Scott and Salmon River Watersheds Road Erosion Inventory and Assessment

Conducted on Siskiyou County roads

Final Report

Prepared by

Five Counties Salmonid Conservation Program

Under Fisheries Restoration Grant Program Contract #P0510326
through the California Department of Fish and Game

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I. Introduction

This report summarizes a Five Counties Road Erosion Inventory and Assessment that was conducted along county roads in the Scott and Salmon River watersheds, in Siskiyou County (refer to Figure 1 in Section IV Project Area Description below for a project location map). Sources of erosion inventoried typically include stream crossings, landslides, cutbanks, ditches, road beds, and springs that have the potential to deliver sediment to streams. Funding for this work was provided through the California Department of Fish and Game Fisheries Restoration Grant Program with in-kind contributions from Siskiyou County.

This assessment is part of a larger effort of the Five Counties Salmonid Conservation Program (5C) to identify and prescribe treatments for sources of erosion from county roads for the benefit of water quality and anadromous fishery habitat (refer to Section III Goals and Objectives below for more contextual details). Also recorded is information on what sites can potentially be used to store materials generated during road maintenance, improvement, or construction projects, referred to as spoils disposal sites. This inventory is the first conducted in Siskiyou County and follows the same basic methodology as similar inventories conducted in Del Norte, Humboldt, Mendocino, and Trinity Counties under various grant sources. All inventories utilized the Direct Inventory of Roads and Treatments (DIRT) methodology, developed by the 5C program. This methodology generates volume estimates of the total potential erosion produced by each site over a ten-year period using calculations and modeling based on physical site dimensions and road conditions. Trained survey crews assign both an overall treatment immediacy and an erosion potential rating to each site. The GIS data for all prior inventories has been submitted to CDF&G for incorporation into a statewide GIS database and this report includes the data for this assessment.

Collection of data in this format provides the 5C and member county roads managers with a valuable mechanism with which to evaluate and prioritize erosion sources so that they may more easily develop implementation projects specifically to treat these sites and/or incorporate site treatments into their maintenance schedules. Resulting databases and reports also allow responsible agencies, the public, and funding managers to better understand the data and the process by which it was gathered. Copies of all final reports are available upon request. The 5C website www.5counties.org also contains information on current inventories and resulting sediment reduction projects.

Both the California Department of Fish and Game and the North Coast Regional Water Quality Control Board have designated the Scott River watershed as sediment impaired, impacting anadromous salmonid habitat. One priority of these agencies is to reverse the trends of human related sediment inputs into the river system in order to enhance cold water fisheries and other beneficial uses of these waters. The Salmon River watershed is not identified as sediment impaired but experiences significant natural landsliding and fires that contribute sediment to the river system with only limited sediment sources from forest management, past mining, road construction and maintenance. The Salmon River watershed was included in the DIRT inventory as it still retains large areas of high quality anadromous fisheries habitat, is noted to have one of the largest populations of wild Spring Chinook salmon in California, and any elimination and mitigation of sediment sources to this watershed would be beneficial for this and other salmonid species.

These inventories and resulting implementation projects are part of the larger 5C salmonid and water quality conservation strategy adopted in 1998 by the Boards of Supervisors of Del Norte, Humboldt, Mendocino, Siskiyou, and Trinity Counties in response to the 1997 listing of the coho salmon as a federal Threatened species. These Counties formed a salmonid conservation program based on the boundaries of the coho evolutionarily significant units (ESU) that encompass them. This effort includes multiple program elements for the restoration of salmonid habitat as a means to avoid further regulatory actions (refer to Appendix A of this report). This was the first time that multiple County governments formed a watershed-based conservation strategy to address the biological, watershed, political, social, and economic effects of declining salmonid populations. The 5C efforts were recognized in 2001 when the National Marine Fisheries Service determined that the Klamath Mountains Steelhead ESU population did not warrant listing as a Threatened species in part because of the work done by the 5C member counties and their restoration efforts. Specifically they noted that, "...NMFS intends to capitalize on the significant efforts being made by all entities, ...efforts like those implemented by the Five Counties Salmon Conservation Program and Scott River Watershed Council. These efforts, coupled with ESA protective regulations for listed coho salmon, will likely improve conditions for KMP steelhead as well..." (Federal Register: April 4, 2001 Volume 66, Number 65, Proposed Rules, [Page 17845-17856]).

The field work for this inventory was conducted by a dedicated crew: Carolyn Rourke, Tristan Behm, Christine Jordan, and Cherie Thompson. The data analysis and summary presented here was produced by Sandra Pérez, Christine Jordan, Carolyn Rourke, and Mark Lancaster. Special recognition is given to the Siskiyou County Department of Public Works and road crew, particularly Scott Sumner, Garold Carver, Ed Jacobson, Charlie O'Brien, and Sonny Foster, who greatly helped to facilitate the crews' work. Pacific Watershed Associates provided the training of field staff and Sari Sommarstrom provided valuable watershed information, notably for the Scott River.

II. Summary

In this inventory, 342 miles were surveyed with 1,056 total sites recorded, including erosion sources with the potential to deliver sediment to streams and potential spoils disposal sites. Of these sites, 1,034 are recommended for treatment and are estimated to yield 556,780 yd^3 of total erosion within a ten-year period. Seventeen of the 1,056 sites are recorded spoils sites. Thirteen of those are found to have a good suitability with 308,233 yd^3 total estimated storage capacity. The actual spoils storage capacity at some of the largest sites would be dependent on engineering review and design of sites.

Because sites in this dataset span various geologies, the nature of roads and individual sites is very diverse. Photographs from select sites within this inventory are included as Appendix G to demonstrate a cross section of typical site types. The table below summarizes all of the sites recommended for treatment by type and immediacy.

Sites by Type

Site Type	Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Ditch relief culvert	398	62,091	11.2%
Landslide* (cutbank)	3	13,860	2.5%
Landslide* (fillslope)	12	99,160	17.8%
Other problem	3	6,197	1.1%
Road bed	13	4,297	0.8%
Road ditch	18	3,705	0.7%
Spring	4	1,050	0.2%
Stream crossing	583	366,420	65.8%
Total	**1,034**	**566,780**	**100%**

* This table does not encompass all landslides. Natural landslides unrelated to the road are not included in the inventory.

Sites by Treatment Immediacy

Treatment Immediacy		Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Urgent		14	11,632	2.1%
H	High	178	169,881	30.5%
HM	High-Moderate	273	109,117	19.6%
M	Moderate	385	192,901	34.6%
ML	Moderate-Low	140	36,725	6.6%
L	Low	44	36,526	6.6%
Total		**1,034**	**566,780**	**100%**

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III. Goals and Objectives

As part if its goal to improve water quality and enhance salmonid habitat, the 5C has committed to a long-term, systematic, prioritization-based, sediment reduction program (refer to Appendix A for a more detailed description of the 5C Program). In 1998, the year after the 5C Program began, a court ordered consent decree established timelines for the completion of Sediment Total Maximum Daily Load (TMDL) allocation plans for 18 Northern California watersheds including the Scott River. At that time, the 5C counties identified water quality as an important aspect of their salmonid conservation strategies. The intricate network of County, state, federal, and private road systems within the 5C area can contribute to water quality and habitat degradation where they modify natural stream and hillslope drainage patterns. In some instances, roads modify natural hillslope drainage networks and accelerate erosion, altering natural physical processes. This leads to changes in stream flow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and stability of slopes. These changes can have biological consequences that affect virtually all components of stream ecosystems (Furniss et al. 1991)[1]. Within the 5C, there are 4,790 miles of county roads and approximately 16,600 culverts (see Tables 1 & 2 below). Many county roads were originally constructed in the bottom of stream canyons. Roads located low in drainages contribute a greater percentage of road-related sediment to streams than do roads located higher in the watersheds, closer to ridges and away from drainages. In many cases, stream crossings on county roads low in watersheds cannot adequately handle ten-year or larger storm flow events without the ongoing storm maintenance and debris removal programs in each county. However, road systems are one of the most easily controlled sources of sediment production and delivery to stream channels.

The goals of the Five Counties' road erosion inventory are to identify specific sites along county roads and facilities that are contributing sediment to waterways and to prioritize implementation treatments to assure economic, biological, management, and physical effectiveness.

The primary objectives of the program are to:

- Conserve and restore water quality and salmonid habitat by implementing cost-effective erosion control and prevention work on high priority sites.
- Maintain public safety and open roads at all times.
- Prevent or minimize delivery of sediment to streams.
- Minimize the diversion of water from one watershed to another via road ditches where practical and feasible.
- Protect aquatic and riparian habitat.

The first step in this program, for the benefit of water quality and anadromous fishery habitat, is to identify, quantify, and prescribe treatments for sources of erosion from county roads and facilities that have the potential to deliver sediment

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[1] Furniss et al. 1991. In Forest Ecosystem Management: An Ecological, Economic, and Social Assessment, Report of the Forest Ecosystem Management Assessment Team, 1993, p. V-16 - V-19.

to a stream. During the inventory, prospective spoils disposal sites are also identified. The road erosion source data is then ranked to identify high priority sites and facilitate the development of projects to implement recommended treatments. Data also provides individual county departments of transportation or public works with an inventory of all county stream crossings. This project specifically consists of the inventory of county roads within the Scott and Salmon River watersheds.

Table 1: Estimated Miles of County Maintained Roads

County	Miles of Surfaced County Roads	Miles of Unsurfaced County Roads	Total County Road Miles
Del Norte	302	199	501
Humboldt	907	300	1,207
Mendocino	706	312	1,018
Siskiyou	894	470	1,364
Trinity	455	245	700
Total	**3,264 (68%)**	**1,526 (32%)**	**4,790**

Table 2: Estimated Number of County Maintained Culverts & Stream Crossings

County	Culverts	Bridges	Low Water Crossings
Del Norte	~2000	32	0
Humboldt	~3000	162	3
Mendocino	~3500	157	19
Siskiyou	~4000	175	2
Trinity	~4100	93	9
Total	**16,600**	**619**	**33**

Another part of the 5C effort to protect and improve water quality is the 5C "Water Quality and Stream Habitat Protection Manual for County Road Maintenance in Northwestern CA Watersheds" (5C, 2002). Topics included are: grading practices, road surfacing and dust abatement, vegetation management, culvert maintenance and replacement, spoil disposal, maintenance yard management, bridge maintenance, slide and settlement repair, snow and ice removal, and monitoring the practices. It describes many of the best management practices (BMPs) needed to perform the road treatments prescribed in this DIRT inventory. Standard designs and procedures for BMPs are provided in greater detail in Appendix B of the road manual.

IV. Project Area Description

The Scott and Salmon River watersheds, which encompass approximately one million acres, contain some of the most significant anadromous salmonid habitat in California. The watersheds also support populations of Pacific Lamprey, Green sturgeon (Salmon River) and many native resident fish species. The two watersheds represent about 10% of the overall Klamath River watershed with no major dams in either system. Major dams on the upper Klamath and Trinity Rivers block access to hundreds of miles of spawning and rearing habitat for salmonids and other fish species, making the intact Scott and Salmon watersheds valued for the opportunity to maintain and restore fisheries habitat and water quality.

Approximately 70% of the Salmon and Scott watersheds are federally managed and 30% is in private ownership. The Klamath National Forest manages approximately 65% of the watersheds with five percent under Bureau of Land Management (BLM) direction. The National Forest lands are currently managed for Wilderness and Wild and Scenic River values, limited timber harvesting (commercial, salvage and thinning for forest health), livestock grazing, recreation and gold mining. Between the 1950's and 1980's much of the National Forest management of non-Wilderness areas was for timber production and extensive road construction was a result of the timber management programs. The BLM lands are predominately used for rangeland grazing and mineral exploration.

The remaining watershed areas are under private ownership and characterized by hay and alfalfa pastures (Scott Valley), timber management on hillslopes, and mining in limited areas. The less populated areas consist of the Etna, Ft Jones, Cecilville and Forks of Salmon communities as well as remote and scattered rural residential and homestead parcels. There is a small amount of Tribal Trust lands in the Quartz Valley area of the Scott Valley. Land use and ownership patterns are expected to remain the same for the foreseeable future.

The Scott River watershed, one of the Klamath River basin's larger tributary systems, has a rich history of mining activity and water diversions for agriculture. The Salmon River watershed also has a history of mining, but it is not as predominant as the large and extensive dredge mining of the Scott River. Large, periodic wildfires are more common in the Salmon River watershed, presenting a significant source of sediment to the river and its tributaries.

A number of reports have indicated that within the geographic range of this inventory a variety of watershed problems could be associated with roads including: elevated water temperatures (due to reduced canopy cover on streams); sediment input from poor road drainage and undersized stream crossings; and filling of stream gravels and pools from accelerated erosion. As a result of these factors, the North Coast Regional Water Quality Control Board developed a sediment Total Maximum Daily Load allocation plan for the Scott River (described below in subsection iv).

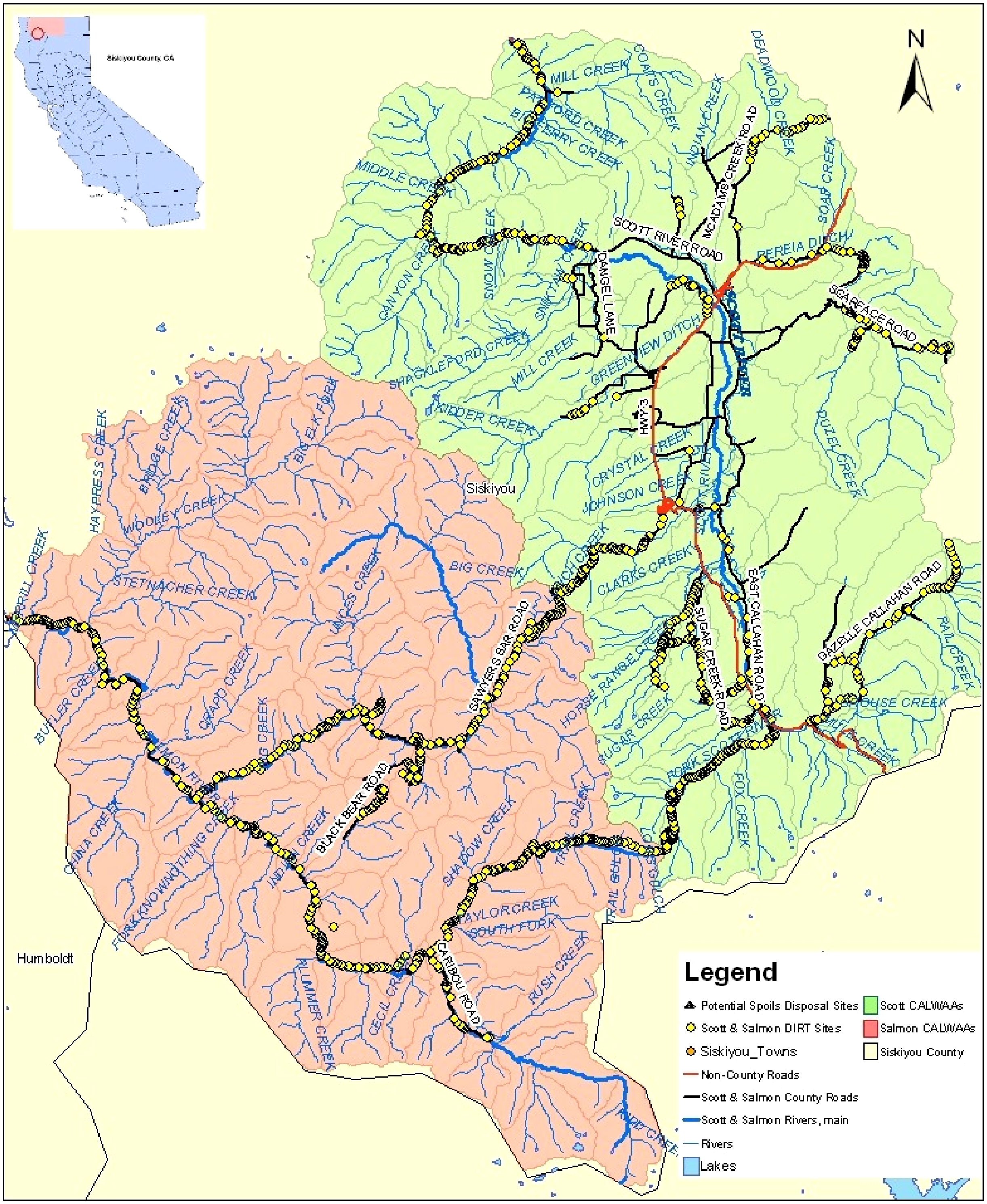
The Salmon River still retains large areas of high quality anadromous fish habitat and is noted to have one of the largest wild Spring chinook salmon populations in California. Once the dominant salmon run in the Klamath River, Spring chinook are now restricted to only a few areas including the Salmon River. Brown et al. (1994) also states that the Scott River probably holds the largest number of native coho salmon within the Klamath River's tributary systems. Elimination and/or mitigation of road related sediment sources in these watersheds would be beneficial for these and other salmonid species.

Within the Salmon River watershed, natural and road related landslides are significant sediment sources. Large slides, such as the 1964 Bloomer Slide, are capable of delivering more sediment in one event than all of the county roads over a 10-year period. The potential exists for high chronic surface erosion and catastrophic failure of culverts during major storm events in this area as well. Large, intense wildland fires, timber harvesting and associated road building in the Salmon River basin contribute directly and indirectly to water quality concerns.

In this project, county roads within the Scott and Salmon River watersheds were inventoried and assessed using the Direct Inventory of Roads and Treatments (DIRT) methodology described in Section V below. Refer to Figure 1 below for a map of the inventory area and overview of sites (potential county road sediment sources and spoils disposal sites). Appendix B contains more detailed site maps shown by various DIRT factors.

View of the Scott River watershed

Figure 1: Project Location Map
Scott and Salmon River Watersheds Road Erosion Inventory



Scott River Watershed

The 520,968-acre (814 square mile) Scott River watershed contains substantial variation in geology, geomorphology, and climatology. The Scott River is one of four major tributaries to the Klamath River. Major tributaries to the 58 mile long

Scott River include: Shackleford, Mill, Kidder, Etna, French, and Moffett Creeks, as well as the South and East Fork Scott River.

Elevations in the watershed range from 2,620 feet in the valley to 8,000 feet in the surrounding mountain ranges. The average annual precipitation for the entire watershed is 36 inches. Mean precipitation varies, depending on location in the watershed, due to the fact that the drainage is bordered to the west and south by the Marble, Salmon, Trinity Alps and Scott Mountain ranges. These ranges exert a strong orographic effect on the incoming storms, allowing the higher elevations, along the west and south sides of the drainage, to receive 60 to 80 inches of precipitation annually. In contrast, the rain-shadow effect that the west-side mountains create reduces the amount of annual precipitation to 12 to 15 inches on the eastern side of the watershed (SRWC, 2005). From 1852 through present day, there have been approximately 9 major flood events (including 1955 and 1964) and 4 droughts, including a prolonged drought period from 1986-1994.

The Scott River runs south to north through Scott Valley, turning west near Ft. Jones and then north again near Canyon Creek. The Marble Mountains on the west side of the watershed are the source of several steep, high gradient perennial streams: Sugar, French, Etna, Kidder, and Shackleford/Mill creeks and numerous diversions originate in the mid to lower reaches of these tributaries. Geomorphic characteristics and streamflows are greatly influenced by snow accumulation and melt runoff. The high gradient streams flow into low gradient, moderately confined valley bottom stream channels. In most west side streams, flows naturally go sub-surface through the pronounced alluvial fans during the summer months (Mack, 1958).

Within Scott Valley, landform processes have created a wide, alluvial floodplain and a sinuous channel pattern where bars, islands, side and/or off-channel habitats are common (Sommarstrom et al., 1990). The river is prone to periodic overbank flooding within the valley and portions of the river and lower reach tributary channels are stabilized by riprap to prevent erosion. The US Army Corps of Engineers also built levees in the late 1930's for flood control. Extensive river-bottom gold dredging between Etna and Callahan, and some tributaries, washed away soil and left mounds of cobbles, hindering riparian vegetation establishment. In some tributary streams, tailing piles have blocked stream channels resulting in subsurface flows and preventing fish migration upstream (e.g. Indian Creek). Within the Valley, the Scott River is predominantly surrounded by irrigated farmland (50 square miles) and rangeland (80 square miles) comprising 16% of the watershed (DFG, 2004). Approximately 600 individual water diversions are named within the Scott Valley.

Scott Valley Flooded in 2005/2006 Storms

The lower Scott River differs greatly from the valley in that it winds for approximately 20 miles through a steep canyon before entering the Klamath. The dissection of the surrounding mountains by streams has established a wide variety of slopes, aspects, elevations, and soil types. Perennial tributaries in this river reach include Canyon, Kelsey, Middle, Tompkins, and Mill Creek. Six different geomorphic landscapes occur in this area, predominated by steep, mountainous terrain prone to debris slides and flows (KNF, 2000-TBO in Scott River Watershed Council Strategic Action Plan).

Dry foothills extending north from the Scott Mountains dominate the east side of the Scott Valley. The largest watershed is Moffett Creek (227.9 square miles). Other east side streams are ephemeral, flowing only during the winter and spring months after prolonged periods of precipitation.

The entire Scott River watershed is geologically complex, as the GIS geology coverage used for the Scott River TMDL[2] shows "not less than twelve geologic units mapped in the Scott" River watershed. For the TMDL, for their sampling purposes, the North Coast Regional Water Board staff combined similar geologic map units and aggregated them into four broader geologic units (Quaternary Deposits, Granitic Bedrock, Mafic and Ultramafic Bedrock and Sedimentary and Metamorphic Bedrock) (refer to Geology Map, below). The Water Board Staff Report aggregated unit summaries are restated or paraphrased below:

Quaternary Deposits make up the floor of Scott Valley and the lower reaches of some tributary valleys and consist primarily of unconsolidated gravels, sands, and soils that form flat or gently sloping land. The valley soils have a high water table and/or are subject to flooding because of the high rainfall and snowmelt

[2] Saucedo et al., 2000, In "Staff Report for the Action Plan for the Scott River Watershed Sediment Sediment and Temperature Total Maximum Daily Loads" North Coast Regional Water Control Board (12/2005)

during winter and spring. The NCRWCB staff report indicates that the main causes of erosion of this unit are not slope processes but rather bank erosion of streams and occasional gullying. The primary management-related sediment delivery over most of the unit is not associated with roads.

Granitic Bedrock is exposed in the mountains paralleling the west side of Scott Valley and ranges from granite to granodiorite[3], which generally weathers to non-cohesive and highly erodible decomposed granite (DG) soils. A significant portion of the Scott River watershed (10.6[4] percent) is underlain by granitic bedrock. The DG soils are widely recognized as some of the most erosive soils anywhere and are highly susceptible to dry ravel, rill and gully erosion, debris slides and torrents[5].

Mafic and Ultramafic Bedrock units are largely serpentine along with minor basalt, peridotite, and gabbro intrusions. These rocks occur in parts of the Marble Mountains in the northwestern part of the watershed, in the Scott Mountains in the southeast, and in a disconnected belt that runs from the south of the watershed to the northeast. Most of the ultramafic outcrops are partly or wholly altered to serpentine which weathers to form soil that is finer-grained and more clay-rich than soil formed on granitic rocks. The result is a reduced tendency toward dry ravel, sheetwash, and rillwash. Some limited areas of sheared bedrock are vulnerable to landslides however.

Sedimentary and Metamorphic Bedrock make up more than half of the Scott River watershed and include sedimentary rocks of many lithologies, mostly of Mesozoic age. Metamorphic rocks of low to medium grade include amphibolite, greenschist, blueschist, metavolcanics, and some Tertiary metavolcanics[6].'

Table 3: Summary of the Extent of Geologic Units in the Scott River Watershed[7]

Geologic unit	Area (acres)	Area (sq miles)	Area (by percent)	Stream Miles
Quaternary	51218	80	10%	199
Granitic	54938	86	11%	259
Mafic	87370	137	17%	401
Sed & Met	326657	510	63%	1641
TOTALS	***520184***	***813***	***100%***	***2500***

[3] Mack, 1958, p. 24 ibid..
[4] From Table 3.2 ibid.
[5] Kellogg, 1992, p. 64 ibid.
[6] Wagner and Saucedo, 1987 ibid.
[7] Table 3.1ibid.

Figure 2: Scott River Simplified Geology Map[8]

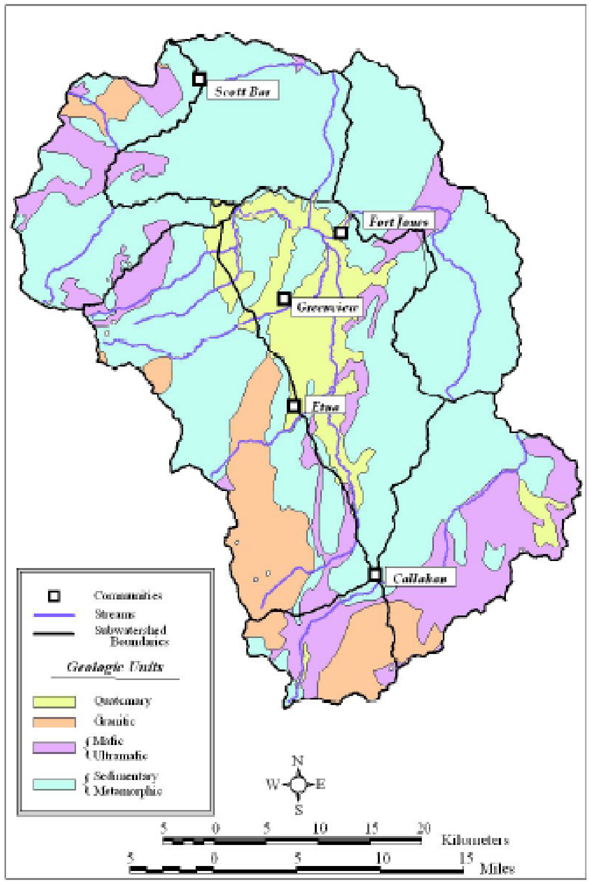


Figure 3.2 Geologic map of the Scott River watershed showing combined geologic units (combined from Saucedo et al., 2000)

The Klamath National Forest administers 182,221 acres in the Scott River watershed, 54,534 acres of which are in Wilderness designation (35%); the BLM administers 11,513 acres; 133 acres are held in Tribal Trust lands; and, 327,101 acres are privately owned. Road Mileage by ownership breaks down as follows: 600 miles in the USFS system; 25 miles managed by the BLM; 41 miles are in State ownership (Highway 3); 1,275 miles are private; and, Siskiyou County maintains 251 miles.

The primary land use in the watershed is agricultural production of range and croplands in the valley and timber production/wilderness designation in the higher elevations. Historic mining from the late 1800's on, combined with forest management, rural development, irrigation diversions, channel alteration, wildland fires and fire suppression have all contributed to human associated declines in watershed conditions.

The California Department of Fish and Game identified several critical habitat limiting factors within the watershed: water diversion and diversion dams (resulting in lower summer flows and high summer temperatures as well as limiting fish

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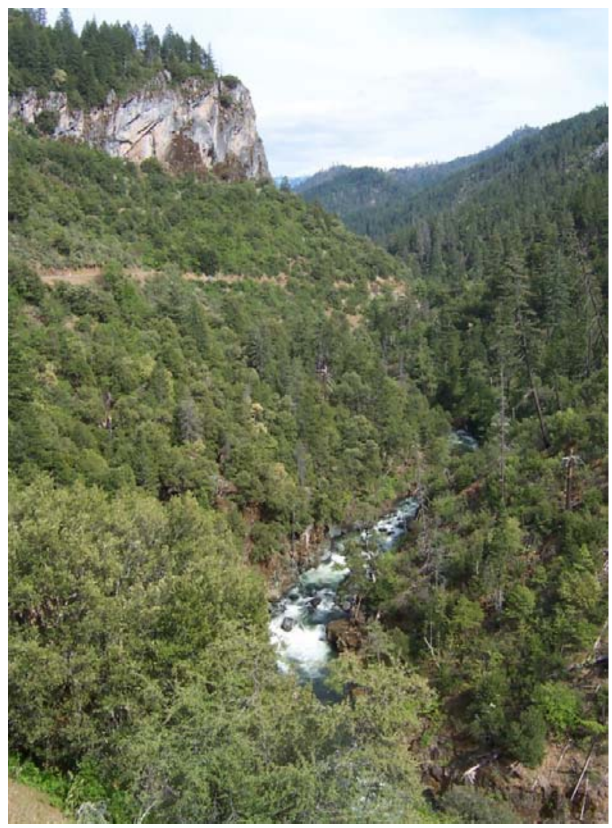
8 Ibid

passage), road culverts and other fish barriers, log jams and siltation; and siltation from past logging and mining activities.

Over the past 10-15 years private landowners, timber companies and others have cooperated with the Siskiyou County Resource Conservation District and Scott River Watershed Council to address some of the limiting factors to fisheries. These efforts have included installation and maintenance of over 62 fish screens with headgate structures, installation of fish passage weirs (replacing gravel dams) at 17 diversion sites, riparian restoration (fencing, planting and bank stabilization), limited road decommissioning, and forest fuels reduction projects[9]. A Scott Valley Water Trust has been formed and eventually could provide water to the river during critical summer low flow periods. Siskiyou County has removed four migration barrier culverts in the Salmon and Scott River watersheds and has modified road maintenance practices to reduce sediment delivery to streams. This road inventory is an example of the increasing focus on water quality and land use management that has been underway within both watersheds.

Salmon River Watershed



The 480,864-acre (751 square mile) Salmon River watershed consists of the mainstem, North and South Fork Salmon Rivers. It is the largest cold-water tributary system to the Klamath River and is home to several species of fish including summer and winter runs of wild Klamath Mountains Province ESU steelhead, Upper Klamath-Trinity Rivers ESU spring/fall chinook, green sturgeon and SONCC ESU coho salmon. The headwaters are located in designated federally protected Wilderness Areas, consisting of: Marble Mountain, Russian, and Trinity Alps. The Salmon River basin is subdivided into four major watersheds; North Fork, South Fork, Wooley Creek and the Main Stem that drain approximately 1,414 miles of streams. The Salmon River subbasin contains sixty-three drainages overall, ranging in size from 3,300 to 14,500 acres. Elevations range from 500 feet to 8,000 feet and average annual rainfall is 40 to 120 inches per year. There are no major dams or diversions, urban areas, major industry or significant irrigation withdrawals in the watershed. 99% of the watershed area is located primarily within the Klamath National Forest with the remainder in the Shasta-Trinity & Six Rivers Forests. 42.67% of the watershed is held in protected status (designated as wilderness and/or Wild & Scenic River) with 56.04% being managed for public

[9] http://www.siskiyourcd.org/ and http://www.scottriver.org/

multi–use lands (federal & state). 1.3% of the watershed is private and 67% of the total watershed lies within the Karuk Tribe's ancestral lands (Klamath National Forest LRMP, 1994).

The primary historic and ongoing land uses and natural processes in the watershed include Wilderness and Wild and Scenic River management, timber harvest, recreation, mining, minimal agriculture and grazing practices, landslides and periodic fire. The watershed is one of the highest risk fire areas on the Klamath NF as it has a high natural frequency of lightning occurrence. USFS and CDF fire suppression activities since 1911 and more recent climatic change have increased the frequency and magnitude of catastrophic fires in the watershed. Fire intensity and acres burned in high or severe burn class conditions have increased in the past few decades. In the last 96 years, approximately 44% of the subbasin has burned and in the last 20 years, 31% has burned or reburned (SRRC, 2005), resulting in loss of riparian and upslope vegetation, reduced evapotranspiration, and loss of tree root strength as roots decay. These and other factors such as rain on snow events increase sediment delivery, which in turn increases water temperatures in tributaries (USFS Sediment Analysis, 1994). Water quality in the Salmon River began to deteriorate from its natural condition as a result of gold mining activity beginning in the 1850s when the river and streams were dammed, diverted and drained for mining activities and massive amounts of sediment were discharged into the river.

The Salmon River flows through a rugged gorge in which rock outcrops and bluffs are common. Numerous temporary large landslide dams (including the Bloomer Slide (1964) and Murder's Bar slide (1955)) have formed along the Salmon River and its tributaries. High precipitation, seismic events, and activities that disturb the soil or vegetation (such as timber harvest activities and fire disturbance) can initiate landslide activity.

The watershed is situated within the Klamath Mountain physiographic province and the geomorphology of the subregion consists of an uplifted and dissected peneplain on strong rocks with extensive monadnock ranges where mass wasting and fluvial erosion are the main geomorphic processes. Lithology and stratigraphy consist of Paleozoic sedimentary and volcanic rocks, and Mesozoic ultramafic, granitic, sedimentary, and volcanic rocks. The watershed includes three distinct rock belts; the Western Paleozoic and Triassic Belt, the Central Metamorphic Belt and minor portions of the Eastern Klamath and Western Jurassic Belts (Irwin, 2002). The major geologic composition of the watershed consists of metasedimentary and metavolcanic rocks with the Wooley Creek and English Peak batholiths located in the northwest and central part of the watershed (near Salmon River and Sawyer's Bar Roads, respectively). Cecilville Road, which traverses the East Fork of the South Fork Salmon and the South Fork Salmon, is a conglomerate of the Stuart Fork formation in the higher elevations, and Salmon Hornblende schist at lower with intrusions of metasedimentary and ultramafics near Forks of Salmon. The prevalent geomorphic processes of uplifting and landsliding have continued to shape the watershed into its present day form of low relief and thick, well-weathered soils (peneplain). Both large and small landslides are common in the watershed and the soils range from moderately to highly erosive.

Cutbank slide on Salmon River Road during 2005/2006 Storms

Narrow floodplains and high terraces along the river and its tributaries best characterize the watershed. Ancient terrace deposits and older erosional surfaces are preserved throughout the basin and the older river terraces are found up to several hundred feet above the present-day channel, identified by their weathered red clay-like soils. More recent terrace deposits consisting of sand, gravel and boulders occur near the active channels of streams. Large landslide/slump deposits occupy much of the Western Paleozoic and Triassic Belt, particularly along Blue Ridge that forms the divide between the north and south forks of the Salmon River (between Cecilville and Sawyer's Bar Road).

The watershed is transected by three designated Forest Highway Routes maintained by the County (Sawyer's Bar, Cecilville, and Salmon River Road), County local roads, Forest Service, and other private roads totaling 971 miles. Siskiyou County maintains 103 miles of road within the Salmon River watershed. Sawyer's Bar Road is located in the northeast section of the watershed and intersects the Russian Creek, Middle and Lower North Fork Salmon River watersheds. It primarily consists of steep rocky and forested terrain. Cecilville Road intersects the southeast section of the watershed and the Yoakumville, Blackbear, Canyon Mountain, and East Fork South Fork Salmon River watersheds. Numerous colluvial hollows, areas of loose soil material that has eroded from between exposed bedrock leading to road failures in some areas, are located on this road as are several fault zones. Caribou Road is located in the Summerville watershed and the most prevalent soil type along this road is decomposed granite. Salmon River Road transects the western portion of the watershed and the Crapo Creek and Butler Mountain watersheds.

Watershed and Regulatory Factors Related to Erosion Inventory

There are many watershed factors and plans and/or regulations affecting various aspects of the regions surveyed in this inventory. Some relate to water quality and have a direct bearing on sediment sources from roads. Others affect the inventory in that they influence the prioritization of treatments. For example, roads or sites that deliver sediment to streams containing listed species will be of higher priority for treatment than will be comparable sites with no such impacts to listed species.

During the fieldwork it became evident that significant road segments in the Scott River are not delivering sediment to anadromous salmonid streams. In all, 62.1 miles of county roads in the watershed were not inventoried or reported here (Appendix H lists these roads). In some locations road runoff either delivered to pastures directly as overland flow or entered ditches that were used for flood irrigation of fields (portions of Eastside Road for example). In some cases, entire steams on the east side of the Scott Valley deliver to the Scott Valley Irrigation Ditch (SVID) or similar irrigation ditches and the flow of those ditches is applied to pastures, never reaching a stream. Scarface Road is an example of a County road where sediment is delivered to Hamlin Gulch and then to the irrigation ditch, but never reaches an anadromous salmonid stream. As sediment fills Hamlin Gulch, landowners remove it and incorporate it into berms and then into fields. Hamlin Gulch then flows into the SVID and onto other pastures. In other instances mine tailings dam a stream channel, intercept stream flow and force water to flow subsurface and/or pool behind the tailings. Much of Indian Creek Road related sediment is trapped and stored upstream of tailing "dams" in Indian Creek.

Indian Creek is considered to be a non-delivery road because it enters an area of mine tailings, where it goes subsurface and where any upstream sediments would be filtered out.

The more relevant regulatory plans and rules are listed below.

A. North Coast Basin Plan Water Quality Objectives

Water quality basin plans provide the basis for protecting water quality in California. Basin Plans are mandated by both the Federal Clean Water Act (CWA) and the State Porter-Cologne Water Quality Act (Porter-Cologne). Sections 13240-13247 of Porter-Cologne specify that the regional basin plans shall include: water quality objectives to protect beneficial uses and a program for achieving those objectives that must include the actions taken, time schedule, and monitoring program. The goal of the Basin Plan is to provide a definitive program of actions designed to preserve and enhance water quality and to protect beneficial uses of water in the North Coast Region. The Basin Plan is comprehensive in scope and includes provisions to address the following: suspended material, settleable material, sediment, and turbidity. The Basin Plan is used as a regulatory tool by the Regional Water Board's technical staff. Regional Water Board orders cite the Basin Plan's water quality standards and prohibitions applicable to a particular discharge. The Basin Plan is also used by other agencies in their permitting and resource management activities. It also serves as an educational and reference document for dischargers and members of the public.

B. Section 303(d) of the Federal Clean Water Act

Section 303(d) of the federal Clean Water Act requires states to identify waterbodies that do not meet water quality standards and are not supporting their beneficial uses. These waters are placed on the Section 303(d) List of Impaired Waterbodies. Placement on this list triggers development of a pollution control plan called a Total Maximum Daily Load (TMDL) for each waterbody and associated pollutant/stressor on the list. California’s current Section 303(d) List of Water Quality Limited Segments shows that the Scott River is being addressed by a “USEPA approved TMDL” (see next section below). Water bodies that drain fifty percent of the area of the North Coast Region are listed, per Section 303(d) of the Clean Water Act, as sediment impaired because the water quality of those rivers and streams does not meet sediment-related water quality objectives nor protect certain beneficial uses.

C. TMDL Watershed Indicators Related to Road Management

The TMDL process provides a quantitative assessment of water quality problems, contributing sources of pollution, and the pollutant load reductions or control actions needed to restore and protect the beneficial uses of an individual waterbody impaired from loading of a particular pollutant. More specifically, a TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards which will insure the protection of beneficial uses (40 CFR §130.2). It is based on the sum of the individual waste load allocations for point and non-point sources as well as natural background levels. It also includes a margin of safety and consideration of seasonal variations.

While the Scott River has a Sediment TMDL and an adopted Action Plan (discussed in the following section) that necessitates a road sediment source inventory, the Salmon River watershed is not identified as sediment impaired from human sources. The Salmon River watershed was included within the DIRT Inventory grant in recognition of its high value for anadromous salmonids in general and its spring run Chinook population in particular.

The TMDLs for streams and rivers in the project area include a series of watershed indicators that could be evaluated or measured to assess the progress of meeting the recovery goals established by each TMDL. Watershed indicators that directly relate to road management are: 1) Stream Crossings with Diversion Potential or

Significant Failure Potential; 2) Hydrologic Connectivity; 3) Annual Road Inspection and Correction; and 4) Road Location, Surfacing, Sidecasting.

The North Coast Regional Water Quality Control Board approved Resolution R1-2004-0087 for the Total Maximum Daily Load (TMDL) Implementation Policy Statement for Sediment Impaired Receiving Waters in the North Coast Region on November 29, 2004 (www.waterboards.ca.gov/northcoast/programs/basinplan/tipfsiw.html). The Policy Statement describes the implementation actions necessary to achieve sediment TMDLs. That resolution contains the following relevant sections (here paraphrased):

> [1] *D. Work cooperatively with other agencies and organizations to encourage more sediment waste discharge control, watershed restoration, and protection activities.*
>
> *E. "Work with local governments and non-profit organizations to develop sediment prevention, reduction, and mitigation strategies, including, but not limited to, grading ordinances and road management policies."*
>
> *F. Enhance non-regulatory actions with organizations and individuals to encourage sediment waste discharge control, watershed restoration, and protection activities.*
>
> *H. Develop a guidance document on sediment waste discharge control for use by the public, landowners, organizations, the Regional Water Board and staff, and other agencies. This document will include sediment waste discharge sites, sediment control practices, and road management practices; suggested content of a comprehensive inventory of sediment waste discharge sites and a comprehensive erosion or sediment control plan; sediment assessment methods; suggested prioritization criteria; and monitoring guidance. The guidance document should be presented by December 31, 2005, as part of the initial workplan.*
>
> *I. Develop a sediment TMDL implementation monitoring strategy to track the recovery of sediment-impaired water bodies in the North Coast Region and implement adaptive management.*

This road inventory meets several of the Water Board objectives.

D. Scott River TMDL Implementation Workplan

Water Quality Control Board staff completed a Staff Report and Action Plan For the Scott River Watershed Sediment TMDL in December 2005 and the Board adopted the Scott River Sediment TMDL Implementation Work Plan in February 2007. The Work Plan encourages parties responsible for roads and sediment waste discharge sites to take actions necessary to prevent, minimize, and control road-caused sediment waste discharges. Such actions may include the inventory, prioritization, control, monitoring, and adaptive management of sediment waste discharge sites and proper road inspection and maintenance.

The Implementation Workplan sets out the timeline and actions related to County roads and facilities. The following Workplan Actions are related to the DIRT Inventory:

<u>*Mid Term (FY 07/08)*</u>

- *Identify discharging site:*

The DIRT Inventory identifies county road related sites that have the potential to yield 20 yd^3 or more of sediment to a stream that will reach an anadromous salmonid stream.

- *Evaluate and determine appropriate method to address, based on extent of discharge and the level of proactive involvement on the part of responsible parties.*
  Find out what the County and other responsible or cooperating parties/groups have done, what they plan to do next to address road and sediment waste discharges, how they intend to prioritize their actions, and an implementation schedule for proposed actions. The Regional Water Board may formalize these plans in MOU(s), general waiver or WDRs requiring individual property owners to prepare and Implement site-specific erosion control plans, etc.:
  The DIRT inventory provides a database and GIS mapped data to identify sites and allows for prioritization of sites based on various criteria (refer to section VIII for discussion of prioritization criteria).

Other elements of the Implementation Workplan Actions are relevant to 5C work products but are not directly related to the inventory and prioritization of county road sediment sources and thus are not addressed in the Final Report.

E. Federal Endangered Species Act

The project area is included within the federally designated Southern Oregon/Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU) for coho salmon, which was listed as Threatened under the federal Endangered Species Act (ESA) in 1997. This ESU extends from the Mattole River watershed in California north to the Elk and Rogue River watersheds in Oregon. Other ESU's included in the inventory area are the Klamath Mountains Province steelhead and the Klamath-Trinity Rivers chinook salmon. Refer to Table 3 below for listing statuses.

Coho salmon have declined in abundance overall during the past several decades. Water diversions for agriculture, flood control, domestic, and hydropower purposes (e.g. Trinity Dam and the diversion of Trinity River flows to the Sacramento River) have greatly reduced or eliminated historically accessible habitat and degraded remaining habitat. Loss of habitat complexity has also contributed to the ESU's decline. NOAA's National Marine Fisheries Service, Southwest Regional Office, lists priority recovery actions for the ESU, including: improving freshwater habitat quantity and quality and improving county road maintenance programs.

The federal listing prevents the direct take or incidental take of a listed species, except as permitted under Sections 4(d), 7, and/or 10 of the act. A programmatic Section 4(d) take limit has been established for routine road maintenance activities or improvement projects within the scope of the 5C Program's road maintenance manual. Additionally, most road projects and management activities that may affect coho and chinook salmon and steelhead trout are currently addressed under Section 7 of the ESA either through the Federal Highway Administration, Federal Aviation Administration, U.S. Forest Service, Bureau of Land Management, or the U.S. Army Corp of Engineers.

F. California Endangered Species Act

On February 25, 2004 the California Fish and Game Commission determined that coho salmon from Punta Gorda north to the Oregon border should be listed as a state Threatened species. Also in February 2004, the CA Fish and Game Commission adopted “The Recovery Strategy for California Coho Salmon; Report to the California Fish and Game Commission” which contains recommendations for the recovery of coho populations proposed for listing. Many of its range-wide and watershed specific recommendations identify sediment delivery from roads and other sources as having a significant impact on habitat quality. It includes region-wide recommendations to implement the DIRT road erosion inventory and subsequent sediment reduction projects (e.g., RW-VI-A-02, RW-VI-D-01) as follows:

> *RW-VI-A-02 Identify and prioritize specific sediment source locations for treatment that may deliver sediment to coho salmon streams. Encourage the use of protocols, such as the California Stream Habitat Restoration Manual Guidelines. Work with others to educate and provide technical assistance to landowners to implement upgrades.*
>
> *RW-VI-B-02 Continue to fund and provide technical support to local government and private landowner actions to reduce identified sediment input from upslope sources. Basin-wide assessments should prioritize remediation activities, which would include slope stabilization and minimizing sediment production.*
>
> *RW-VI-D-01 Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems. Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses. Support activities to:*
>
> > *a. Reduce road densities where necessary and appropriate;*
> > *b. Upgrade roads and road-maintenance practices to eliminate or reduce the potential for concentrating run-off to streams during rainfall events. Employ best available technology when appropriate;*
> > *c. Encourage measures to reduce sediment delivery from unpaved roads;*
> > *d. Decrease potential for streamflow to become diverted at road crossings during high flow events, resulting in flow along the road that returns tothe channel at undesirable locations;*
> > *e. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams;*
> > *f. Minimize alteration of natural hill slope drainage patterns; and*
> > *g. Encourage funding authorities to allocate adequate budgets to Federal,State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for fish passage projects.*
>
> *SA-HA-01 With the goal of reducing sediment and providing coho salmon passage at all life history stages where roads affect coho salmon habitat:*
>
> > *a. Implement Forest Roads Analysis, private and county roads assessment recommendations;*
> > *b. Complete road sediment source inventory on all roads within the Salmon River HSA; and*
> > *c. Correct identified passage barriers on all roads.*

SS-HA-02 Support actions to reduce human-caused sediment input from upslope sources identified through public and private inventories. Prioritize remediation activities, which would include slope stabilization, minimizing sediment production, and eliminating coho salmon passage barriers.

Additionally, the inventory and resulting data will help Siskiyou County and the 5C Program to address the following high priority tasks in the Scott River hydrologic area of Scott Bar and Scott Valley as outlined in the *Recovery Strategy for California Coho Salmon* (DFG 2004):

- Task # SS-HA-02; Improvement of spawning habitat by reducing human-caused sediment input from upslope sources identified through public and private inventories.
- Task #SS-HA-03; Prioritizing and implementing remediation activities for human-caused sediment, which would include slope stabilization, minimizing sediment production and eliminating barriers to coho salmon.
- Task #SS-HA-05; Continue road and or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.
- Task #SS-HA-07; Decrease the potential for stream flow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.

Table 4: Federal and State Endangered Species Act- Status of Listings of Salmon & Steelhead in the Inventory Region (updated October 2006)

Species / ESU	Listing Status	ESU Area
Coho Salmon		
So. Oregon / No. California ESU	*Federal & State Threatened	Elk River, OR to Mattole River / Klamath & Trinity Basins
Chinook Salmon		
Upper Klamath-Trinity Rivers ESU	Not Listed	Oregon border south through the South Fork Trinity River
Steelhead		
Klamath Mtns. Province	Not listed	Cape Blanco, OR to South Fork Trinity Basin
Green Sturgeon		
Klamath Mtn. Province	Federally Threatened	Klamath & Trinity Rivers

*The Fish and Game Commission determined that the Coho from Punta Gorda to the Oregon border should be listed as Threatened February 25, 2004. As part of the normal listing process, this determination is currently under review by the Office of Administrative Law.

V. Inventory and Data Management Methodologies

Erosion Source Inventory

The methodology used in all inventories is based on the protocols for forest and ranch road inventories set forth by Pacific Watershed Associates (PWA) that were modified to reflect the differences between private and public roads (see Table 5 below).

Table 5: Comparison of County and Private Roads

County Roads	Private Forest and Ranch Roads
Public safety and access are the highest priority. *Work based on the greatest population/safety needs.*	**Resource access often the priority:** *Road closure typically does not impact public access or safety.*
Provide primary access to nearly all other roads *(i.e. driveways/private roads, timber roads, highways). This means constant maintenance costs for all roads.*	**Roads primarily have limited uses.** *Maintenance can be done 'as needed' and grading, patching, etc. may not be needed as often.*
Must meet minimum design speed and *provide safe travel for the 'average' skilled motorist based on that design speed.*	**Speed & Skill not a mandatory design criteria** *and treatments do not have to meet specific design speed for the 'average' skilled motorists.*
Must be open in all weather.	**Often closed to winter or wet weather.**
Counties have full time staff and equipment *to treat problems during a storm event.*	**Often do not monitor winter storm effects but** *assess road conditions in the spring or under favorable circumstances.*
Financial accountability to the public: *Requires Gas Tax funds be used for safety, CIP, and maintenance. Maintenance costs are based on use (not on cost/benefit ratio).*	**Financial accountability to resource costs and** *benefits only: Can remove or not repair a road if costs exceed benefits.*
Inventory tens of thousands of sites: *This effort encompasses hundreds of watersheds and multiple counties.*	**Inventory hundreds of sites:** *Typical inventory may reach 200-300 sites in a single watershed for a single ownership.*
Treatment designs must be done or *approved by a Registered Engineer.*	**Implementation work can often be done by** *landowner without formal engineer review.*

Based on these factors the PWA protocol was modified as follows:

Inventory Methods:

- Stream crossing surveys were modified to use a single profile of the crossing and road cross section measurements. Based on the type of crossing, appropriate trigonometric and volumetric calculations were done in the inventory software. Site data using this method was compared to similar crossing types and volume measured using original, unmodified PWA protocols. The results were significantly similar (±95%). At all county sites with significant fill depth or complexity, a detailed survey with elevation controls will be completed by engineering staff as part of the treatment implementation project design.

- The 100 year flood flow calculation, done automatically in a field data sheet, CulvQ, for watersheds <100 acres, allows for immediate estimation of culvert flow capacity and the volume of water that would be displaced/diverted if the crossing were undersized. For watersheds greater than 100 acres, the Waananen Crippen method was used. Significant limitations with these calculations may occur and sizing of culvert crossing should be reviewed by County engineers as needed. Refer to discussion under Section VI D: Prescribed Treatments for more information.

<u>Treatment Options:</u>

- Inventory crews were instructed to use treatment protocols such as outsloping roads and installing rolling and critical dips where they could be safely applied under the worst weather conditions (typically snow or ice) and based on the posted speed limit for the road. Where there are no posted speed limits on native or rock surfaced roads, the design speed was assumed to be 25 miles per hour. These safety considerations limited the use of certain treatments that would be appropriate for private ranch and forest roads. The 5C Program has developed a Low Impact to Hydrology road standard to guide the use of rolling and critical dips as well as outsloping (refer to Appendix I).
- Where the use of treatment protocols such as cross drains, ditch relief culverts, and other drainage treatments (which return water to Class III drainages of origin) were recommended, inventory crews were instructed to indicate where downslope landowner permission was anticipated. Crews noted instances where the County would have to work with landowners towards any recommended treatment. In some areas the original watercourses have been eliminated by irrigation drainages and in a few areas rural/urban development where reintroduction of water would cause flood damage. For most forest and ranch road inventories, the primary landowner typically owns the downslope drainages, which can often accommodate the natural storm flows. In cases where treatment of erosion sources could not occur within the road right of way, the crews indicated the volume of those sources as “Untreated Erosion” on the treatment tab and described them.
- To the extent possible, inventory crews prescribed treatments to address the various types of erosion sources observed. However, there are many instances in which the inventory crews called for an engineer to verify and/or prescribe treatments for more complex sites. This is especially true when the crews were recommending the upgrade of stream crossings that drain large watersheds or recommending treatment of landslides.

<u>Treatment Costs:</u>

- Previous inventories included estimates of the sediment cost savings (cost of treatments as compared to total yield estimated to be treated) as part of the analysis for each inventory report. However, it is important to note that cost is not and has never been considered until after the data has been collected and the initial data analysis. For this current inventory, cost savings estimates as part of the data analysis have not been generated for various reasons (e.g., rapidly changing price of fuel, equipment rates, materials). In reality, each County’s road department analyzes cost during project development and/or prioritization. Standard costs for each treatment are based on county costs and mandatory wage requirements for contract labor. Counties maintain equipment yards and storage facilities and can purchase materials in bulk, which allows for some standardization of costs.

The final county roads inventory protocol, known as the Direct Inventory of Roads and Treatments (DIRT), was then converted to a Microsoft Access database by the 5C Program with assistance from Pacific Watershed Associates (PWA), which was used in the field to directly input data from each site. The DIRT database has continually been upgraded and improved to better reflect usability and site accuracy. Four versions were used in past inventories. For this inventory, a further upgraded version was developed (2.1) that is compatible with prior versions and contains more information and more accurately captures potential volumes from fillslope landslides (refer to Appendix C). The database form used by inventory crews for data entry are also included as hard copy printouts in Appendix D.

According to the DIRT methodology, sites include locations where there is direct evidence that future erosion or mass wasting would likely deliver sediment to a stream channel over a ten year period in amounts greater than or equal to 20yd^3. However, with the 2.1 database version, a field entitled "<20cyd Volume Tx Cluster Site?" was included to indicate sites that by themselves would not qualify as a site because of the 20 yd^3 rule, but which are located in close proximity to other sites, were thought to divert and converge with each other during storm events, and together as a group contribute the equivalent of a single, traditional ≥ 20yd^3 site. Those stream crossings without a culvert or with an undersized culvert are calculated to fail at some point. However, all stream crossings and ditch relief culverts, regardless of total potential volume, are recorded into the culvert log that is recorded during the inventory. Past erosion sites and sites that were not expected to deliver sediment to a stream channel were not included in the inventory. Inventoried sites generally consist of stream crossings, potential and existing road related landslides, ditch relief culverts and long sections of uncontrolled road and ditch surface runoff which discharge to the stream system. The type of site is determined by the feature at the point of delivery to a stream (where the sediment leaves the road to enter the stream). For example, a landslide that goes into a ditch and enters the stream from the road system at a stream crossing would be classified as a stream crossing, not a landslide. However, erosion from that landslide would be quantified and captured in the landslide tab of that crossing site, and commented on in the General Comments section.

Field crews, trained by PWA, identify and enter data on each site into the database. The database contains questions about the location, the nature and magnitude of existing and potential erosion problems, the likelihood of erosion or slope failure, and recommended treatments to eliminate the site as a significant future source of sediment delivery (refer to Appendix D for a hard copy of the database forms and Appendix C for an electronic copy of the database). On virtually all stream crossings, tape and/or electronic distance measurers and clinometers were used to complete longitudinal profile surveys. The database generates the fill volume of crossings in the field for immediate review. This survey allows for an accurate and repeatable quantification of future erosion volumes (assuming the stream crossing failure during a future storm) and of excavation volumes that would be required to complete a variety of road upgrading and erosion prevention treatments (culvert replacement, complete excavation, etc.). CulvQ, a program developed by Redwood National and State Parks that produces hydraulic culvert sizing recommendations based on either the Waananen Crippen or Rational methods, was used for stream crossing culvert replacement/installation treatment prescriptions. For crossings where the upstream watershed area was less than 100 acres in size, the Rational Method formula, Q=CIA, was used while empirical formulas developed by Waananen & Crippen for California were used for larger watersheds within the CulvQ program.

A runoff coefficient of 0.45 was applied in all instances for calculating flows at crossings, regardless of the actual upslope land conditions. For most of the inventoried crossings, a 0.45 coefficient is a reasonable approximation of the watershed condition. In some instances, however, the actual coefficient may by 50% higher or lower than the value used (e.g. the eastside Scott Valley watershed, Duzel Creek, has extensive bedrock, shallow soils and rapid runoff and would have a higher coefficient than deeper soils in the Etna Creek watershed). Once the flow was calculated, a culvert diameter capable of passing the 100-year flow through the crossing was included in the treatment section of the database. For very large watersheds, the surveyor recommended that the replacement culvert size be calculated by a Registered Engineer.

For this inventory, an additional factor was captured in the database by the field crews that is referred to as "Extraordinary Fill Failure Potential." Sites thought to have Extraordinary Fill Failure Potential typically occur when a stream crossing or ditch is thought to have a high likelihood of plugging such that water may divert out of its natural channel and travel downslope, often over the outboard fill of a road. The diversion may trigger a debris slide or saturate a large fill and cause it to fail. The factors that are considered when evaluating whether a ditch may divert include the likelihood of rocks or other debris falling from above into the ditch or the accumulation of branches or twigs plugging a ditch segment. One factor that these sites seemingly have in common is past failure with evidence of that failure readily present and observable. During this inventory, "extraordinary" sites that were thought to have the potential to yield 1,000 yd^3 or more were noted. A total of 19 sites on the following roads were observed: Sawyers Bar, Cecilville, East Moffett Creek, and Duzel Creek. Given the steep gradients, erodible soils and high diversion potential of ditches and streams on these roads it is anticipated that significant additional erosion will occur on these roads during future storm events. All together, these 19 sites are estimated to potentially yield ~46,134 yd^3 of total sediment over a ten year period, which represents just over eight percent of the total potential volume from treatment sites captured in this inventory. It should be noted that all but one of these sites (with a total potential sediment yield of 42 yd^3) are within the Scott River watershed.

Sawyer's Bar Road (Etna Creek watershed) blew out in the 05/06 winter storms.

Field crews also assigned each site with a treatment priority, referred to as treatment immediacy. This was assigned based on the potential for delivery of deleterious quantities of sediment to stream channels in the watershed. Major factors considered in the field based evaluation include overall site condition, erosion activity, and total potential sediment yield. Sites where the crews believed there was a high likelihood of the road blowing out if left untreated were classified with an Urgent treatment immediacy. Estimates of future expected volume of sediment delivered to streams calculated for each site provide quantitative estimates of how much material could be eroded and delivered if no erosion control or prevention work is performed. Potential sediment yield estimates are a function of both episodic (generated during large storms or landslides) and chronic decadal sediment delivery (continual erosion). In a number of locations, especially at stream diversion sites, actual sediment loss could easily exceed field predictions. These volumes represent the total volume of sediment that could potentially be delivered to a stream over a ten year period.

All inventory sites were located using map coordinates and GPS points to allow them to be loaded into an ArcView GIS platform. PWA completed an intensive field-training program for all crew members and conducted quality assurance and control (QA/QC) of inventory crews and assessments.

Spoils Site Inventory

The protocol used to identify ideal spoils disposal sites was also obtained from PWA. Suitable sites should be located such that they will not deliver sediment to a stream and are easily accessible. Potential locations are evaluated for any limitations such as: possible presence of archeological resources, current use, location within the flood plain, steep ground slopes (>10%), and nearby waterbodies (springs, wetlands), and conditions that would make winter access difficult. Locations are usually within the road right-of-way. However, because suitable sites are relatively uncommon relative to the disposal need, appropriate sites observed even outside of the right-of-way are recorded so that the local department of transportation may pursue permission to use them if they desire. Recorded along with location are the estimated total capacity and area of the site, whether it may be used for permanent, temporary, or only emergency storage (available term), and any limitations or other considerations. The field crew assigns an overall suitability rating based on all of these factors. Local departments of transportation may then follow-up on the list of potential sites by further evaluating them for potential conflicts with cultural or environmental resources.

Data Management

The data management started in the field. With the newest database version used, checks in the form of queries were set up to allow crews to check data for errors in the field. These checks were designed to catch data entry errors and missing data. They were used approximately once a week, depending on the amount of data collected over any given period. The database manager also ran a series of additional queries with every progress report that were designed to check for possible errors in the assigned treatment immediacy or other prioritizations. For example, a site with large potential delivery volume, high erosion potential, but low immediacy would be reviewed. The database manager would review these sites and go over them with the field crews. If it was determined that there was a data entry error, for example clicking on the wrong immediacy, it would be corrected. As a result, this dataset did not require much cleanup at the end, as it was already performed as part of the inventory process. All sites were imported into GIS to allow for the production of maps and to facilitate any future prioritization needs. Final data management as part of this inventory consists of initial prioritization of sites as explained in section VIII, Treatment Prioritization below and shown in Appendix F, list 1.

VI. Erosion Source Inventory Results

A. Summary of Sites

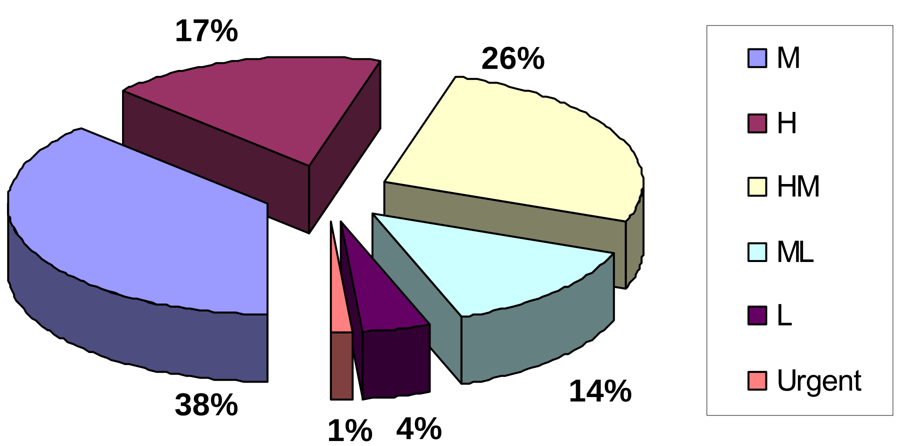
In this inventory, 342 miles were surveyed with 1,056 total sites recorded, including erosion sources with the potential to deliver sediment to streams and potential spoils disposal sites. Of these sites, 1,034 are recommended for treatment and are estimated to yield 556,780 yd^3 of total sediment to streams within a ten-year period. Seventeen of the sites are potential spoils sites with 559,131 yd^3 total estimated storage capacity. All treatment sites are summarized below by immediacy with total potential volumes.

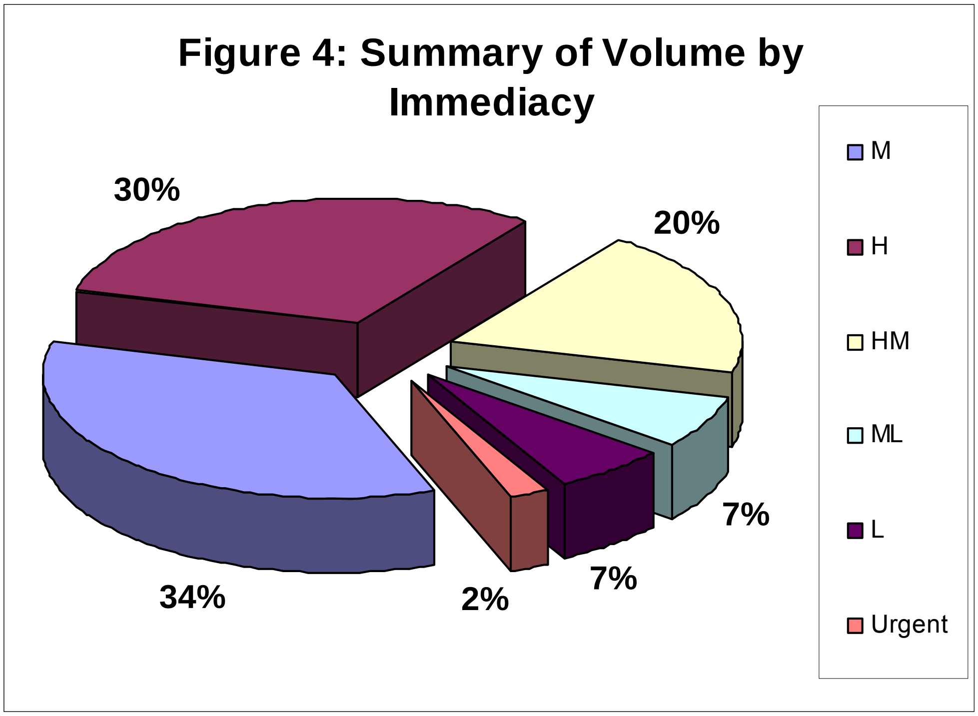
Given that a total 342 miles of road was inventoried, there is an average of 3 potential erosion sites per mile of county road with each site averaging 538 yd^3 of sediment delivery to a stream. In actuality, the potential volume per site and site locations are a factor of slope location, inherent geologic stability, soil erosion potential, the age of the road, road construction techniques, and numerous other factors. For example, some roads in more developed urban areas had very few or even no sites with a potential for sediment delivery to streams. Basic information on individual sites recommended for treatment is found in Appendix E.

Table 6: Summary of Sites by Treatment Immediacy

Treatment Immediacy		Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Urgent		14	11,632	2.1%
H	High	178	169,881	30.5%
HM	High-Moderate	273	109,117	19.6%
M	Moderate	385	192,901	34.6%
ML	Moderate-Low	140	36,725	6.6%
L	Low	44	36,526	6.6%
Total		**1,034**	**556,780**	**100%**

Figure 3: Number of Sites by Immediacy





B. Summary of Volumes by Type of Erosion Source

Summaries of the types and quantities of erosion produced and estimated to deliver to a stream are shown below. Chronic erosion occurs annually with the passing of even minor storms, while crossing and landslide volumes are typically episodic in nature (i.e. strongly associated with storm intensity).

Table 7: Summary of Volume by Type

Type of Sediment Source	Total Delivery Volume (yd3)	% of Total Volume
Chronic Decadal	149,204	26.8%
Landslide	126,183	22.7%
Stream Crossing	281,393	50.5%
Total Volume	**556,780**	**100%**

Chronic Erosion

Chronic erosion is what constantly erodes, mostly from cutbanks, ditches, and the road surface, and is analyzed over a ten year period. It is a result of a number of types of erosion sources continually yielding sediment to streams. The types of erosion sources within this category include: ditch down-cutting/enlargement and associated cutbank slumps; diversion of ditches down roads or over hill slopes; road surface erosion (mechanical pulverizing and wearing down of the road surface); gully formation or enlargement at the outlets of ditch relief culverts; berms or other points of discharge; cutslope erosion (dry ravel, rainfall, freeze-thaw processes, brushing/grading practices, etc); and other minor sources of sediment. This inventory estimates that at least 149,204 yd^3 of sediment will be delivered to streams over a period of ten years from chronic sources.

The predominant road shape (i.e., crowned, insloped, outsloped) along the entire length of a site is indicated for each record contained in the inventory. Based on this information, the relative percentage of each road shape for all records is:

- 41.3% crowned*;
- 28.4% outsloped; and
- 30.3% insloped.

It should be noted that this information reflects all 1,056 records and not just the 1,034 recommended treatment sites. *Additionally, where there were both insloped and outsloped sections in roughly equal amounts for any site, the predominant road shape was categorized as crowned.

Stream Crossing Erosion

Stream crossing volumes are those resulting from the failure of the crossing that is estimated to occur during the 100 year storm event. They represent the greatest potential source of sediment delivery in the watersheds inventoried. The most common causes for stream failures include undersized and/or improperly placed culverts, high culvert plug potential, high diversion potential, and/or gully erosion at the outlet. The sediment delivery from stream crossings is always classified as 100% of the amount eroded because sediment produced at the site is delivered directly to the stream. Even sediment that is delivered to small ephemeral streams will eventually be delivered to downstream fish-bearing stream channels. A summary of stream crossing sites is found in section C, Summary of Site Types, below.

In addition, 104 undersized stream crossings were found to have no diversion potential out of the crossing and down the road. In these locations a culvert or stream crossing will fail in place rather than divert down the road. 75% of the undersized crossings without diversion potential also act as critical dips in the way that they convey water. An actual critical dip is designed to allow the water to overflow the road but is usually rock armored to protect the road fill.

Landslide Erosion

Erosion occurring from landslides is what is estimated to occur during a failure of the fill, cutbank, hillslope, etc. The most common forms of landslides on County roads are related to fill slope and cutbank failures. Cutbank and fillslope failures tend to fail in the same places and are rapidly removed by road maintenance crews. Hillslope landslide sites are large, complex, and are typically deep-seated earthflows, debris torrents, or colluvial filled hollows that cannot be treated with a series of standardized treatments. Some of these sites are naturally unstable slopes or are caused by stream undercutting of the toe slopes. Others are the result of road construction or road drainage that has contributed to overall slope instability. Many of these features have already delivered the majority of the stored sediment in past failures and now represent chronic surface erosion sources. While these large features represent a small number of sites, they potentially contain a significant volume of sediment. At these sites, engineering and geologic designs are necessary to determine appropriate treatments. Natural landslides unrelated to the road are not included in the inventory, as they lie outside of the scope of road related erosion sources.

The relative amounts of different erosion types captured in this inventory as shown in Table 7 above is consistent with past inventories in that the majority of the total potential erosion volume is attributed to episodic sources, stream crossings in particular. However, the volume attributed to landslides is much higher in this inventory than in past inventories of comparable mileage. This is due to a number of factors including:

- since the initial inventories, DIRT crews have gained more experience as well as more targeted training in recognizing landslides and capturing associated volumes;
- the nature of the geology, topography, fire history, road location, and other factors within the inventory area.

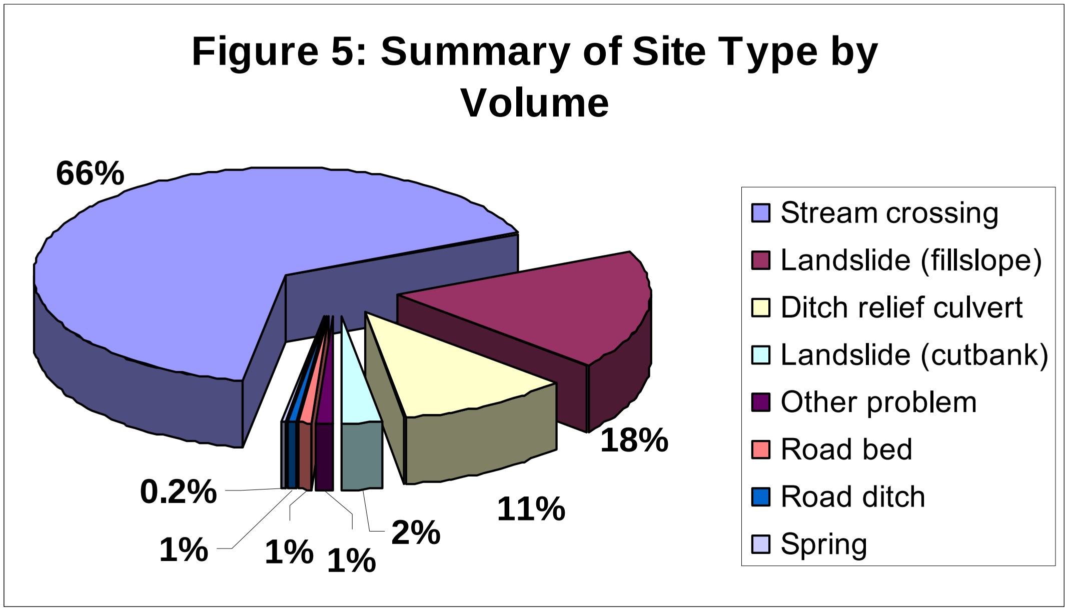
C. Summary of Site Types

Each site is classified by the type of erosion source and physical structure where the sediment is being generated and/or delivered. The following table summarizes the types of sites with the total potential delivery volumes for each type. There are different kinds of stream crossings, those with structures – culverts, bridges, humboldts – and those with no structures, referred to as fill crossings. All crossings are combined into a single site type.

Table 8: Summary of Treatment Sites by Type with Volume

Site Type	Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Ditch relief culvert	398	62,091	11.2%
Landslide* (cutbank)	3	13,860	2.5%
Landslide* (fillslope)	12	99,160	17.8%
Other problem	3	6,197	1.1%
Road bed	13	4,297	0.8%
Road ditch	18	3,705	0.7%
Spring	4	1,050	0.2%
Stream crossing	583	366,420	65.8%
Total	**1,034**	**556,780**	**100%**

* This table does not encompass all landslides. Natural landslides unrelated to the road are not included in the inventory.



As mentioned above, stream crossing sites are the most predominant site type and also yield the most sediment to streams. A total of 583 stream crossing sites were inventoried and recommended for treatment. They could potentially generate a total of approximately 366,420 yd^3 of future road related sediment, approximately 66% of the total volume produced by all treatment sites. Each county has a full complement of staff and equipment that patrol County roads during storm and flood events. These crews regularly clean culverts and remove debris during high flows. While this is an effective short-term practice, the potential of culverts to plug remains. A washed-out stream crossing not only results in adverse impacts to fish and water quality, but can preclude access to other stream crossings on roads behind the plugged culvert. As a result of the inventory, the condition of existing culverted stream crossings was evaluated and priority problem sites located. This evaluation will be particularly beneficial for the identification of culverts installed following the 1964 flood. Many of these culverts are nearing the end of their effective lives and will require replacement or repair over the next 5-10 years. This inventory will help to prevent future culvert failure. The following table summarizes the number of stream crossings by immediacy.

Table 9: Stream Crossing Sites by Immediacy

Treatment Immediacy	Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Urgent	10	9,948	2.7%
H	99	59,962	16.4%
HM	148	84,156	23.0%
M	227	146,207	39.9%
ML	76	31,469	8.6%
L	23	34,677	9.5%
Total	**583**	**366,420**	**100%**

Ditch relief culverts are the second most predominant type of site. There are a total of 398 sites that have the potential to deliver 62,091 yd^3 of sediment to streams. Although they far outnumber landslides, the total potential delivery volume from landslides is nearly twice that of ditch relief culverts (see below). This is apparent when you consider that on average, each ditch relief culvert can potentially deliver 156 yd^3 of sediment to streams while the landslides captured here on average can potentially deliver over 7,500 yd^3 over the same period.

Table 10: Ditch Relief Culvert Sites by Immediacy

Treatment Immediacy	Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Urgent	4	1,684	2.7%
H	66	18,488	29.8%
HM	116	18,841	30.3%
M	137	17,069	27.5%
ML	55	4,390	7.1%
L	20	1,620	2.6%
Total	**398**	**62,091**	**100%**

Landslides, while relatively few in number, contribute significantly to the total potential sediment delivery identified in the inventory. Fifteen landslide site types were recorded on only eight roads with a total potential sediment delivery volume of 113,019 yd^3 (shown in order of decreasing magnitude of total potential delivery volume): Cecilville Road, Scott River Road, Salmon River Road, Sawyers Bar Road, East Moffett Creek Road, Caribou Road, and Scarface Road.

Table 11: Landslide Sites by Immediacy

Treatment Immediacy	Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
H	9	86,782	76.8%
HM	2	1,074	1.0%
M	4	25,163	22.3%
Total	**15**	**113,020**	**100%**

It should be noted that there are other site types (e.g., stream crossings) that have potential associated landslide erosion (13,163 yd^3), which would bring the total potential sediment delivery volume from all landslide sources to 126,183 yd^3.

D. Prescribed Treatments

As described in the methodology above, crews are trained to prescribe treatments for each site. They draw from a large palette of treatments to treat the various sources and types of erosion. Typical treatments for chronic erosion can include outsloping road sections (where safe and suitable) and filling ditches, removing berm, installing rolling dips, installing ditch relief culverts (DRCs), installing downspouts on existing DRCs, surfacing native roads (rocking, paving), and armoring cutbank or fill faces. Treatments for stream crossing sites can include installing and/or upgrading undersized or deteriorated culverts, installing and/or upgrading emergency overflows, culvert maintenance, installing flared inlets and/or downspouts on existing culverts, installing critical dips to catch overflow and prevent diversion during storms, and installing wet crossings where a culvert cannot or should not be practically installed.

Prescribed treatments and relevant assessments provide a guide for and assist in estimating the costs and complexity of a site. In many instances the prescribed treatment is the most appropriate for a site. In other instances the actual treatment(s) may be different than the prescribed treatment(s) based on more precise site information. Even in these instances, the prescribed treatment(s) is a good starting point because it conveys one method on how the sediment source may be addressed. The DIRT methodology includes a subjective rating for how effective the inventory crews estimate that the prescribed treatments will be in managing sediment sources at each site. This rating is captured on the database Treatment Tab in a field called "Controllability." Approximately 79% of the 1,034 treatment sites have either a High or High Moderate Controllability. Sites with lower controllability tend to be complex in nature (e.g., landslides) or have physical site conditions that restrict the feasibility of treatments.

Limitations associated with culvert sizing recommendations used in the inventory are important to understand. These limitations include: the application of a single runoff coefficient for calculating storm flow (refer to discussion under Section V Inventory and Data Management Methodologies); the use of local rainfall nomographs for calculating rainfall intensity; and models used for determining flow (Rational Method and/or Waananen Crippen) and hydraulics (CulvQ) may under estimate culvert capacity and over estimate culvert size especially in small (<100 acre) watersheds when compared to the Army Corps of Engineers' HY-8 Hydraulic model.

Rainfall intensity is highly variable within these watersheds. As noted in Section IV, elevations range from 500 feet at the mouth of the Salmon River and 700 feet at the mouth of the Scott River to over 9,000 at Thompson Peak and Mt. Eddy, the highest points in the respective watersheds. In addition the orographic effect of the mountain ranges has a significant effect on storm flows. On the east side of the Scott Valley, channel forming flows may be associated with short duration summer thunderstorms more than from larger winter storms. Thunderstorms may produce 500 year peak flows for only a few minutes in a small area, but these storms can result in much of the road erosion in these watersheds. Conversely, relatively small warm rainstorms (10 year to 25 year storms for example) that occur on a large snow pack, known as "pineapple expresses" can result in flows equivalent to a 100 year rain storm or more. For these and other reasons, site specific rainfall assumptions may be applied to calculate the hydrology and hydraulics of a site after the inventory.

An exception to the sizing standards of this inventory was used for ditch relief culverts above approximately 3,000' elevation. In these areas, the Siskiyou DPW already installs oversized pipes to address the effects of freezing of water in culverts in the winter and the increased flows of snow melt. For high elevation sites (at 3,000 ft or above, whose average watershed elevation is much higher), the crews prescribed larger diameter pipes for the same reasons. There is a field in the database called “Unusual Watershed Conditions” that contains various types of information, including whether it is a high elevation site. The treatment tab and comments would also indicate relevant information.

Some less common or unique treatments are not listed as discreet, quantified treatments, but are instead described narratively on the treatment tab. In these instances, review of the site’s Treatment Comments is required to determine the complete treatment recommendation. Additional helpful information for these sites may also be found in the General Tab Comments or comment box in the Crossings and Channels tab.

A summary of treatments prescribed in this inventory is shown on the following page.

Table 12: Treatments by Immediacy

Treatment	%Urgent	%H	%HM	%M	%ML	%L	Units	Total
Number of Sites	1.4%	17.2%	26.4%	37.2%	13.5%	4.3%	#	1,034
Clean or cut ditch length	0.0%	18.6%	45.9%	25.4%	8.5%	1.6%	ft	23,785
Outslope & retain ditch length	0.0%	10.6%	42.1%	42.0%	5.3%	0.0%	ft	7,566
Outslope & fill ditch length	1.5%	9.6%	30.2%	53.7%	5.1%	0.0%	ft	50,573
Install rolling dips	1.7%	8.3%	49.7%	29.8%	10.5%	0.0%	#	181
Remove berm length	1.6%	13.9%	31.8%	40.7%	12.0%	0.0%	ft	49,641
Breach berm	0.0%	27.6%	11.0%	61.4%	0.0%	0.0%	#	290
Volume berm to remove	2.3%	13.2%	36.3%	39.0%	9.1%	0.0%	yd3	2,439
Fill ditch length	0.0%	9.3%	25.1%	63.1%	2.5%	0.0%	ft	15,941
Pave road length	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	ft	6,277
Rock road length	0.0%	13.2%	24.7%	62.2%	0.0%	0.0%	ft	13,723
Pave or rock surface area	0.0%	7.3%	52.2%	40.5%	0.0%	0.0%	ft2	370,370
Install ditch relief culverts (DRC)	1.5%	20.5%	32.8%	33.7%	8.1%	3.3%	#	332
Install DRC length	1.7%	22.9%	29.2%	34.7%	8.2%	3.3%	ft	16,460
Replace DRC length	1.9%	24.1%	38.5%	26.8%	7.0%	1.6%	ft	11,486
Install downspouts	1.7%	24.1%	40.5%	25.9%	7.8%	0.0%	#	116
Downspout length	2.2%	29.9%	44.2%	17.8%	5.9%	0.0%	ft	5,403
Culvert Treatment								
Install Culvert	3.0%	24.2%	27.3%	36.4%	6.1%	3.0%	#	33
Install Emergency Overflow (EOF)	0.0%	6.8%	18.2%	50.0%	18.2%	6.8%	#	44
Replace Culvert	1.5%	17.8%	26.7%	37.5%	13.0%	3.5%	#	461
Replace Culvert & Install EOF	0.0%	50.0%	25.0%	25.0%	0.0%	0.0%	#	4
Replace EOF	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	#	1
Length of Culvert to Install/Replace	2.4%	17.9%	27.8%	36.9%	11.7%	3.4%	ft	28,288
EOF length	0.0%	11.3%	21.4%	41.0%	19.1%	7.2%	ft	3,460
DRC Culvert Maintenance								
Clean	0.0%	15.5%	25.2%	35.0%	18.4%	5.8%	#	103
Clean & Repair	4.0%	24.0%	20.0%	32.0%	20.0%	0.0%	#	25
Repair	0.0%	21.4%	7.1%	50.0%	7.1%	14.3%	#	14
Culvert Maintenance								
Clean	0.0%	12.5%	25.0%	45.0%	15.0%	2.5%	#	40
Clean & Repair	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	#	2
Repair	0.0%	50.0%	0.0%	50.0%	0.0%	0.0%	#	2
Install crossing downspouts	3.2%	16.1%	29.0%	35.5%	11.3%	4.8%	#	62
Crossing downspout length	1.4%	14.7%	28.9%	39.2%	12.0%	3.8%	ft	4,175
Install critical dip	4.1%	16.4%	39.3%	32.0%	6.6%	1.6%	#	122
Install armored ford	0.0%	0.0%	33.3%	50.0%	16.7%	0.0%	#	12
Armor area	5.0%	27.6%	33.4%	28.8%	4.8%	0.5%	ft2	267,261
Volume of fill to reconstruct	0.0%	0.0%	0.0%	99.2%	0.8%	0.0%	yd3	373
Volume of soil to excavate	7.4%	22.9%	33.0%	35.5%	1.1%	0.1%	yd3	14,407
Other Treatment								
Inslope Road	12.5%	50.0%	37.5%	0.0%	0.0%	0.0%	#	8
Install Cross Road Drain	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	#	2
Install Drop Inlet	1.7%	26.7%	32.5%	29.2%	8.3%	1.7%	#	120
Install Natural Bottom	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	#	2
Extra treatment	2.3%	24.2%	29.7%	30.6%	10.0%	3.2%	#	219
Engineer must verify recommended treatments	3.9%	32.2%	25.0%	31.6%	5.3%	2.0%	#	152
Requires treatment of nearby site(s)	1.2%	30.0%	32.0%	31.2%	3.6%	2.0%	#	247
Decadal Erosion Volume	2.4%	27.1%	30.5%	31.2%	6.5%	2.2%	yd^3	149,204
Crossing Volume Total	2.8%	12.9%	19.9%	43.1%	9.6%	11.8%	yd^3	281,393
Landslide Volume Total	0.0%	73.9%	6.1%	19.9%	0.0%	0.0%	yd^3	126,183
Total Erosion Volume	2.1%	30.5%	19.6%	34.6%	6.6%	6.6%	yd^3	566,780

VII. Treatment Costs

In past inventory reports, Treatment Costs have been estimated to convey an idea of the resources that would be required to implement the majority of DIRT prescribed treatments and the resulting cost per cubic yard of sediment savings. However, due to the highly variable nature of rates for equipment (e.g., fuel), materials, labor, etc that tend to change based on geographic location (e.g., cost of transportation), this type of cost summary has been omitted from this inventory report. In any case, not all costs are captured as there are sites with treatments whose price could not be easily estimated while other sites require engineer review before treatments can be determined. Also, during the development of any implementation project, all treatments prescribed are reviewed with the Departments of Transportation and Public Works. Often, it is necessary to modify treatments to allow for practical, cost effective treatment of a site. For example, it may not be feasible to install a ditch relief culvert because of downslope landowner concerns about discharge. Alternative, more practical solutions are developed when prescribed treatments are not viable. However, these are not known until individual implementation projects are developed.

The average total estimated cost to treat all sites in past inventories has varied from $13 to $29 per cubic yard of sediment treated. This amount does not include all treatments necessary to fix the sites but only those treatments prescribed during the inventory whose costs could be easily quantified. If an average of cost per cubic yard from past inventories is used to project a ballpark total cost of prescribed treatments based on the total volume captured in this inventory, then the total would be approximately $10 million. Because of inflation, the skyrocketing price of fuel, and the fact that unusual treatments that are not easily quantified on the scale of the inventories have never been captured, this estimate is likely very low.

VIII. Treatment Prioritization Methodology

One of the goals of the 5C Program is to find practical, economical ways to achieve watershed and biological restoration. The approach used for prioritizing implementation projects is to apply a systematic process based on both regional ecosystem and management considerations. This has significantly reduced inter-county competition for funding sources and has resulted in multi-county cooperation and the application of better biological and watershed science to funding opportunities.

Prioritization of DIRT inventory sites begins in the field with assignment of a site's treatment Immediacy based on: a) the probability of future erosion based on the age and nature of direct physical indicators; b) evidence of current or pending instability or erosion (Erosion Potential); and b) the total potential erosion volume. It is a professional evaluation of the likelihood that a significant amount of erosion will be delivered to a stream during a future storm event. These are described in subsection 1 below.

These field factors are also considered during subsequent prioritization steps. Prioritization after the initial field phase very much depends on the purpose and need for ranking sites. For example, most prioritization is done in the development of grant proposals to implement DIRT treatments. Often in these cases, the available funding targets specific watersheds or areas. Therefore, prioritizing sites naturally begins with narrowing the dataset to sites within those specific areas. However, there are factors and criteria which always weigh into any prioritization, at varying stages and to different degrees. For example, if certain road segments are scheduled to be paved as part of a road department's capital improvement project, then those sites would probably be of a higher priority to implement DIRT types of treatments in order to maximize cost effectiveness and efficiency. How these factors, listed below, are brought together with DIRT factors is further explained in subsection 1.

- Cost:
  The total cost and cost/yd^3 are large factors that help determine the feasibility of treatments. Higher immediacy sites with high costs are more closely evaluated to determine whether more practical alternative treatments can be implemented. These are determined by the county road department after the inventory based on the actual final treatments and current, local costs.
- Biological and Regulatory Factors:
  As described in section IV Project Area Description above, there are many rules and plans that govern policies and regulations affecting water quality and wildlife populations within the inventory area. Priority is given to sites that deliver to streams with listed species or TMDL plans or sites that impede salmonid migration.

- Management Factors:
  This addresses a variety of factors related to cost, scheduling, and design. The following concerns must be addressed for each proposed project:
  - Road funds must be allocated to provide for public safety as the first priority.
  - County road managers must comply with County, State, and/or Federal policies or legal obligations to maintain year round access on public roads.
  - County roads are merely "ribbons" across the landscape and the County often does not own the underlying or adjacent lands and thus can have only limited effects on the landscape.
  - Many County roads were the earliest constructed and located low in watersheds, often within or adjacent to stream banks with limited options to prevent sediment delivery to the stream at these locations.
  - The County does not own land on which to relocate roads upslope or away from problematic sites. Even if this were not the case, many driveways and private roads have been developed off of County roads making relocation problematic.
  - Sediment reduction and habitat restoration costs must fit within the financial capacity of county road programs and must not overtax staff to the point that maintenance and public safety are compromised.

Sediment Reduction Project Prioritization Model

The many factors and criteria described above address a number of concerns and complexities faced by counties that must be considered throughout the prioritization process. To facilitate the process, a conceptual model was developed to account for each factor. This model is a guide for comparing sites and may be modified over time to reflect additional factors. The result is referred to as the 5C Sediment Reduction Project Prioritization Model (SRPPM). It has yet to be approved by the individual counties. It is made available to each county for consideration. If a county chooses to follow the guide, or a modified version, there are many criteria that must be filled in by county staff prior to use. The parameters for the model are discussed below:

1. DIRT Inventory/Physical Site Prioritization

Physical criteria consist of the data collected in the field: treatment immediacy, erosion potential, and total potential sediment yield. These reflect the overall importance of sites relative to each other based only on DIRT data. Two additional factors, Complexity and Controllability, indicate the practicality of implementing the recommended treatments and their likely success.

- Immediacy values are a professional evaluation of the likelihood that a significant amount of erosion will be delivered to a stream during a future storm event and are assigned as: Urgent, High, High-Moderate, Moderate, Moderate-Low, and Low.

- Erosion Potential is based on field indicators such as slope steepness and shape, distance to the stream channel, soil moisture, culvert or structure condition, and evaluation of erosion processes. Sites with less than 20yd^3 are usually excluded from initial review (refer to Section V above).
- Controllability is a measure of how successful the prescribed treatments for any site are estimated to be in preventing sediment delivery. Landslide treatments are notorious for being difficult to determine and may have a lower effectiveness rate than treatments for more conventional problems. For example, a treatment for a landslide where the source of water responsible for destabilization of the soil cannot be removed because it is outside of the road right-of-way is generally assigned a low controllability.
- Complexity is an indication of how difficult it may be to implement the recommended treatments. Common factors that lower this rating include the presence of buried utility or communication lines, replacement of large culverts that require engineering, a lot of traffic at the site, limited access for equipment, etc.

2. Biological Overlay Criteria

Restoration of usable salmonid habitat upstream of migration barriers and improvement of water quality in salmonid bearing streams is a high priority of the overall 5C strategy. Whenever possible, priority is given to sites where treatment results in water quality and wildlife habitat benefits. To this end, treatment of sites that result in fish passage improvements, with other prioritization factors being equal, are weighed more heavily based on available data. The primary data source are inventories of stream crossings in all five counties completed and prioritized by Ross Taylor and Associates (RTA) under a series of SB 271 and Prop 204 grants. Further prioritization was completed for all migration barriers through a series of meetings of federal, state, university, private industry, and consultant fisheries biologists who work in Northwestern California. These biologists established a prioritization list across the counties to ensure that the focus of restoration activities was on the highest priority sites. Copies of these reports can be reviewed at www.5counties.org, the 5C website.

3. Management Criteria

Prioritization criteria are also based on the existing maintenance and capital improvement plans for each county. Areas where a county has already programmed significant work are of particular focus. In these cases, the DIRT recommendations are the primary selection criteria. The economic efficiency of these opportunities may make it possible to treat sites that would not otherwise warrant priority treatment. Therefore, biological criteria may not need to be considered, but can also weigh into the ranking.

Conversely, counties may not be able to accomplish work due to resource constraints. Typically, County maintenance staff must shift workloads in response to natural events (flood, fire, snow, etc.) that disrupt public safety and access. In these instances, the Counties often lack the resources to complete all levels of maintenance, capital improvement, and restoration actions. Other constraints must be factored in at the local level including multiple construction project schedules that are restricted to limited operating periods, limited availability of specialized equipment needed at multiple job sites, detailed geo-technical or engineering designs, and other factors.

Even after specific sites have been targeted for implementation, prescribed treatments must be reviewed to ensure that adjacent landowner concerns and county road and safety standards have been properly addressed.

Within the Scott River watershed, several tributary watersheds are considered to have significant management constraints that may affect the prioritization of treatments. A simplified sediment source study of two sub-watersheds of the Moffett Creek watershed (Mill and Cottonwood Creeks) found that road related sediment volumes reaching Moffett Creek are very low compared to "bank erosion and incision occurring along tributary stream channels. This type of erosion accounts for approximately 95% or the total management induced sediment contribution to Moffett Creek. This contribution is followed to a much lesser extent by sheet wash and gully erosion occurring along roads and on upland slopes" (SHN 2001). From a watershed treatment prioritization perspective, treatment of sediment sources in watersheds other than Moffett Creek will result in a relatively greater benefit to cold water fisheries given the extremely high sediment load delivering from other causes or sources in this watershed.

Many of the watersheds that join the Scott River in Scott Valley have significant water diversions that affect instream habitat and water temperatures during critical summer months and many streams on the east side of the Scott Valley dry up in most of their reaches. While many of the west side streams have perennial flows and cooler water temperatures, their lower reaches can also dry up due to water diversions and natural alluvial soil conditions. These west side streams however, have year round flow in the upper two-thirds of the watersheds (Etna, Sugar, French, Miner and Kidder Creeks for example) and provide some refugia for fish. The upper reaches of these streams are high gradient, low order channels which are not well suited to support anadromous salmonid fish species.

Similar watershed condition factors, such as diverted flow, mined stream channels, and/or tailing pile dams can be considered in the prioritization of watersheds for treatments.

4. Economic Overlay Criteria

It is well-recognized that implementing recommended treatments at all identified problem sites is cost-prohibitive. The total estimated cost to treat all sites in past inventories is nearly $56 million for nearly 3 million yd^3 of potential sediment. In another example, the U.S. General Accounting Office has estimated that the cost to mitigate road related impacts to salmonids on National Forests in Oregon and Washington would exceed $375 million and take decades to accomplish. For this reason economic factors must be considered in the prioritization process. The effects of greater biological need and regulatory requirements (factors discussed above and below) will lower the cost-benefit ratio factor to some degree. But in general, where the cost-benefit ratios are high, prioritization will tend to be lower.

These ratios are typically determined by the total cost per cubic yard of total potential sediment delivery.

More weight is given to sites or areas that qualify for grant funding. The higher and more diverse the cost share, the less the local road department or any one grant is burdened with the costs of implementation. Unique funding sources for sediment reduction and habitat restoration efforts typically target specific watersheds or counties. The following are examples of potential funding sources that could affect project prioritization:

- Secure Rural Schools and Communities Self-Determination Act (PL 106-393. 114): The Act and its amendments are set to expire in September 2008. However, Congress is currently considering an Emergency Supplemental Appropriations Bill, which includes a $400 million appropriation nation-wide for a one-year extension of the Act. If this funding source is not authorized, Siskiyou County would lose several million dollars in road maintenance and improvement funds over the next few years, resulting in reduced staffing and maintenance work. It could also reduce a potential funding source for restoration projects. In Trinity County for example, the County Resource Advisory Council has allocated hundreds of thousands of dollars to roads and watershed restoration activities in the past few fiscal years. This money is to be used on National Forest lands, but can include County roads within the land base.
- Propositions 50 and 84 have allocated millions of dollars of funding for projects designed to improve water supply reliability and quality. Under the terms, sediment reduction projects may be eligible for funding.
- Coastal Conservancy Funding: The Coastal Conservancy has indicated an interest in supporting restoration efforts in the Klamath River watershed and may grant funds for both sediment reduction and migration barrier removal projects.
- Private Foundations: Private foundations can be approached for project or conservation plan funding. For example, the McConnell Foundation financially supports some projects within Siskiyou and Trinity Counties.
- Additional public funding sources may be available.

5. Regulatory Criteria

A significant number of regulatory factors are considered in the prioritization and implementation of sites for each county's Department of Transportation (DoT) or Public Works (DPW). Many of these are discussed in section IV Project Description above. They include TMDL plans, possible violations of Basin Plans, and restrictions on activities that affect streams that host listed species. Much of the regulatory criteria affect individual sites differently and are usually dependent on specific treatments. For example, treatment of crossings on salmonid bearing streams would likely be more difficult and costly than would road surface treatments. Generally more attention is focused where cost effective treatment of sites results in additional benefits identified by various regulations or plans. These criteria are factored into the prioritization process in different possible areas such as water quality, biological importance, and complexity factors.

Model

The factors above were integrated into one spreadsheet based model where values are assigned to each criterion. This allows for assessment of sites based on multiple criteria. The higher the total score, the higher is the site's treatment priority. Values for the various main factors are weighted as follows:

Table 13: Sediment Reduction Project Prioritization Model

Criteria	% Overall Total	MAX points
DIRT evaluation/Physical Site Conditions	42%	210
Water Quality	17%	85
Biological Importance	5%	25
Initial Analysis Subtotal	**64%**	**320**
Economic	23%	115
Management	13%	65
Secondary Analysis Subtotal	**36%**	**180**
OVERALL PRIORITIZATION TOTAL	**100%**	**500**

This model is ideally suited for use when a particular funding source has been identified or when a manageable region (a few watersheds or a county) is targeted so that management factors can be better identified and addressed relative to the DIRT, biological, and regulatory factors.

In this report, because of the large dataset and geographic area, an initial prioritization was conducted based on DIRT factors alone. Biological factors were not looked at because of the large nature of the dataset. This initial prioritization is included in Appendix F, list 1. It serves as a platform for further prioritization analysis that includes biological, economic, and maintenance and capital improvement planning factors. One additional factor that can be applied to the DIRT factors is the fact that there is a sediment TMDL and action plan for the Scott River as discussed in Section IV Project Area Description above, which increases the overall priority of those sites. A second prioritization reflecting this additional regulatory factor is included in Appendix F, list 2. Both prioritization sorts are provided here for Siskiyou County's use and consideration.

There are other recommendations based on observations resulting from this inventory, field visits by inventory crews and managers to all watersheds, and past studies in the Scott River watershed that are offered for Siskiyou's consideration. There are several watersheds that are so substantially impacted and/or modified that, while they may deliver sediment to a stream, in-stream conditions reduce the value of treating roads in these watersheds, compared to treating roads in other

Scott River watersheds. The following is a brief summary of the watersheds where this report recommends that, all other things being equal, sites in these watersheds be given a lower priority (see Section IV above for references):

- Moffett Creek, Duzel Creek, and Mill Gulch: 90% to 95+% of all sediment is from stream and floodplain scour with all roads contributing less than 2%. The sediment load is so large that there would be no measurable improvement in water quality from county road projects until there is a stream and watershed stabilization program.
- Noyes Creek: The upper portion of the watershed in which the county roads are located are acting as large wetlands and are retaining sediments behind historic and active beaver dams. The low gradient of the valley and dams maintain a very broad floodplain that absorbs sediment deposits.
- East Fork Scott River: Similar to Noyes Creek.
- McAdams Creek: Much of this stream was bucket/dredge mined with the channel defined between large gravel and tailing piles. The disturbed nature of the creek means that flows are subsurface in some areas. The stream has low value for fisheries and the nature of the flows reduce the potential for sediment delivery to anadromous salmonid habitat.
- Rattlesnake Creek: Similar to McAdams Creek.

IX. Project Implementation

Projects are implemented based on available funding and prioritization results as described in the previous section at the discretion of each county. Ideally, projects are administered by the local department of transportation and may be subcontracted out depending on the scale and duration of the project, availability of local staff, and other management factors. To date within the 5C region, seven partially grant funded implementation projects have been implemented based on the DIRT erosion inventories previously completed with an estimated sediment savings of over 26,770 yd3. An additional large, multi-year project is underway and has been partially completed with an estimated sediment savings of 74,490 yd3. An additional sediment reduction project is also underway with an additional two planned for 2009. The treatment of 50 migration barriers as part of the 5C Fish Passage Improvement element has also removed 69,361 yd3 of fill that would have washed out with crossing failures at these sites.

In addition, local departments of transportation have been implementing road improvements as part of their road maintenance and capital improvement schedules. This work has contributed to reductions in water quality and typically consists of road surfacing and culvert replacements.

A component of every partially grant funded project is effectiveness monitoring. The usual, more practical approach is to photo document and observe conditions before and after project implementation. Post project monitoring is done immediately after project completion and after the first few winter seasons following construction. This allows the 5C and its member departments of transportation to observe the performance and effectiveness of the treatments. Specifically, what is evaluated are the integrity of treatments and visual erosion (road ruts, ditch formation, retention of critical and rolling dips). If more funds were available for monitoring, it would be possible to re-inventory treated sections in order to compare volumes, immediacy, erosion potential, and other factors. However, without the availability of grant funding, this option is too costly to pursue.

X. Spoils Disposal Site Inventory Results

It is recognized that improper disposal of materials generated during construction or road maintenance activities (spoils) can also lead to sediment delivery to streams. As part of the DIRT inventory, suitable locations for disposal of spoil were identified and recorded. Refer to section V Inventory & Data Management Methodologies above for a description of the protocol used to select sites. Local departments of transportation can then further evaluate the potential sites identified in the inventory for conflicts with cultural or environmental resources for final determination of suitability. This process is described in the 5C road maintenance manual.

In this inventory, a total of seventeen spoils disposal sites were identified, as outlined in the table below, and 14 were found to be potentially suitable. These 14 sites can accommodate a total theoretical capacity of 316,153 yd^3 or more with the majority thought to be suitable for long term use. The inventory included sites of past or current storage. It was not always possible to determine their ownership or if the sites were being used by the county or other parties. The 14 potentially suitable sites have a relatively large capacity to store materials, but some are located in areas where there is less demand for storage capacity. Spoils storage on some of the steeper roads in highly erodible soils (e.g., Salmon River, Cecilville, Sawyer's Bar Roads) remain constrained due to steep slopes, watercourses, and other factors.

Table 14: Summary of Recorded and Potential Spoils Disposal Sites

Suitability	Available Term*	Number of Sites	Total Capacity Volume (yd3)
H	P	8	224,728
HM	P	3	79,592
ML	T	1	7,920
L	T	3	5,070
H	T	2	3,913
All		**17**	**321,223**

* P indicates Permanent; T indicates Temporary

Generally speaking, the spoils sites indicated for long term use had a higher suitability. Suitability refers to how ideal their location is such that they will not deliver sediment to a stream and do not have any noticeable limitations such as: possible presence of archeological resources; location within the flood plain, on steep ground slopes (>10%), or near waterbodies; or limited winter access.

Potential Spoils Disposal Site located on a ridge top

X. Conclusion

Approximately 342 miles of county road were inventoried under this contract in the Scott and Salmon River watersheds in Siskiyou County. A total of 1,056 sites were recorded, including erosion sources with the potential to deliver sediment to streams and potential spoils disposal sites. Of these sites, 1,034 are recommended for treatment and are estimated to yield 556,780 yd^3 of total erosion over a ten-year period. Seventeen of the 1,056 sites were recorded as spoils sites with 321,223 yd^3 total estimated storage capacity, though three of them with 5,070 yd^3 estimated capacity were thought to have a low suitability. There were many watershed conditions present in this inventory that were not encountered in previous inventories. This affected the amount of actual sites and road segments with potential sediment delivery, the type of treatments prescribed, and overall evaluation of the roads. Perhaps most notably, because of drainage modifications, some county roads do not deliver to a stream that is connected to an anadromous stream, which automatically excludes them from the inventory.

This data collected here will be included with existing inventories as part of the 5C metadata on county road erosion sources. As with past contracts, the local department of transportation included in the inventory, Siskiyou County, will be provided with a list of structures, culverts, and other stream crossings. They will also receive a list of potential spoils disposal sites from which they can begin to compile a list of actual disposal sites based on need and a final determination of suitability.

The 5C will continue to apply for funding to inventory remaining program areas. This data will be used to identify and implement high priority projects. Proposals to treat these sites will then be developed and submitted for funding. Local road departments may also use the data to incorporate treatments into their capitol improvement and/or road maintenance schedules. Inventories on both a large and small scale like these also improve the public's confidence that proposed projects are resulting in the greatest cost-benefit to the resources at risk. Results from the inventories are available to each county's road department for use in maintaining roads and/or scheduling improvement projects at their discretion. Prioritization is a complex process that includes multiple factors. A model has been provided to each county for consideration as described in section VII Treatment Prioritization Methodology above. Each county determines implementation priority and timing of projects.

This project was completed between June 2006 and June 2008. Approximately 6,310 personnel staff, grant funded hours and an additional 200 hours of in-kind personnel hours were expended for a total cost of approximately $193,315. The total project cost is approximately $247,883, 86.5% of which comes from this contract, 2.8% from matching grant sources, and 10.7% from in-kind contributions.

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