Salmon River Private Roads Sediment Reduction Project, Klamath Watershed Restoration Program, Siskiyou County, California

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1 PROJECT SUMMARY

The Salmon River Private Roads Sediment Reduction Project work area encompasses portions of the Butler Creek, Negro Creek, and Robinson Gulch subbasins, as well as portions of unnamed tributaries to the North Fork and South Fork Salmon River in Siskiyou County, California. The individual properties are privately owned and managed, and tributary channels within drain to important habitat and spawning refugia for anadromous salmonids including coho and Chinook salmon, as well as wild Klamath Mountain Province steelhead trout, pacific lamprey, and green sturgeon. Currently, excessive sediment delivery from networks of eroding and/or abandoned forestland roads in the watershed is recognized as a significant, but controllable, threat to water quality and fish habitat in Salmon River and its tributaries.

In 2008, the Salmon River Restoration Council (SRRC), a non-profit organization committed to educating and empowering riverine communities, with funding from the Bureau of Reclamation's (BOR) Klamath Watershed Restoration Program, contracted Pacific Watershed Associates Inc. (PWA) to undertake the project layout, and heavy equipment supervision required to implement sediment reduction treatments (upgrading and/or decommissioning) for approximately 3.1 mi of road and 15 individual point source sediment delivery sites in the Salmon River Private Roads Sediment Reduction project area. The proposed work plan was based on the prioritized treatment plan developed as part of the road related sediment source assessment completed during the 2007 field season.

Between July 2009 and September 2010**,** PWA supervised the treatment of 5 individual project areas and 15 sediment delivery sites in the project area. Roads within four of the project areas were upgraded and 1 project area included both upgraded and decommissioned roads. Sediment delivery sites treated for the project include 13 stream crossings, 1 ditch relief culvert, and 1 discharge point from concentrated road surface runoff. Successful erosion control and erosion prevention treatments for some sites also required treating adjacent segments of hydrologically connected road that were contributing fine grained road surface, inboard ditch and cutbank sediment to each delivery point. Hydrologically connected road reaches treated in the project area totaled approximately 1.60 mi: 1.45 mi leading to stream crossings, 0.08 mi adjacent to the discharge point from concentrated road runoff and a total of 0.07 mi associated with the ditch relief culvert. PWA estimates that implementing the site-specific treatments will prevent the future, episodic delivery of approximately 1,090 yd^3 of sediment to the stream system in the coming decades, primarily from stream crossings in the project area. In addition, PWA estimates that treating the hydrologically connected reaches to reduce chronic erosion from roadbeds, ditches, and cutbanks will prevent the delivery of fine sediment to streams by approximately 1,560 yd^3 per decade.

With this extensive remediation of private landowner, road related erosion problems within the Salmon River Private Roads Sediment Reduction project area, the threat of sediment delivery to salmonid streams in the area is significantly diminished. If employed with responsible future land use practices, the erosion control and erosion prevention treatments completed for this project will contribute to the long term recovery of salmonid habitat in the Salmon River watershed.

This project was funded under Grant Number R10AP20601 through the Klamath Basin Restoration Program administered by the Klamath Basin Area Office, Mid Pacific Region, Bureau of Reclamation.

2 CERTIFICATION AND LIMITATIONS

This report, entitled *Salmon River Private Roads Sediment Reduction Project, Klamath Watershed Restoration Program, Siskiyou County, California*, was prepared by or under the direction of a licensed professional geologist at Pacific Watershed Associates Inc. (PWA), and all information herein is based on data and information collected by PWA staff. Erosion control treatment prescriptions, on-the-ground pre-implementation layout, and technical oversight of heavy equipment for the project were similarly conducted by or under the responsible charge of a California licensed professional geologist at PWA.

Analyses, data, and results presented in this report are only intended to meet the reporting requirements as specified in the Bureau of Reclamation Assistance Agreement #08FG200140. Data used to generate the original proposal and work plan are based on road erosion inventories conducted in 2007. Changes in site conditions may have occurred since that time, and the data are therefore PWA's best approximations based on the available information. Final data for heavy equipment hours and excavation volumes were provided to PWA by heavy equipment subcontractors, and PWA is not responsible for any errors in their records or reporting.

Initial recommendations prescribed for restoration and erosion control at specific sites are based on observations of surficial conditions at the time of the original assessment. Once implementation is underway, subsurface conditions revealed by heavy equipment may not reflect the original surficial observations. Where necessary, original treatment prescriptions may be modified based on the updated site-specific subsurface conditions. This practice of "adaptive management" is undertaken as necessary in order to maximize the success of the project and to minimize the risk of future erosion and sediment delivery.

The interpretations and conclusions presented in this report are based on a study of inherently limited scope, and findings are valid as of the report submittal date. Observations are semi-quantitative, confined to surface expressions of limited extent and artificial exposures of subsurface materials. Interpretations of problematic geologic and geomorphic features (such as unstable hillslopes) and erosion processes are based on the information available at the time of the study, and on the nature and distribution of existing features. PWA is not responsible for changes in the conditions of the property with the passage of time, whether due to natural processes or to the works of man, or changing conditions on adjacent properties.

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3 INTRODUCTION

One of the most important elements of long-term restoration and maintenance of both water quality and fish habitat is the reduction of future impacts from upland erosion and sediment delivery. Sediment delivery to stream channels from roads and road networks has been extensively documented, and is recognized as a significant impediment to the health of salmonid habitat (Harr and Nichols, 1993; Flosi et al., 1998). Unlike many watershed improvement and restoration activities, erosion prevention and "storm-proofing" of rural, ranch, and forest road systems has an immediate benefit to the streams and aquatic habitat of a watershed (Pacific Watershed Associates, 1994; Weaver and Hagans, 1999; Weaver et al., 2006). It helps ensure that the biological productivity of the watershed's streams is minimally impacted by future road related erosion, and that future storm runoff can cleanse the streams of accumulated coarse and fine sediment, rather than depositing additional sediment from managed areas.

The Salmon River watershed is the one of the most biologically intact subbasins of the Klamath River drainage basin. It provides habitat to salmonids and other at-risk species, and is recognized as one of the largest cold-water contributors to the Klamath River, where recent large-scale fish kills have been attributed to poorly oxygenated warm water. The Salmon River subbasin supports a coldwater resident and anadromous fishery which includes: spring and fall run Chinook salmon (*Oncorhynchus tshawytscha*), summer and winter run steelhead (*O. mykiss*), coho salmon (*O. kisutch*), sea run Pacific lamprey (*Lampreta tridentata*), and green sturgeon (*Acipenser medirostris*). Non-anadromous species include Klamath speckled dace (*Rhinichthys osculus Klamathensis*), Klamath small scale sucker (*Catostomus rimiculus*), and marbled sculpins (*Cottus klamathensis*). Threespine sticklebacks (*Gasterosteus aculeatus*) may be present, but their use of the habitat is unconfirmed. Resident trout are located throughout the subbasin. Introduced fish stocks include American shad, brown trout, and brook trout. Anadromous salmonid habitat is extensive in the subbasin, distributed among tributaries of the Main Stem, Wooley Creek, North Fork and South Fork Salmon River. The Klamath National Forest (KNF) identifies the Salmon River as the watershed with the best anadromous fisheries habitat in the Klamath National Forest (de la Fuente and Haessig, 1994). The basin provides habitat for the largest wild run of spring Chinook salmon in the entire Klamath River system. It is possibly the largest remaining wild spring Chinook run left in California (West, 1991). Problems facing coho salmon and other fish include invasive exotic species, barriers to fish passage, depleted large woody debris, high sediment loads from the extensive road system, large wildfires, limited riparian function due to mine tailings, unscreened water diversions, unstable spawning gravels, and nutrient and temperature impairment (NCRWQCB, 2005).

The Salmon River drains into the mainstem Klamath River south of Somes Bar, at the Humboldt-Siskiyou County line. Its 751 mi^2 watershed drains slopes located in Siskiyou County, California (Map 1) and is composed primarily of coniferous forests. The majority (~99%) of the watershed area is within the Klamath National Forest. The remaining 1% is privately owned, with 4 rural communities, totaling approximately 250 residents, dispersed within the watershed.

In 2008, SRRC contracted PWA to undertake the project layout and to supervise implementation of the prioritized treatment plan developed as part of the earlier road related sediment source assessment for the watershed (Pacific Watershed Associates, 2008). The implementation work, reported here, was completed between 2009 and 2010 on properties privately owned and managed, and funded through a BOR Klamath Watershed Restoration Program grant with matching funds from SRRC. The goals of the project were to implement well-established erosion control and prevention techniques in order to minimize the impact of road-related sediment to anadromous streams.

In this report we provide a summary of the road related sediment reduction treatments completed under the supervision of PWA between 2009 and 2010. The project primarily focused on upgrading main access roads in the Salmon River project area, but also included decommissioning two abandoned road segments (Map 3, Appendix A , B). All erosion control and erosion prevention treatments implemented for this project followed guidelines described in the *Handbook for Forest and Ranch Roads* (Weaver and Hagans, 1994), as well as CDFG's *Salmonid Stream Habitat Restoration Manual*, Parts IX and X (Taylor and Love, 2003; Weaver et al., 2006). Implementation results are provided in Maps 1-6, Tables 2-5, and Appendixes A-B.

4 FIELD AREA / PROJECT ROADS

4.1 Location and Travel Directions

The Salmon River watershed encompasses approximately 751 mi^2 in Siskiyou County, California. The Salmon River flows generally westward to its confluence with the Klamath River just south of the town of Somes Bar, California (Map 1). The Salmon River Private Roads project area covers a broad area, extending both up the North and South Forks, as well as along the mainstem. The project area includes reaches of 3 small tributaries of Salmon River (Butler Creek, Negro Creek, and Robinson Gulch) as well as portions of unnamed tributaries to the North Fork and South Fork Salmon River. These account for more than 6.5 mi of blueline streams in the project area (Maps 2 - 6, Appendix A).

The Salmon River Private Roads project area is accessed by taking National Forest Road 93 (Salmon River Road off US Highway 96 near Somes Bar) east approximately 17 mi to Forks of Salmon. The town of Forks of Salmon is centrally located within the project area.

4.2 Regional Climate, Terrain, and Geology

The climate of the central Klamath Mountain region in the Salmon River watershed is characterized by dry, warm summers and cool winters with periods of intense rainfall and snow accumulation during cold storms. Mean annual precipitation ranges from 35 to 85 in., with most of the rainfall occurring between November and April (NCRWQCB, 2005). Elevation ranges from approximately 450 ft to 8,920 ft in the Salmon River basin (USGS, 1979a, b).

The Salmon River watershed is located in steep, mountainous terrain, with hillslope gradients frequently exceeding 70% along inner gorges, headwalls, and upper ridge slopes. Vegetation types are highly variable throughout the watershed and include both conifer and hardwood forests, low level chaparral/brush lands, prairie/grassland, and barren, relatively vegetation free landscape in dominantly rocky areas (de la Fuente and Haessig, 1994).

The geology of the Salmon River watershed is composed of diverse rock groups including several distinct metamorphic belts, intrusive granitic batholiths, alluvial terrace deposits, colluvial deposits, and recent alluvial deposits (Wagner and Saucedo, 1987). The Salmon River watershed is part of the greater regional physiographic Klamath Mountain province. Poorly consolidated and sheared metamorhic rocks as well as deeply weathered granitic rocks that are particularly susceptible to erosion and mass wasting during periods of sustained or heavy rainfall are exposed throughout the watershed. Large- and small-scale mass wasting is evident and pervasive within the watershed, including a significant historical record of landslides that have had major impacts on the main stem Salmon River (de la Fuente and Haessig, 1994). Hillslope debris slides, earthflows, slumps, cutbank landslides, and road fill landslides have all occurred within the watershed.

All 4 species of anadromous salmonids as well as the Pacific lamprey and green sturgeon are all present in the Salmon River watershed. Of significance for salmonid habitat, the combination of high rainfall and erodible, potentially unstable geologic substrate results in high rates of erosion and sediment delivery from road networks to stream channels. The lower tributaries and main channels alternately traverse deep gorges with steep and unstable slopes, and low-gradient channel reaches where sediment deposition and accumulation is amplified, especially as a result of historical mining and road building practices. Whereas salmonid populations have evolved and flourished with the natural processes of rainfall and erosion in the area, the impact of anthropogenically induced habitat fragmentation and erosion (e.g., mining, timber production and road construction) has resulted in a degradation of salmonid habitat and accelerated sediment delivery to streams in this important watershed.

4.3 Roads by Project Area

PWA supervised erosion control and erosion prevention treatments (upgrading and/or decommissioning) for 5 separate project areas in the Salmon River Private Roads Sediment Reduction project area, (Map 1, Appendix A).

These project areas included are:

1. <u>Butler Flat</u>: Work on the Butler Flat area included 4 separate roads; a 0.68mi long loop in the north-central part of the property, a 0.16mi spur road in the eastern portion of the property, and two short driveways totaling 0.05mi (Map 2). All roads within the Butler property were upgraded.
2. <u>Bloomer Mine</u>: Work on the Bloomer Mine area included 4 separate roads; 1 main access road and 3 short spur roads (Map 3). Road #1 is the main access road through the property and is 0.36mi long from the intersection with Salmon River Road to its terminus adjacent to a small pond near the northwestern property boundary. Spur #1 Road is a 0.09mi long spur road adjacent to a small pond in the northwest portion of the property. Spur #2 Road is a 0.01mi long spur road in the northwest portion of the property. Spur #3 Road is a 0.27mi long spur road from the intersection with Road #1 to its terminus at a

small landing. Road #1 and Spur #3 were upgraded for this project while Spurs 1 and 2 were both decommissioned.

3. Godfrey/Harris Ranch: Work completed on the Godfrey/Harris Ranch area included upgrading 3 separate roads; 2 private access roads and one Forest Service access road (Map 4). 39N30.18 Road is a private 0.11mi long access road to a driveway. 39N30.17 Road is a very short 0.02mi long spur leading to a potential building site. 39N29 Road is a 0.58mi long Forest Service road that accesses private property upslope.
4. Finley Camp: Work on the Finley Camp roads involved upgrading two separate segments on adjacent properties. Finley Camp Road #1 is a 0.53mi long driveway and Finley Camp Road #2 is a 0.21mi long access road (Map 5).
5. Cecilville/Taylor: Work on the Cecilville/Taylor property involved upgrading a single 0.49mi long road that accesses private residences (Map 6).

5 FIELD METHODS AND IMPLEMENTATION TECHNIQUES

5.1 Overview of Road Upgrading and Road Decommissioning

Forest and rural roads may be storm-proofed by one of two methods: upgrading or decommissioning (Weaver and Hagans, 1994, 1999; Weaver et al., 2006). Upgraded roads are kept open, and are inspected and maintained. Their drainage facilities and fills are designed or treated to accommodate the 100-year peak storm flow. Conversely, properly decommissioned roads are closed and no longer require maintenance. Whether through road upgrading or road decommissioning, the goal of storm-proofing is to make the road as “hydrologically invisible” as possible, that is, to minimize the hydrologic effects of the road and to reduce or prevent future sediment delivery to the local stream system. A well-designed storm-proofed road includes specific characteristics (Table 1), all proven to contribute to long-term improvement and protection of watershed hydrology and aquatic habitat.

Road upgrading

Road upgrading involves a variety of treatments used to make a road more resilient to large storms and flood flows. The most important of these include upgrading stream crossings (especially culvert upsizing to accommodate the 100-year peak storm flow and debris in transport, and treatments to correct or prevent stream diversion); removing unstable sidecast and fill materials from steep slopes; and applying road drainage techniques (e.g., installing ditch relief culverts, removing berms, constructing rolling dips, insloping or outsloping the road) to improve dispersion of surface runoff. Road upgrading often also includes adding road rock or riprap as needed to fortify roads and crossings. The treatments are fully described by Weaver et al. (2006).

Installing rolling dips

Rolling dips are installed on low- to moderate-gradient, hydrologically connected roads to disperse surface runoff and discharge it onto the native hillslope below the road. Rolling dips may extend from the inboard edge to the outboard edge of a road prism, or just on the roadbed,

Table 1. Characteristics of storm-proofed roads (*from* Weaver et al., 2006).

Storm-proofed stream crossings
• All stream crossings have a drainage structure designed for the 100-year peak storm flow (with debris). • Stream crossings have no diversion potential (functional critical dips are in place). • Stream crossing inlets have low plug potential (trash barriers installed). • Stream crossing outlets are protected from erosion (extended beyond the base of fill; dissipated with rock armor). • Culvert inlet, outlet, and bottom are open and in sound condition. • Undersized culverts in deep fills (greater than backhoe reach) have emergency overflow culvert. • Bridges have stable, non-eroding abutments and do not significantly restrict 100-year flood flow. • Fills are stable (unstable fills are removed or stabilized). • Road surfaces and ditches are “hydrologically disconnected” from streams and stream crossing culverts. • Class I stream crossings meet CDFG and NMFS fish passage criteria (Taylor and Love, 2003).
Storm-proofed fills
• Unstable and potentially unstable road and landing fills are excavated or structurally stabilized. • Excavated spoil is placed in locations where it will not enter a stream. • Excavated spoil is placed where it will not cause a slope failure or landslide.
Road surface drainage
• Road surfaces and ditches are “hydrologically disconnected” from streams and stream crossing culverts. • Ditches are drained frequently by functional rolling dips or ditch relief culverts. • Outflow from ditch relief culverts does not discharge to streams. • Gullies (including those below ditch relief culverts) are dewatered to the extent possible. • Ditches do not discharge (through culverts or rolling dips) onto active or potential landslides. • Decommissioned roads have permanent drainage and do not rely on ditches. • Fine sediment contributions from roads, cutbanks, and ditches are minimized by utilizing seasonal closures and implementing a variety of surface drainage techniques including berm removal, road surface shaping (outsloping, insloping, or crowning), road surface decompaction, and installing rolling dips, ditch relief culverts, waterbars, and/or cross-road drains to disperse road surface runoff and reduce or eliminate sediment delivery to the stream.

and are constructed at intervals as needed to control erosion (typically 100, 150, or 200 ft). They are effective in reducing year-round (“chronic”) sediment delivery from road surfaces, and are designed to be easily drivable and not impede vehicular traffic.

Road shaping

Road shaping changes the existing geometry or orientation of the road surface, and is accomplished through insloping (sloping the road toward the cutbank), outsloping (sloping the road toward the outside edge), or crowning (creating a high point near the center axis of the road so that it slopes both inward and outward). Outsloped roads are typically constructed with a 2-4% slope, and depending on the cutbank moisture regime, can be constructed with or without an inboard ditch. Like rolling dips, road shaping is used to prevent uncontrolled delivery of road surface runoff by dispersing it into the inside ditch or onto the hillslope below the road. This is also effective in preventing the formation of gullies at the edge of the road, and localized slope instability below the road. Road shaping is almost always used in concert with rolling dips to disperse surface runoff.

Installing ditch relief culverts

A ditch relief culvert is a drainage structure (usually an 18 in. pipe) installed across a road prism to move water and sediment from the inboard ditch so that it can be dispersed on native hillslope downslope from the road. Ditch relief culverts are used to drain ditch flow on roads that are too steep for rolling dips or outsloping, as well as at sites with excessive flow from springs or seepage from cutbanks.

Excavating unstable fillslope

The fillslope, the sloping part of the road between its outboard edge and the natural ground surface below, may fail or show signs of potential failure. As a preventative measure, unstable fillslope sediment is excavated and relocated (endhauled or pushed) to a permanent, stable spoil disposal site.

Upgrading stream crossings

Techniques used to remediate road related erosion at a stream crossing are dependent on the size of the stream channel, and specific physical characteristics at the crossing site. Class I and large stream crossings may require a bridge, or, if their banks are small or low gradient, a ford crossing may be suitable, particularly if seasonal use is anticipated. A common approach to upgrading moderate-sized crossings of Class II and III streams is to construct a culverted fill crossing capable of withstanding the 100-year flood flow. Techniques for upgrading small and moderate-size stream crossings include:

<u>Installing or replacing culverts.</u> A culvert capable of withstanding the 100-year peak storm flow is installed or replaced in the fill crossing. Culverts on non fish-bearing streams are placed at the base of fill, in line and on grade with the natural stream channel upstream and downstream of the crossing site. Backfill material, free of woody debris, is compacted in 0.5-1.0 ft thick lifts until 1/3 of the diameter of the culvert has been covered. At sites where fillslopes are steeper than 2:1, or where eddying currents might erode fill on either side of the inlet, rock armor is applied as needed.

<u>Installing an armored fill.</u> Armored fills are installed on smaller stream crossings with relatively small fill volume, but where debris torrents are common, channel gradients are steep, or inspection and maintenance of a culverted crossing is impossible or unlikely to occur. Armored fill crossings are constructed with a broad rolling dip in the axis of the crossing to prevent diversion of the stream flow, and ultimately focus the flow over the part of the fill

that will be most densely armored. A keyway is excavated from the base of the outboard fillslope to the middle third of the roadbed and backfilled with interlocking rock armor of sufficient size to resist transport by stream flow.

Installing secondary structures. A variety of secondary structures may be used to increase the function of small stream crossings by allowing uninterrupted stream flow, decreasing plugging, and controlling erosion. Where a culvert has been improperly installed too high in the fill, a *downspout* may be added to its outlet to convey the flow close to the ground surface, rather than letting it cascade from the height of the culvert. *Rock armor* may be used to buttress steep fillslopes, as well as to prevent erosion of inboard or outboard fillslopes by eddying currents. A *trash rack* placed in the channel above a culvert inlet will trap debris and reduce plugging. To prevent stream diversion should the culvert become plugged or its capacity exceeded, a *critical dip* (essentially a rolling dip constructed on the down-road hingeline of the fill) may be installed to ensure that stream flow will be directed across the road and back into the natural channel. Finally, an *overflow culvert* may be a necessary addition at a culverted crossing where, a very large and deep stream crossing fill exists or because of site conditions, plugging or capacity exceedence of the primary culvert is anticipated.

Road decommissioning

In essence, decommissioning is "reverse road construction," although complete topographic obliteration of the roadbed is not usually required to achieve cost-effective erosion prevention. In most cases, serious erosion problems are confined to a few, isolated locations along a road (perhaps 10% to 20% of the full road network to be decommissioned) where stream crossings need to be excavated, unstable sidecast on the downslope side of a road or landing needs to be removed before failure, or the road crosses unstable terrain and the entire road prism must be removed. But typically, lengths of road beyond the extent of individual treatment sites usually require simpler, permanent improvements to surface drainage, such as surface decompaction, additional cross-road drains, and/or partial outsloping. As with road upgrading, the heavy equipment techniques used in road decommissioning have been extensively field tested and are widely accepted (Weaver and Sonnevil, 1984; Weaver et al., 1987, 2006; Harr and Nichols, 1993; Pacific Watershed Associates, 1994).

Road ripping or decompaction

Road ripping is a technique in which the surface of a road or landing is disaggregated or "decompacted" to a depth of at least 18 in. using mechanical rippers. This action reduces or eliminates surface runoff and usually enhances revegetation.

Installing cross-road drains

Cross-road drains (also called "deep waterbars") are large ditches or trenches excavated across a road or landing surface to provide drainage and prevent runoff from traveling along, or pooling on, the former road bed. They are typically installed at 50, 75, 100 or 200 ft intervals, or as necessary at springs and seeps. In some locations (e.g., streamside zones), partial outsloping may be used instead of cross-road drain construction.

In-place stream crossing excavation (IPRX)

IPRX is a decommissioning treatment used for roads or landings that are built across stream channels. The fill (including the culvert or Humboldt log crossing) is completely excavated and the original streambed and side slopes are exhumed. Excavated spoil is stored at nearby, stable locations where it will not erode. In some cases, this may necessarily be as far as several hundred feet, or more, from the crossing. An IPRX typically involves more than simply removing a culvert, as the underlying and adjacent fill material must also be removed and stabilized. As a final measure, the sides of the channel may be cut back to slopes of 2:1, and mulched and seeded for erosion control.

Exported stream crossing excavation (ERX)

ERX is a decommissioning treatment in which stream crossing fill material is excavated and the spoil is hauled off-site for storage (the act of moving spoil material off-site is called “endhauling”). This procedure is necessary when large, stable storage areas are not available at or near the excavation site. It is most efficient to use dump trucks to endhaul the spoil material.

In-place outsloping (IPOS)

IPOS (also called "pulling the sidecast") calls for excavation of unstable or potentially unstable sidecast material along the outside edge of a road prism or landing, and placement of the spoil on the roadbed against the corresponding, adjacent cutbank or within several hundred feet of the site. As a further decommissioning measure, the spoil material is placed against the cutbank to block vehicular access to the road.

Export outsloping (EOS)

EOS is a technique comparable to IPOS, except that spoil material is moved off-site to a permanent, stable storage location. EOS is required when it is not possible to place spoil material against the cutbank, e.g., where the road prism is narrow or where there are springs along the cutbank. EOS usually requires dump trucks to endhaul the spoil material. This technique is used for both decommissioning and upgrading roads, but as the roadbed is partially or completely removed, EOS is more commonly used for decommissioning.

5.2 Project Organization, Supervision, and Monitoring

PWA provided technical oversight during on-the-ground implementation (road decommissioning and road upgrading) for this project during the summer and fall months of 2009 through 2010. The treatment plan employed for the project was based on the detailed field inventory conducted during the original project assessment, which included observations of initial site conditions, estimated risks of future erosion, and a proposed course of action for implementing treatments at each site (Pacific Watershed Associates, 2007).

Pre-implementation layout included compiling road logs for project sites; reevaluating and flagging all work sites in the field; conducting pre-construction landowner meetings; and finalizing lists of needed materials, including culverts, rip-rap and road rock, seed, and mulch. During the course of the project, PWA supervised the progress of heavy equipment operations, and conferred with operators in the field as needed to review treatment specifications. To monitor remediation efforts while in progress, and evaluate the overall effectiveness and success of the treatment plan, PWA photographed work sites from designated vantage points before, during, and after heavy equipment operations and treatment implementation. A sample of pertinent photosets for site and road drainage treatments for this project are provided in Appendix B.

5.3 Heavy Equipment Operations

SRRC contracted Mace Welding and Heavy Equipment of Orleans, California, to provide the heavy equipment, operators, and laborers to carry out the work plan. The heavy equipment included a Hitachi 120 excavator; John Deere 650 (Cat D5 equivalent) crawler bulldozer; 10 yd^3 dump truck; 2,500 gallon water truck; Benford 4 ft vibratory roller; service truck, and a lowbed to haul equipment. All work was undertaken during summer low-flow periods when any potential impacts to water quality could be minimized.

Uses for the excavator were numerous, and included: (1) opening access to each site on abandoned roads (brushing and moving large obstructions); (2) excavating soil and organic debris (including logs and brush) from stream crossings; (3) placing small volumes of excavated spoil on stable slopes near decommissioned stream crossings; (4) insloping and outsloping road beds between sites; (5) “mulching” decommissioned roads with logs, limbs, and brush; (6) constructing cross-road drains on decommissioned roads; (7) excavating material from the outboard edge of the road prism at locations where rolling dips were constructed, to prevent material from becoming sidecast; (8) excavating and replacing fill at stream crossings with upgraded culverts; (9) installing settling basins to allow fine sediment to settle out before entering the stream; (10) generating rip-rap and road rock from quarries; and (11) placement of rip-rap as rock slope protection at stream crossings (Maps 2 - 6, Appendix A).

Uses for the bulldozer included: (1) creating access for the dump truck by reconstructing roads and stream crossings, (2) pushing excavated material to nearby disposal sites, (3) grooming off-site spoil disposal sites where excavated material was dumped, (4) ripping (decompacting) old road surfaces, and (5) installing road drainage structures such as rolling dips and critical dips (Maps 2 - 6, Appendix A).

A dump truck was used to haul road rock, riprap, and culverts to upgrade sites specified in the erosion control plan, and endhaul excess spoil material to stable spoil sites.

Finally, a water truck and the vibratory roller were used to obtain proper compaction at stream crossing fills, rolling dips and when applying the finish grade of rock surfacing to the road bed.

6 RESULTS

6.1 Summary of Completed Erosion Control and Erosion Prevention Treatments

Between July 2009 and September 2010, PWA supervised the treatment at a total of 15 sites in the project area, including 13 stream crossings, 1 discharge point from concentrated road runoff and 1 ditch relief culvert site (Maps 2 - 6; Table 2; Appendixes A-B). Successful erosion control and erosion prevention treatments for some sites also required treating adjacent segments of hydrologically connected road that were eroding and conveying concentrated flow to the sites and into the stream system. Hydrologically connected road reaches treated in the project area totaled approximately 1.60 mi: 1.45 mi leading to stream crossings, a total of 0.08 mi adjacent to the concentrated road runoff discharge point, and a total of 0.07 mi associated with the ditch relief culvert site (Table 2).

Table 2. Number of sites and hydrologically connected lengths of road treated to reduce sediment delivery, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Site type	Sites treated (#)	Hydrologically connected[a] road segments treated (mi)
Stream crossing	13	1.45
Discharge point	1	0.08
Ditch relief culvert	1	0.07
Total	**15**	**1.60**

[a]*Hydrologically connected road segments* refer to lengths of road adjacent to the treatment sites that are conveying sediment to the sites and into the stream system at delivery points.

Table 3 shows the *sediment savings* achieved for this project, which is the estimated volume of sediment that will be prevented from eroding into the stream system over time as a result of implementing the site and road drainage treatments. PWA estimates that implementing the site-specific treatments will prevent the future, episodic delivery of approximately 1,090 yd^3 of sediment to the stream system in the coming decades. The majority (99%) of site-specific sediment savings (1,088 yd^3) is the result of erosion control and erosion prevention treatments at stream crossings. In addition, we estimate that treating the road drainage discharge point and ditch relief culvert in the project area will prevent delivery of about 6 yd^3 of sediment associated with additional gully enlargement and hillslope erosion from beyond the culvert outlet. The sediment savings achieved from implementing road drainage treatments on hydrologically connected road reaches, which will reduce chronic erosion and runoff from road surfaces, ditches, and cutbanks in the Salmon River project area, is calculated for a 10 yr period and is projected to be approximately 1,560 yd^3 for the next decade alone.

Table 3. Estimated sediment savings for treated sites and hydrologically connected road reaches, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Sediment sources	Estimated sediment savings (yd^3)	Percent of total
1. Episodic sediment delivery from road related erosion sites (indeterminate time period)		
Stream crossings	1,088	99%
Road drainage discharge point	1	<1%
Ditch relief culvert	5	<1%
Total episodic sediment delivery	**1,094**	**100%**
2. Chronic sediment delivery from road surface erosion (estimated for a 10 yr period)[a]		
Total chronic sediment delivery	**1,567**	

[a]Decadal sediment delivery for unsurfaced roads, assuming a 25 ft wide road surface and cutbank contributing area and 0.2 ft lowering of road and retreat of cutbank surfaces per decade.

6.2 Implementation Results by Treatment Area

PWA supervised treatment of roads within 5 separate treatment areas along a total of 3.09mi of road (Map 2, Appendix B). Roads within four of the treatment areas were upgraded and 1 area included both upgraded roads and decommissioned roads. None of the sites or road reaches in the project area were unusually complex or problematic to treat.

Table 4 provides a summary of as-built results for each road (treated road length, treatment sites, sediment savings), and treatment details for each road are provided in Appendix A (as-built road logs). A summary of the types of erosion control and erosion prevention treatments employed in the project area is provided in Table 5. Pre- and post-implementation photos of select project sites are provided in Appendix B.

Table 4. Treated sediment delivery sites and estimated sediment savings by treatment area, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Project Area	**Treated road lengths (mi)[a]**			**Treated sediment delivery sites[b]**					**Estimated sediment savings (yd^3)**	
	Upgrade	**Decom**	**Total**	**Upgraded sites**		**Decommissioned sites**		**Total sites**	**Site-specific (episodic)[c]**	**Road surface (chronic)[d]**
Butler Flat	0.89	-	0.89	3	SC: #101, 102, 104	-	-	3	105	143
Bloomer Mine	0.67	0.06	0.73	1	SC: #1.1	2	SC: #3 RS: #2	3	116	140
Finley Camp	0.27	-	0.27	1	SC: #36	-	-	1	287	144
Godfrey & Harris Ranches	0.71	-	0.71	6	SC: #18, 28, 30, 31, 32 DRC: #19	-	-	6	560	819
Cecilville/Taylor	0.49	-	0.49	2	SC: #41, 42	-	-	2	26	321
Totals			**3.09**	**13**	**-**	**2**	**-**	**15**	**1,094**	**1,567**

[a]Includes road reaches treated to improve drainage plus hydrologically connected sections treated to reduce sediment delivery.
[b]SC: stream crossing;; DRC: ditch relief culvert; RS: concentrated road runoff.
[c]Episodic sediment savings for road related sites (indeterminate time period).
[d]Chronic sediment savings from adjacent hydrologically connected roads and cutbanks (estimated for a 10 yr period).

Table 5. As-built (completed) treatments, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Treatment type		As-built treatments	As-built sites (site #)
Site-specific treatments	Install Culvert	2	#30, 32
	Replace Culvert	6	#18, 28, 41, 42, 102, 104
	Install Bridge	1	#36
	Wet Crossing (install an armored fill or armored ford)	3	#1.1, 31, 101
	Critical Dip	2	#32, 104
	Excavate soil	11 sites 1,114 yd^3	#1.1, 2, 3, 18, 28, 30, 32, 36, 41, 101
	Rock armor/riprap	9 sites 145 yd^3	#1.1, 18, 19, 28, 30, 31, 36, 42, 101
Road surface treatments	Rolling dip (install)	50	-
	Install/replace DRC	2	-
	Clean/cut inboard ditch	1,265 ft	-
	Cross-road drain	5	-
	Outslope road and retain ditch	965 ft	-
	Outslope road and remove ditch	170 ft	-
	Inslope road	180 ft	-
	Rock road surface	740 yd^3	-

7 CONCLUSIONS

Implementation is complete for the Salmon River Private Roads Sediment Reduction Project, which included the upgrading and decommissioning of approximately 3.1 mi of roads within 5 privately held treatments areas in the Salmon River watershed. Under PWA's supervision, heavy equipment crews successfully treated 15 individual road related sediment delivery sites (stream crossing, ditch relief culvert, and road surface sites), and 1.60 mi of hydrologically connected roads, for erosion control and erosion prevention. The expected benefit of completing this work lies in the long-term reduction of sediment delivery to the Salmon River and downstream to the Klamath River, which provide important habitat for salmonid production in Northern California.

PWA estimates that treating the 15 sites against primarily storm-driven erosion and sediment delivery will prevent the delivery of approximately 1,090 yd^3 of coarse and fine sediment to Salmon River and its tributaries in the coming decades. In addition, improving road drainage along the 1.60 mi of hydrologically connected roads will reduce the delivery of fine-grained, roadbed-derived sediment by approximately 1,560 yd^3 per decade, as well as improve drivability along these road reaches. This implemented project, when employed in combination with protective land-use practices, can be expected to contribute to the long term improvement and protection of water quality and salmonid habitat in the watershed.

This project is dedicated to Jim Villeponteaux, who tirelessly promoted watershed restoration and habitat improvement in the Salmon River watershed. Unfortunately, do to circumstances beyond his control, he was unable to see this project and many others he spearheaded to final completion.

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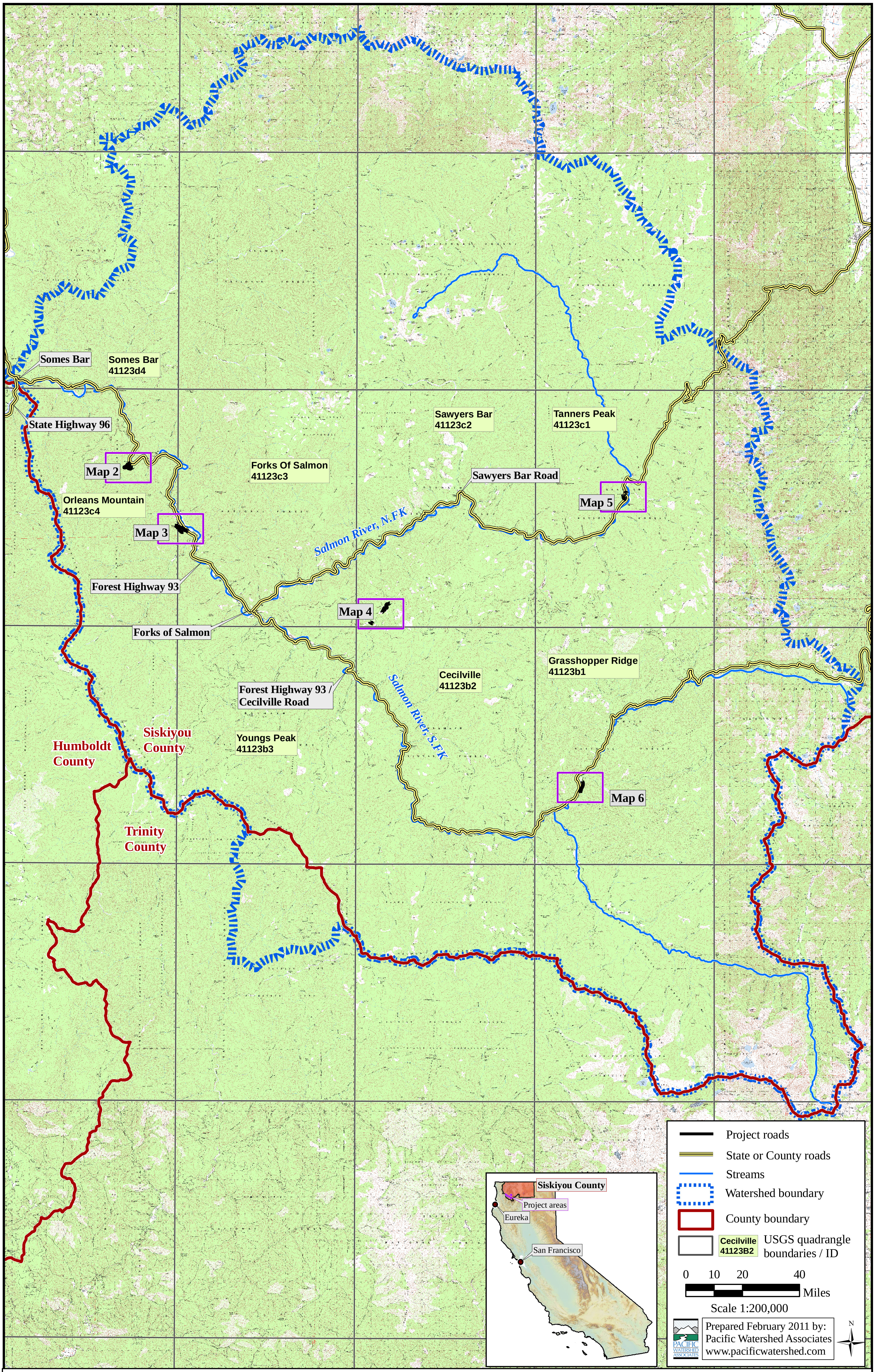
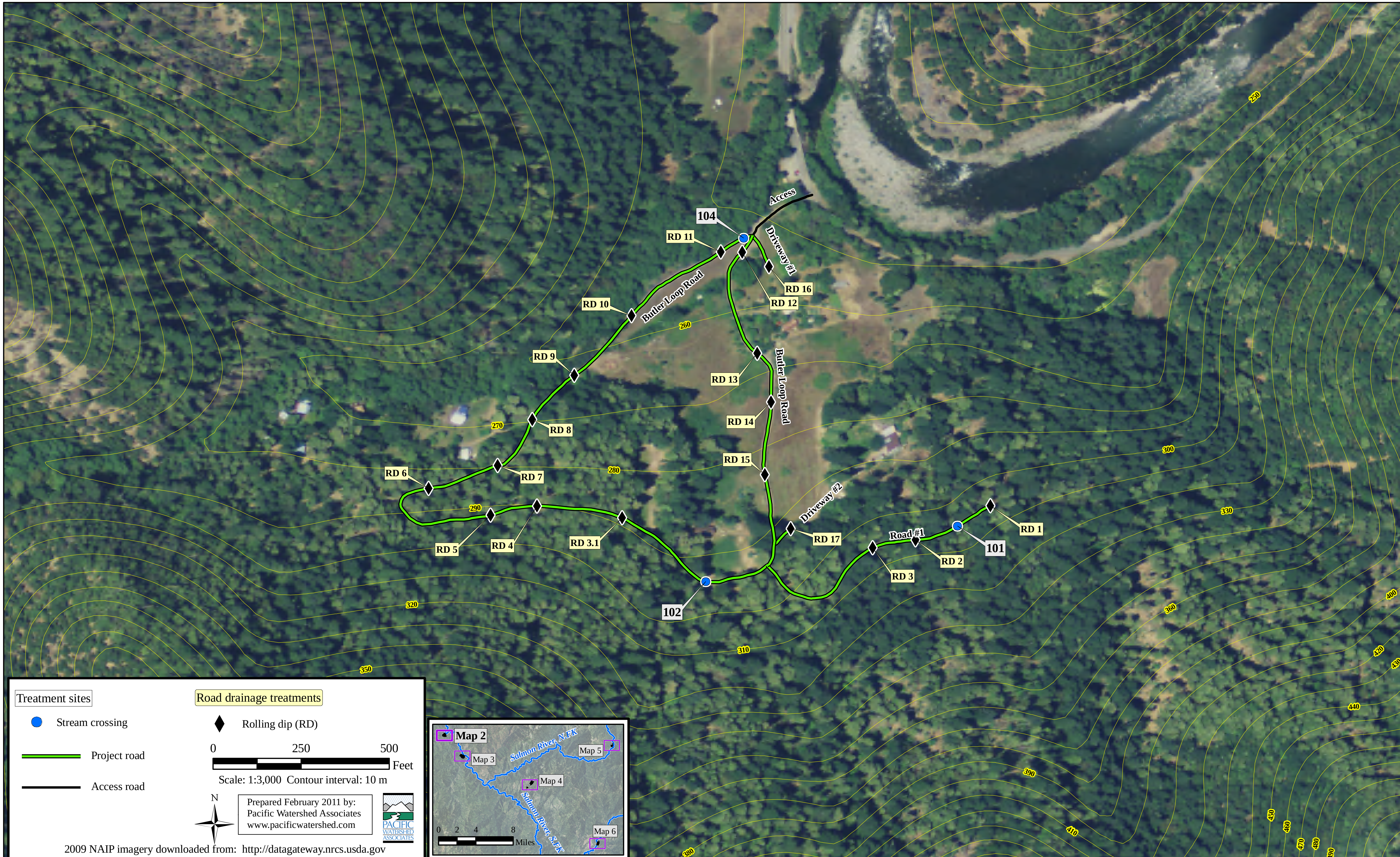
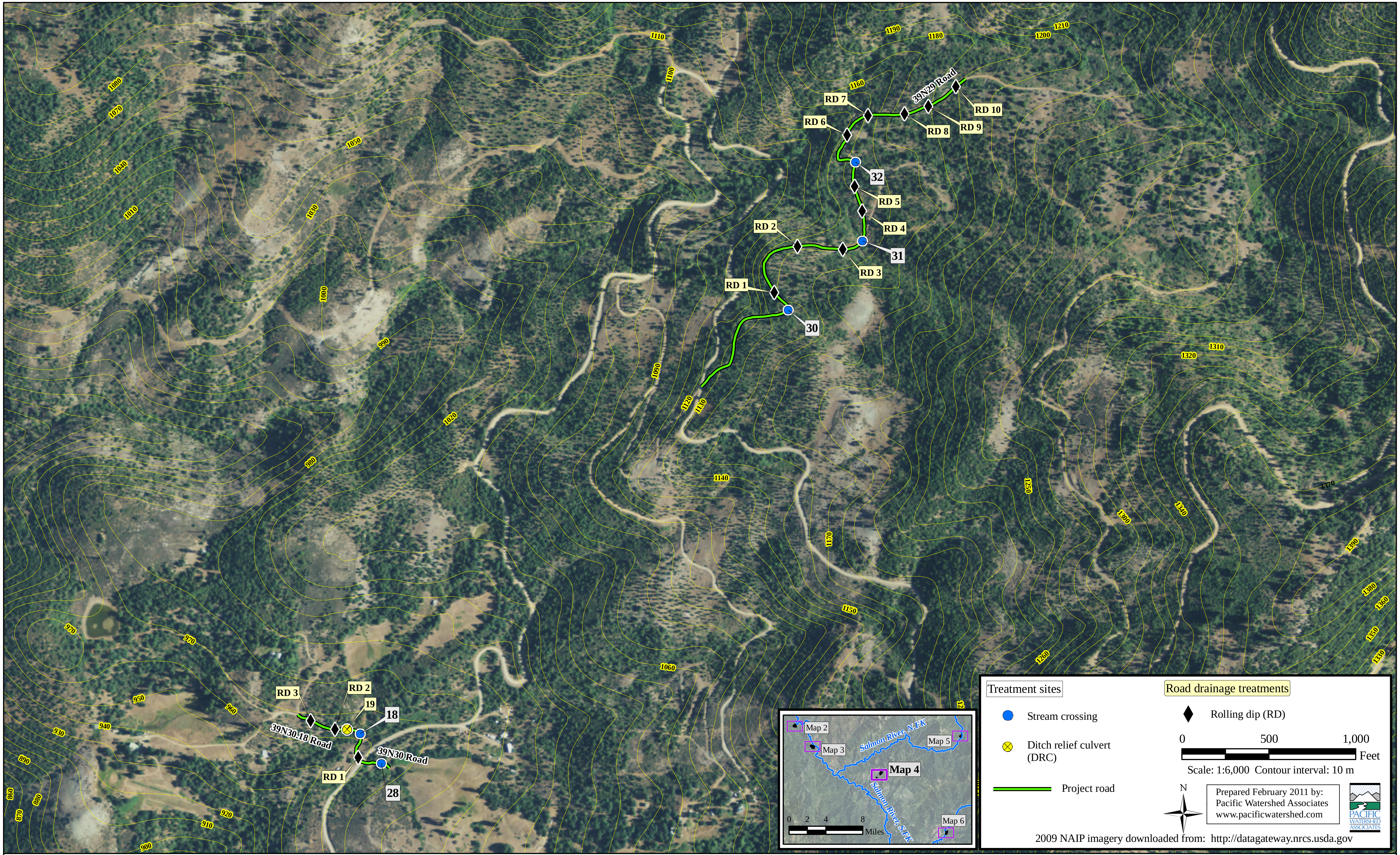


Map 1. Project Location Map, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.



Map 2. Butler Flat Treatment Area Map, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Map 3. Bloomer Mine Treatment Area Map, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.



Map 4. Godfrey/Harris Ranch Treatment Area Map, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Map 5. Finley Camp Treatment Area Map, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Map 6. Cecilville/Taylor Treatment Area Map, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, California.

Appendix A

Road logs of as-built treatments

Salmon River Private Roads Sediment Reduction Project,
Klamath Watershed Restoration Program,
Siskiyou County, California

Table #	Road name	Table #	Road name
A1	39N29 Road	A8	Loop Road
A2	39N30.17 Road	A9	Road #1
A3	39N30.18 Road	A10	Butler Driveway #1
A4	Bloomer Mine Road #1	A11	Butler Driveway #2
A5	Spur #1 Road	A12	Cecilville/Taylor Road #1
A6	Spur #2 Road	A13	Finley Camp Road #1
A7	Spur #3 Road	A14	Finley Camp Road #2

A1: Road Log of As-Built Treatments for 39N29 Road, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Intersection with 39N30 (Godfrey Road).		
0.140	30		A small fill stream crossing. Heavy equipment crews excavated from TOP to BOT and installed a 24” x 80’ culvert at natural channel grade and in line with CLP. Equipment crews also installed 5yds^3 of 0.5-1.5’ diameter rock armor for headcut control at TOP. Spoils were stored locally.	24” x 80’ 3 couplers	5yds^3 of 0.5-1.5’ diameter rock armor, 10yds^3 of 2”- road rock
0.179		RD #1	Heavy equipment crews installed a rolling dip.		
0.225		RD #2	Heavy equipment crews installed a rolling dip.		
0.283			Rusted gate.		
0.303		RD #3	Heavy equipment crews installed a rolling dip.		
0.316	31		A small fill stream crossing. Heavy equipment crews installed an armored fill crossing by creating a broad dip through crossing, a minimum of 2’ deep at the outboard edge of the road. Equipment crews excavated a keyway approximately 20’w x 2’d x 13’l = 19 yds^3. Spoils were stored locally. Crews also installed 20 yds^3 of 0.5-1.5’ diameter rock armor to keyway and re-rocked the road through crossing.		20 yds^3 of 0.5-1.5’ diameter rock armor, 10 yds^3 of 2”-road rock
0.348		RD #4	Heavy equipment crews installed a rolling dip.		
0.372		RD #5	Heavy equipment crews installed a rolling dip.		

A1: Road Log of As-Built Treatments for 39N29 Road, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.406	32	CD #1	A small culverted stream crossing. Heavy equipment crews excavated from TOP to BOT and installed a 24” x 60’ culvert at natural channel grade and in line with CLP. Equipment crews also installed a critical dip on left hingeline of crossing. Spoils were stored locally.	24” x 60’ 2 couplers	10 yds^3 of 2”-road rock
0.435		RD # 6	Heavy equipment crews installed a rolling dip.		
0.464		RD # 7	Heavy equipment crews installed a rolling dip.		
0.491		RD # 8	Heavy equipment crews installed a rolling dip.		
0.530		RD # 9	Heavy equipment crews installed a rolling dip.		
0.578		RD # 10	Heavy equipment crews installed a rolling dip. End of road log and treatments.		

A2: Road Log of As-Built Treatments for 39N30.17 Road, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Intersection with 39N30 Road.		
0.019	28		A small, class II stream crossing with a rusted out 18" culvert. Heavy equipment crews excavated TOP to BOT to remove old culvert and installed a 24" x 20' culvert at natural channel grade and in line with CLP. Equipment crews also installed a critical dip to the right. Spoils were stored locally. End of road log and treatments.	18" x 20'	5 yds^3 of 0.5-1.5' diameter rock armor

A3: Road Log of As-Built Treatments for 39N30.18 Road, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Intersection with USFS Road 39N30 (Godfrey Road).		
0.010		RD #1	Heavy equipment crews installed a rocked rolling dip and a cross road drain on bench below main road so that flow did not divert back onto road.		10 yds^3 of 2”-road rock
0.035	18		A moderate sized class II stream with an undersized and rusted out culvert. Heavy equipment crews excavated from TOP (~30’ above IBR) to BOT (~50’ below OBF) and installed a 72” x 60’culvert at natural channel grade and in line with CLP. Crews also installed 5 yds^3 of 0.5-1.5’ diameter rock armor to inboard fillslope and 15 yds^3 of 0.5-1.5’ diameter rock armor to outboard fillslope.	72” x 60’ 2 couplers	20 yds^3 of 0.5-1.5’ diameter rock armor, 20 yds^3 of 2”-road rock
0.042		CD #1	Heavy equipment crews installed a critical dip on the right hinge line of site #18.		
0.051	19		A plugged and undersized DRC. Heavy equipment crews replaced an existing DRC with an 18” x 30’ long DRC. Crews cleaned the inboard ditch for 60’ up the left road to the right hinge of site #18 to drain spring flow. They also cleaned the inboard ditch for 75’ up the right road to capture and convey ditch flow to the inlet. Finally, they installed 5 yds^3 of 0.5-1.5’ diameter rock armor to below the outlet as energy dissipation.	18” x 30’ 1 coupler	5 yds^3 of 0.5-1.5’ diameter rock armor, 5 yds^3 of 2”-road rock
0.067		RD #2	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 of 2”-road rock
0.074		Begin OSR-PB & FD	Begin - Heavy equipment crews outloped the road by removing berm along outboard edge of road and filling inboard ditch. Shape road with a 2-3% outslope.		25 yds^3 of 2”-road rock

A3: Road Log of As-Built Treatments for 39N30.18 Road, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.

Miles From Start	PWA Site#	Road Tmt[1]	Comments/Treatment	Culvert Materials Used	Rock Used
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.096		RD #3	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 of 2”-road rock
0.106		End OSR-PB & FD	End - Heavy equipment crews outloped the road by removing berm along outboard edge of road and filling inboard ditch. Shape road with a 2-3% outslope.		
0.109			Drainage divide at intersection with driveway uphill to right. End of road log and treatments.		

A4: Road Log of As-Built Treatments for Bloomer Mine Road #1, Bloomer Mine Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.

Miles From Start	PWA Site#	Road Tmt[1]	Comments/Treatment	Culvert Materials Used	Rock Used
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
			Intersection at Bloomer driveway and Salmon River Road.		
0.000		RD #14	Heavy equipment crews installed a rocked rolling dip to drain road to left.		10 yds^3 of 2”-road rock
0.034		RD #13	Heavy equipment crews installed a rocked rolling dip to drain road to right.		10 yds^3 of 2”-road rock
0.165			Drainage divide.		
0.171			Natural low in road.		
0.187			Intersection with Spur #4 uphill to right.		
0.193			Intersection with driveway to house uphill to left at drainage divide.		
0.226		RD #10	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 of 2”-road rock
0.250		Begin ISR #1, Begin Cut IBD #1	Heavy equipment crews began insloping road to provide better drainage and began cutting the inboard ditch. Equipment crews rocked the inboard ditch with 10 yds^3 6” road rock. The crew also cleaned the sloughing cutbank material and installed 5 yds^3 0.5-1.5’ diameter rip-rap as buttress rock.		5 yds^3 of 0.5-1.5’ diameter rock armor, 10 yds^3 of 6” road rock
0.278		End Cut IBD #1	Heavy equipment crews ended cutting inboard ditch. The crew also installed a cross-road drain (#3) just below to connect flow to settling basin #1.		
0.284		End ISR #1	Heavy equipment crews ended insloping the road to provide better drainage.		
0.299		Begin OSR #1, Begin Cut IBD #2	Heavy equipment crews began outsloping the road and cutting the inboard ditch. The equipment crew also rocked the inboard ditch with 10 yds^3 6” road rock.		10 yds^3 6” road rock

A4: Road Log of As-Built Treatments for Bloomer Mine Road #1, Bloomer Mine Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.326		End OSR #1, End Cut IBD #2	Heavy equipment crews ended outsloping the road and cutting the inboard ditch to existing settling basin.		
0.335		RD #2	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 of 2"-road rock
0.364			End of road log and treatments at end of road adjacent to pond.		

A5: Road Log of As-Built Treatments for Spur 1 Road, Bloomer Mine Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to DECOMMISSION road:** Rip road bed and install cross road drains at least every 75' to drain road; XRD# = Install a cross-road drain; BB# = Breach berm on outside edge of road; SB# = Install a settling basin.					
0.000	3		A small, failing class II stream. Heavy equipment crews excavated from TOP to BOT. Equipment crews excavated back the sideslopes to 2H:1V for decommission where possible with a 6' wide channel bottom. The left bank was steeper than 2H:1V due to natural bedrock. Spoils were stored locally to right and left.		
0.047		RD #1	Heavy equipment crews installed a rolling dip.		
0.095			End of road log and treatments at Intersection with Bloomer Road #1.		

A6: Road Log of As-Built Treatments for Spur 2 Road, Bloomer Mine property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to DECOMMISSION road:** Rip road bed and install cross road drains at least every 75' to drain road; XRD# = Install a cross-road drain; BB# = Breach berm on outside edge of road; SB# = Install a settling basin.					
0.000			Begin road log at intersection with Bloomer Main Road.		
0.006	2	XRD #1	Road drainage concentrates to this point. Heavy equipment crews installed a large cross-road drain to convey flow across road.		
0.011		XRD #2	Heavy equipment crews installed a large cross-road drain, excavating approximately 10’ down fillslope, to convey flow from swale above across road. Spoils were stored locally.		
		*BB #1	Equipment crews breached a small berm above road to connect drainage with cross-road drain #1 below.		
		*SB #1	Equipment crews installed a 5’w x 5’l x 2’d settling basin to capture road runoff sediment from the inboard ditch in order to settle out material prior delivering to a stream below.		
			* Berm Breach #1 and Settling Basin #1 are above site #2. End of road log and treatments.		

A7: Road Log of As-Built Treatments for Spur 3 Road, Bloomer Mine property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Begin road log at intersection with Road #1.		
0.048		RD #7	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”- road rock
0.082		RD #6	Heavy equipment crews installed a rolling dip in axis of swale and installed 10 yds^3 4”- road rock to dip.		10 yds^3 4”- road rock
0.098		RD #5	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”- road rock
0.125			Drainage divide.		
0.134	1.1		A small fill crossing. Heavy equipment crews created a broad dip through road prism. Equipment crews excavated a keyway approximately 10’w x 2’d x 15’l = ~10 yds^3 and installed 15 yds^3 0.5-1.5’ diameter rock armor to keyway. Spoils were stored locally.		15 yds^3 0.5-1.5’ diameter rock armor, 10 yds^3 2”- road rock
0.148		RD #4	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”- road rock
0.170			Drainage divide.		
0.184		RD #3	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”- road rock
0.198			Natural low in road.		
0.213			Drainage divide.		
0.236			Natural low in road.		
0.265			End of road log and treatments at small landing.		

A8: Road Log of As-Built Treatments for Loop Road, Butler Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.

Miles From Start	PWA Site#	Road Tmt[1]	Comments/Treatment	Culvert Materials Used	Rock Used
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Begin road log at end of road adjacent to pond.		
0.015		RD #12, Begin Cut IBD #1	Heavy equipment crews installed a rocked rolling dip and began cutting/cleaning the inboard ditch.		10 yds^3 2”-road rock
0.076		RD #13	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.140		RD #14	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.142		RD #15	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.157		End Cut IBD #1	Equipment crews ended cutting/cleaning the inboard ditch.		
0.180			Intersection with Beaver driveway to left and ‘Mountain” driveway to right.		
0.218			Intersection with Spur #1 at drainage divide.		
0.246	102		A small culverted stream crossing. Heavy equipment crews excavated from TOP to BOT and installed a 24” x 30’ culvert. Equipment crews established the right ditch by laying back the cutslope and expanding the inboard ditch width. Rock armor was applied to the ditch in the process. Equipment crews also maintained the critical dip post installation. Spoils were stored locally.	24” x 30’ 1 coupler	5 yds^3 0.5’ diameter rock, 10 yds^3 of 2”-road rock
0.259			Drainage divide.		
0.276			Natural low in road.		
0.303		RD #3.1	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.334			Drainage divide.		
0.351		RD #4	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock

A8: Road Log of As-Built Treatments for Loop Road, Butler Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.

Miles From Start	PWA Site#	Road Tmt[1]	Comments/Treatment	Culvert Materials Used	Rock Used
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.376		RD #5	Heavy equipment crews installed a rolling dip.		10 yds^3 2”-road rock
0.395			Natural low in road.		
0.417			Drainage divide.		
0.424			Intersection with driveway to left at drainage divide.		
0.448		RD #6	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.488		RD #7	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.518		RD #8	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.553		RD #9	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.598		RD #10	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.655		RD #11	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.668	104	CD #1	A crushed and undersized culvert from stream site #102 above. Heavy equipment crews excavated the old culvert and installed an 18” x 30’ culvert at natural channel grade. Spoils were stored locally.	18” x 30’ 1 coupler	10 yds^3 2”-road rock
0.675			End of road log and treatments at end of loop.		

A9: Road Log of As-Built Treatments for Road #1, Butler Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000		RD #1	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.021	101		A small stream with a plugged CMP. Heavy equipment crews installed an armored fill crossing by creating a broad dip through the road prism and excavated a keyway approximately 10’w x 2’d x 10’l = 7 yds^3. Equipment crews then installed approximately 10 yds^3 of 0.5-1.5’ diameter rip-rap to keyway. Spoils were stored locally.		10 yds^3 of 0.5-1.5’ diameter rip-rap, 10 yds^3 2”-road rock
0.047		RD #2	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.071		RD #3	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.104			Natural low spot in road.		
0.131			Drainage divide.		
0.161			End of road log and treatments at intersection with Butler Loop Road.		

A10: Road Log of As-Built Treatments for Butler Driveway #1, Butler Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Intersection with Road #1 uphill to right.		
0.019		RD #16	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.038			End of road log and treatments at drainage divide.		

A11: Road Log of As-Built Treatments for Butler Driveway #2, Butler Property, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.

Miles From Start	PWA Site#	Road Tmt[1]	Comments/Treatment	Culvert Materials Used	Rock Used
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Intersection with Road #1 uphill to right.		
0.011		RD #17	Heavy equipment crews installed a rolling dip to drain concentrated flow into grassy area to left. End of road log and treatments.		

A12: Road Log of As-Built Treatments for Cecilville/Taylor #1 Road, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Intersection with county road.		
0.111		RD #1	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.121		DRC #1	Existing DRC. Heavy equipment crews replaced current DRC with new 18” x 30’ DRC.	18” x 30’ 1 coupler	10 yds^3 2”-road rock
0.135		Begin OSR #1	Begin - Heavy equipment crews outloped the road by removing berm along outboard edge of road and filling inboard ditch. Shape road with a 2-3% outslope.		60 yds^3 2”-road rock
0.164		RD #2	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.196		RD #3	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.223		RD #4	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.255		End OSR #1	End - Heavy equipment crews outloped the road by removing berm along outboard edge of road and filling inboard ditch. Shape road with a 2-3% outslope.		
0.260	41		A small stream crossing. Heavy equipment crews excavated from TOP to BOT and installed a 24” x 30’ culvert at natural channel grade and in line with CLP. The crew also installed 20 yds^3 road rock to the driving surface through crossing. Spoils were stored locally.	24” x 30’ 1 coupler	20 yds^3 2”-road rock
0.278		RD #5	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.434		RD #6	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock

A12: Road Log of As-Built Treatments for Cecilville/Taylor #1 Road, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.

Miles From Start	PWA Site#	Road Tmt[1]	Comments/Treatment	Culvert Materials Used	Rock Used
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.451	42		A moderate sized stream crossing. Heavy equipment crews excavated from TOP to BOT and installed a 36" x 40' culvert set at natural channel grade and in line with CLP. Equipment crews also installed 10 yds^3 of 0.5-1.5' diameter rock armor to outboard fillslope utilizing some local rock. Spoils were stored locally.	36" x 40' 1 coupler	10 yds^3 of 0.5-1.5' diameter rock armor, 10 yds^3 2"-road rock
			End of road log and treatments.		

A13: Road Log of As-Built Treatments for Finley Camp Road #1, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.					
Miles From Start	**PWA Site#**	**Road Tmt[1]**	**Comments/Treatment**	**Culvert Materials Used**	**Rock Used**
[1]**General treatments for UPGRADE road:** Remove berm and outslope road where possible along channel; DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; Cut IBD# = Cut new, or clean existing inboard ditch; SB # = Install a settling basin					
0.000			Intersection with county road.		
0.011		Begin Cut IBD #1	Begin - Heavy equipment crews began cutting a new inboard ditch on left edge of existing road prism and widened the road. Work crews widened the road approximately 3’ on right to accommodate for road width lost for inboard ditch construction. Equipment crews also installed approximately 20 yds^3 of 0.25-0.75' diameter rock armor to the inboard ditch and 30 yds^3 of 4”- road rock to the driving surface.		20 yds^3 of 0.25-0.75’ diameter rock, 30 yds^3 of 4”- road rock
0.053		End Cut IBD #1	End - Heavy equipment crews began cutting a new inboard ditch on left edge of existing road prism and widened the road. Work crews widened the road approximately 3’ on right to accommodate for road width lost for inboard ditch construction. Equipment crews also installed approximately 20 yds^3 of 0.25-0.75' diameter rock armor to the inboard ditch and 30 yds^3 of 4”- road rock to the driving surface.		
0.057			End of road log and treatments.		

A14: Road Log of As-Built Treatments for Finley Camp Road #2, Salmon River Private Roads Sediment Reduction Project, Siskiyou County, CA.

Miles From Start s	PWA Site#	Road Tmt[1]	Comments/Treatment	Culvert Materials Used	Rock Used
[1]**General treatments applied to UPGRADE road:** DRC# = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD# = Outslope road by pulling berm and filling ditch; BB# = Breach berm at specified interval; CD# = Install a critical dip to prevent stream diversion; RD# = Install rolling dip; SB# = Install settling basin; Cut IBD# = Clear/cut inboard ditch to effectively convey flow to the designated drainage structure. CLP = centerline profile, TOP = top of excavation, BOT = bottom of excavation.					
0.000			Intersection with county road.		
0.096			Intersection with spur uphill to left.		
0.110			Cable gate.		
0.112		RD #1	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.119	36		A large stream crossing with undersized, crushed and rusted culvert. Heavy equipment crews excavated from TOP to BOT, removing the old culvert and installed a 50’ flatcar bridge at site. Berms were maintained down left approach and through bridge to discharge flow to RD #1. Equipment crews installed pre-fabricated concrete blocks for abutments to the bridge and installed 40 yds^3 of 2-3' diameter rock armor to each sideslope for bank stabilization.		80 yds^3 2-3’ diameter rip-rap
0.152		RD #2	Heavy equipment crews installed a rocked rolling dip.		10 yds^3 2”-road rock
0.162			Intersection with spurs uphill to left and downhill to right.		
0.213			End of road log and treatments at drainage divide near cabin.		

Appendix B

Selected photos of project sites before and after implementation

Photo 1a, b	Bloomer Mine Spur #1 Road, site #3	Photo 7a, b	Finley Camp Road #2, site #36
Photo 2a, b	Cecilville/Taylor Road #1, site #42	Photo 8a, b	Finley Camp Road #2
Photo 3a, b	Cecilville/Taylor Road #1, site #42	Photo 9a, b	Godfrey/Harris Ranch, site #30
Photo 4a, b	Finley Camp Road #1	Photo 10a, b	Godfrey/Harris Ranch, site #31
Photo 5a, b	Finley Camp Road #1	Photo 11a, b	Butler Flat, site #102
Photo 6a, b	Finley Camp Road #2, site #36	Photo 12a, b	Butler Flat Loop Road

Photo 1a. Bloomer Mine Spur #1 Road, site #3, before implementation. View from the bottom of the site, looking upstream at the crossing of a Class II stream. Prior to treatment, there was no drainage structure at this site and the fill was actively eroding.

Photo 1b. Bloomer Mine Spur #1 Road, site #3, same view as above, after implementation. The stream crossing has been decommissioned with a 6' channel bottom width and 2:1 sideslopes, except on the left bank where bedrock is exposed. Bare soil areas were mulched with straw after the photo was taken.

Photo 2a. Cecilville/Taylor Road #1, site #42, before implementation. View from the top of the site, looking downstream at a crossing of a Class III stream. Prior to treatment, there were two, mostly plugged and rusted out culverts at this site. Note the plywood on the outside edge of the road.

Photo 2b. Cecilville/Taylor Road #1, site #42, similar view as above, after implementation. The channel has been excavated with 2:1 side slopes above the crossing, and a 36 in. diameter × 40 ft long culvert installed. Rock armor has been placed along the inboard fill for fillslope protection.

Photo 3a. Cecilville/Taylor Road #1, site #42, before implementation. View from the bottom of the site, looking upstream at a crossing of a Class III stream. Prior to treatment, there were two, mostly plugged culverts at this site and a plywood/debris supported outboard fillslope.

Photo 3b. Cecilville/Taylor Road #1, site #42, similar view as above, after implementation. The channel has been excavated with 2:1 side slopes below the crossing, and a 36 in. diameter × 40 ft long culvert installed. Rock armor has been placed along the outboard fill for fillslope protection.

Photo 4a. Finley Camp Road #1, before implementation. View west of access road.

Photo 4b. Finley Camp Road #1, similar view as above, after implementation. The road has been widened and road rock was applied. The inboard ditch (on right) was widened, deepened and armored in order to effectively convey ditch/stream flow through the site.

Photo 5a. Finley Camp Road #1, before implementation. View east of access road.

Photo 5b. Finley Camp Road #1, similar view as above, after implementation. The road has been widened and road rock was applied. The inboard ditch (on left) was widened and deepened.

Photo 6a. Finley Camp Road #2, site #36, before implementation. View from the right road approach, looking across this culverted Class I stream crossing.

Photo 6b. Finley Camp Road #2, site #36, similar view as above, after implementation. View from the right road approach, looking across the new bridge crossing of the Class I stream. Both road approaches had road rock applied.

Photo 7a. Finley Camp Road #2, site #36, before implementation. View from the TOP of the crossing, looking downstream towards the old culvert inlet.

Photo 7b. Finley Camp Road #2, site #36, similar view as above, after implementation. View from the TOP of the crossing, looking downstream at the new bridge. The original sideslopes were exhumed and 40yds^3 of 2-3' diameter rock armor was placed on each side to protect the banks from scour and erosion.

Photo 8a. Finley Camp Road #2, rolling dip location, prior to implementation.

Photo 8a. Finley Camp Road #2, rolling dip location (arrow), after implementation.

Photo 9a. Godfrey/Harris Ranch, site #30, before implementation. View from TOP of the crossing, looking downstream at the inboard edge of the road.

Photo 9b. Godfrey/Harris Ranch, site #30, similar view as above, after implementation. View from TOP of the crossing, looking downstream at the new culvert inlet. The channel has been excavated with 2:1 side slopes above the crossing, and a 24 in. diameter × 80 ft long culvert installed. Rock armor has been placed at the inlet and outlet for fillslope protection.

Photo 10a. Godfrey/Harris Ranch, site #31, before implementation. View from the left cutbank, looking downstream across the road prism.

Photo 10b. Godfrey/Harris Ranch, site #31, similar view as above, after implementation. View from the left cutbank, looking downstream across the road prism. An armored fill was constructed by dipping the road and armoring the outboard fillslope.

Photo 11a. Butler Flat, site #102, before implementation. View from TOP of the crossing, looking downstream towards the inlet of this undersized and nearly plugged culvert.

Photo 11a. Butler Flat, site #102, similar view as above, after implementation. View from TOP of the crossing, looking downstream at the new culvert inlet. The channel has been excavated with 2:1 side slopes above the crossing, and a 24 in. diameter × 30 ft long culvert installed. Rock armor has been placed along the right approach, lead-in inboard ditch to minimize future scour from an active spring.

Photo 12a. Butler Flat loop Road, rolling dip # 3.1 location, prior to implementation.

Photo 12b. Butler Flat loop Road, rolling dip # 3.1 location (arrow), after implementation.