additional SSR treatments to minimize mobility and reconnect gully to surrounding grade

SSR 2e: Anchored Brush Bundles & Brush Boxes

Brush bundles and boxes are constructed using forest slash anchored to banks, slopes and gullies to trap sediment, stabilize soils, and catch sloughing vegetation, seed and fertilizer. Brush bundles and boxes provide structural integrity, increase organic matter, and act as terracing to aid in slope stabilization and revegetation.

Brush bundles being installed in a large erosion gully in the Mt. Haggin WMA

Appropriate conditions for Anchored Brush Bundles and Boxes:

- Eroding banks of streams, creeks and channelized gullies
- Where forest slash is easily accessible
- On moderately steep slopes with mild rilling

Design & Application Considerations

- Tight bundles of slash are strung on contour along gully walls and creek banks and fastened with duck bill anchors or posts driven perpendicularly into the slope
- Logs with diameters greater than 6” are laid in trenches dug along contour of gully walls and fastened with driven posts. Backfill and slash are tucked underneath and upslope of log to provide a germination platform along bank wall
- On longer slopes, install a series of staggered brush bundles on contour intervals of 10’
- Where available, place sloughing vegetation directly on top of brush bundles and boxes to expedite vegetation establishment
- Incorporate additional SSR treatments with each structure to provide further stabilization and revegetation potential

Cautions:

- Once needles dry and shed, structures lose substantial volume and increase in porosity. Ensure bundles are secured as tight as possible to minimize the chance of blowouts and failure
- Working on unstable banks can exacerbate erosion. Take care to minimize disturbance and work from the bottom up to minimize sediment loading to gully or creek channel
- Most effective if sod mats from eroding bank are cut and placed on newly created brush bundle

SSR 3a: Slope Pitting and Roughening

Slope pitting and roughening utilizes heavy equipment to increase microtopography on steep slopes in an attempt to reduce overland sheeting, increase water retention and infiltration, promote seed germination and planting success, and reduce soil mobility. Pits can be large, from 3-8 feet from pit bottom to top of pile. Microtopography provides ideal settings for fertilization retention, seed germination and success, and snow and rainwater collection and infiltration.

Appropriate conditions for Slope Pitting and Roughening:

- Eroding slopes accessible to machinery
- Occurs prior to seeding, fertilization or planting efforts

Several acres of slope pitting and roughening adds microtopography which improves water retention, planting success, and soil stability; Stucky Ridge

Design & Application Considerations

- Slopes must be selected based on access, stability and perceived benefits. Choose moderately steep slopes and aspects with high potential for seed germination and planting success
- Excavators descend a slope from the ridgeline or other access point, roughening and pitting the soil as they work downslope
- Typically utilized to treat borrow areas for gully filling activities
- Fertilization, seeding and woody plantings should be installed immediately after earthwork to rapidly colonize loose soil and stabilize the slope
- Incorporate woody debris (logs, slash, beetle kill) and live woody transplants (*Populus, Salix spp.)* into newly worked slopes

Cautions:

- Steep slopes are safety concerns for equipment operation. Take necessary steps to ensure safe access and working conditions
- Consider the use of a winch system attached to machinery to reduce the risks of rollovers or soil sloughing
- Minimize compaction of soils by preventing machinery access after slopes have been worked

SSR 3b: Earthen Sediment Retention Basins

Earthen sediment retention basins are swales dug across contour that catch overland sediment flows. Filled basins become terraces with improved conditions for natural revegetation, including seed germination and moisture retention. These are constructed with an excavator or skid steer- as older swales fill, newer ones are constructed upstream.

A newly constructed earthen sediment basin with broadcast seed and erosion fabric, prior woody shrub plantings; Cabbage Gulch

Appropriate conditions for Earthen Sediment Retention Basins:

- Eroding slopes less than 40°
- Accessible to medium size excavator or bulldozer
- Prior to seeding, fertilization or planting
- Across rills, gullies and at the toe of large sediment plumes

Design & Application Considerations

- Slopes must be selected based on access, stability and perceived benefits. Choose moderately steep slopes and aspects with high potential for seed germination and planting success
- Excavators ascend the slope and work downhill, pulling soil and excavated material downhill to form a trench and subsequent berm. Transplant existing sod and vegetation to toe of earthen berm to stabilize loosened soils
- These can be U-shaped berms at the toe of slope or can tie into gullies to direct sediment and water across the contour
- Erosion control fabric should be used over berm where water velocities in structure are higher
- Small water bars or earthen checks are installed throughout the trench to reduce the velocity of transported sediment
- Seed and fertilizer should be applied before laying erosion fabric over disturbed soil
- Woody plantings or live transplants should be installed after equipment has finalized earthwork

Cautions:

- Steep slopes are safety concerns for equipment operation. Take necessary steps to ensure safe access and working conditions
- Consider the use of a winch system attached to machinery to reduce the risks of rollovers or soil sloughing
- Minimize compaction of soils by preventing machinery access after slopes have been worked
- Careful consideration of grade, slope and sediment loading is required to prevent overtopping of earth berm
- Large areas of disturbed soil invite noxious weeds – apply seed accordingly to prevent invasive weeds

SSR 3c: Gully Grading & Filling

The strategy of filling and grading gullies is accomplished with heavy equipment to reduce sediment by re-contouring the landscape and eliminating entire gullies.
Gullies are filled by pushing material from surrounding areas and creating even grades throughout the landscape to reduce channelization and overland sheeting. Additional SSR treatments are incorporated to minimize soil mobility and promote water infiltration. Check structures ensure water does not re-cut old channel.

Filled gully matches existing slope angle. Stream here was redirected to old channel through sedge mat at new low point in valley

Appropriate conditions for Gully Grading & Filling:

- Accessible to medium size excavator and bulldozer
- Prior to seeding, fertilization or planting
- Across rills, gullies and at the toe of large sediment plumes
- Requires construction of new channel or existence of stable historic channel
- Requires a readily available borrow area

Design & Application Considerations

- Slopes must be selected based on access, stability and perceived benefits. Choose moderately steep slopes and aspects with high potential for seed germination and planting success
- Topsoil and existing vegetation is removed and staged for later reapplication
- Subsoil is bulldozed into the gully to bring it up to the grade of the surrounding slopes
- Reinforced channels are built to accommodate drainage patterns across the landscape
- Additional SSR treatments are installed to act as sediment breaks, water bars and microtopography
- Sod mat, woody debris and vegetation are transplanted onto newly graded areas
- Erosion fabric, seed and woody plantings are installed to aid in stabilization of disturbed soils

Cautions:

- Steep slopes are safety concerns for equipment operation. Take necessary steps to ensure safe access and working conditions
- Topsoil and existing vegetation is especially important to finalize earthwork. Designate areas to source from and minimize disturbance
- Grading must be monitored carefully and reinforced to prevent overland sheeting, channelization and headcuts

SSR 3d: Rock Check Dams

Where large sediment point-sources exist, rock check dams have been utilized to capture and settle all transported materials and runoff. Located at the toe of sediment plumes and large gullies, rock check dams are a mix of earthen berms, rock-reinforced spillways, and settling ponds. Geotextiles are often used to stabilize the earthen berms while rock is used to reinforce spillways to prevent under scour and headcuts.

Rock check dams filled with sediment and runoff in California creek drainage.

Appropriate conditions for Rock Check Dams:

- Accessible to medium size excavator, roller and dozer
- At the confluence of several large channelized gullies or sediment plumes

Design & Application Considerations

- Determine the siting for rock check dams based on machine access, availability of large rock, and appropriate levels of sediment loading
- Locate check dams at the toe slope of large sediment-contributing slopes, gullies and plumes
- Build an access road for machines and dump trucks to bring in fill material and large rock
- Dig a retention basin upslope of the proposed rock check and build an appropriate sized earthen berm across channel with excavated material. Source fill material from upslope if needed
- Install geotextile fabric over compacted earthen berm to stabilize soils
- Install reinforced spillway with 6”+ stone and cobble - minimum of 18”depth.
- Monitor rock check dams for incising, headcuts and blowouts

Cautions:

- May require engineered plans to accommodate volumes of water and sediment for larger drainages
- Overtopping of check dams is possible. Construct with the intention of each dam filling over the course of several years
- Many truckloads of large cobble are necessary for each structure. Dump truck access is required
- Until completely filled and overtopped, structures do not promote natural vegetation establishment

SSR 3e: Hydro-seeding

After construction efforts are completed, large areas of bare soil can be seeded, mulched and fertilized with various hydraulic applications. Hydro-seeding combines mulch, seed and soil amendments into a slurry that is then applied directly onto bare soil. It is often used for erosion control on road construction sites and can include customized recipes for site specific applications.

Hydroseeding applications are restricted to roadsides and can extend upwards of 300- 500 feet from pull-out.

Appropriate conditions for Hydro-seeding:

- Bare soil
- Accessible by truck and trailer
- Near water source

Design & Application Considerations

- Hydroseeding is a common strategy for vegetating bare soil with mixed grasses and perennials, but is limited to sites accessible by road with truck and trailer for tank
- Mulch can be sourced from shredded newspaper, cellulose, or other biodegradable products
- Seed mix is customizable and should be selected based on regional hardiness, root development and beneficial wildlife habitat/forage
- Fertilizer must be dissolvable or small enough to flow through application nozzle system

Cautions:

- Road access limits the use of hydro seeding
- While hoses can be strung to reach several hundred feet, access to water is an additional limiting factor
- Species of seed mix must be tolerable to soaking in application system prior to application and germination

SSR 4

The suite of techniques in SSR-4 include Slope Grading (4a), Compost (4b) and Lime tillage (4c), sediment detention ponds (4d) and soil and earth removal (4e). These techniques are highly mechanized and intensive, typically requiring the existence of haul roads. Due to the following limitations of the RRA, these techniques are not currently prescribed for RRA polygons:

- Soil toxicity and metals contamination is low in the soils of the RRA
- Existing natural conditions and ecological functions have been improving over the last 40 years, providing sediment capture functions which support EPA goals for the injured areas
- More harm than good wood be done in most locations by grading, tilling or removing existing soils, with substantial increases in weeds
- Long-term maintenance of these techniques is required
- Vegetation conditions post-treatment would likely result in a decrease of species composition and biodiversity
- More resilient and sustainable techniques have been demonstrated in the uplands that fit with landowner long-term management objectives
- Opportunities to create natural sediment capture downstream of the RRAs may be explored by project partners to enhance the landscape's ability to attenuate sediment delivery, as well as provide benefits to fish habitat and water quality.
- Locations identified by ARCO for sediment detention ponds (ARCO 2017), including lower California Creek, Oregon Creek or other drainages on private land could be graded to create a series of stepped wetlands and functionally become a sediment trapping reach. This conceptual alternative, illustrated in **Figure 32.**

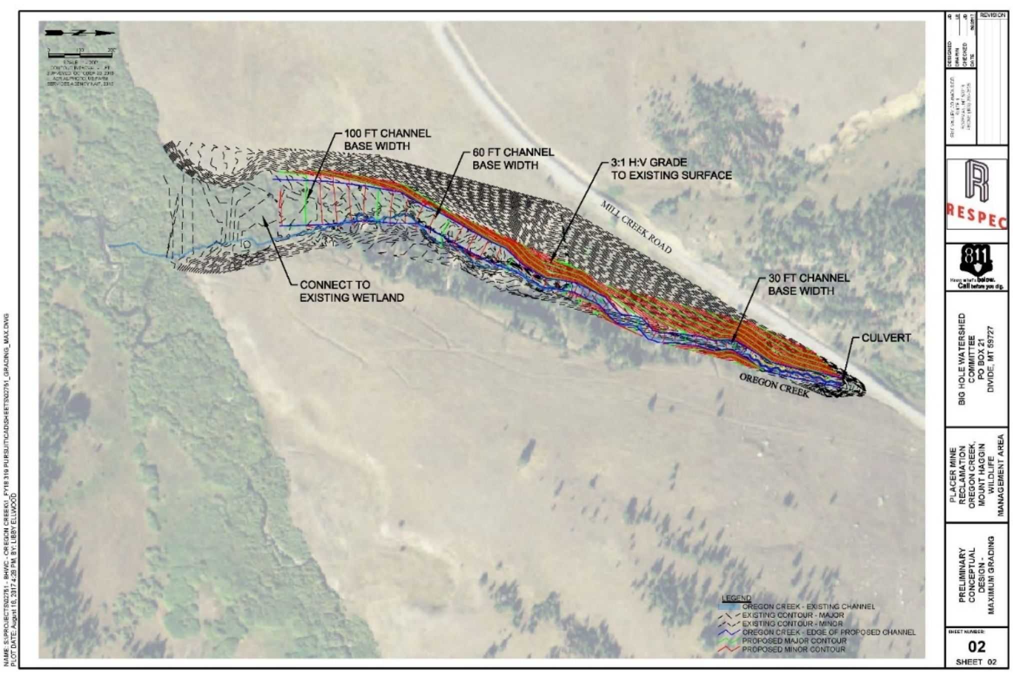

Figure 1. Proposed Oregon Creek Sediment Capture Design

Other Prescriptions used in Plan

Outside of the SSR toolbox other prescriptions are needed to account for all different conditions and approaches used in the RRAs. Many areas in the RRAs have revegetated naturally and are considered completely or mostly functional from the perspective of erosion control and the establishment of vegetation cover. Prescriptions of Monitor-Well Vegetated (M-WV) are applied to portions of polygons with substantial vegetation and positive ecologic trends where remedy activity would likely do more harm than good. The M-WV designation includes vegetation monitoring and weed treatment as part of the weed plan presented below and is the predominant remedy prescribed across the RRAs.

Other areas that may appear bare from aerial imagery have been found from field observations to be tallus or scree slopes that are not actual erosion sources. For areas heavily armored by colluvium a prescription of Rock-No Action (RNA) is applied. These areas are not erosion sources, are unlikely to become sources, and show minimal to no substrate for plant growth. RNA areas should be monitored for weeds as part of the weed plan presented in **Appendix B: Noxious Weed Treatment.**