Five Counties Road Erosion Inventory and Assessment

Conducted in areas of: Del Norte, Trinity (southern portion), and Humboldt (Mad River watershed) Counties

Final Report

Prepared by
Fisheries Restoration Grant Program Contract #P0210420
through the California Department of Fish and Game

June 2003 – March 2005

Five Counties Salmonid Conservation Program

I. Introduction

This report summarizes a Five Counties Road Erosion Inventory and Assessment that was conducted along county roads in portions of Del Norte, Trinity (southern), and Humboldt Counties. 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 Del Norte, Trinity, and Humboldt Counties.

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. 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 will complement past and future inventories completed in Del Norte, Humboldt, and Mendocino Counties under separate California Department of Fish and Game (CDFG) SB 271 grants and an inventory of the Trinity River watershed completed under a Proposition 204 grant through the State Water Resources Control Board. All inventories utilized the same basic methodology, Direct Inventory of Roads and Treatments (DIRT), 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 based on physical site dimensions and road conditions. Trained survey crews assign both an overall treatment immediacy and an erosion potential rating. GIS data for all inventories have been submitted to CDF&G for incorporation into a state-wide GIS database.

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.

These inventories and resulting implementation projects are part of the larger 5C conservation strategy developed in response to the 1997 listing of the coho salmon as a federal Threatened species by the Boards of Supervisors of Del Norte, Humboldt, Mendocino, Siskiyou, and Trinity Counties. 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 (refer to Appendix A of this report). This is the first time that multiple County governments have formed a watershed-based conservation strategy to address the biological, watershed, political, social, and economic effects of declining salmonid populations.

The field work for this inventory was conducted by a dedicated crew: Carolyn Rourke, Christine Jordan, and Darius Damonte. The data analysis and summary presented here was produced by Sandra Pérez, Carolyn Rourke, Christine Jordan, and Mark Lancaster. Special recognition is given to the Del Norte County Community Development Department and road crew, the Trinity County Department of Transportation, and the Humboldt County Department of Public Works.

II. Summary

In this inventory, 367 miles were surveyed with 1,570 total sites recorded, including erosion sources with the potential to deliver sediment to streams and potential spoils disposal sites. Of these sites, 1,334 are recommended for treatment and are estimated to yield 706,746 yd^3 of total erosion within a ten-year period. Twenty-five of the sites are potential spoils sites with 786,800 yd^3 total estimated storage capacity.

Because sites in this dataset span multiple counties and geologies, the nature of roads and individual sites is very diverse. Photographs from select sites within this inventory are included as Appendix H 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	366	35,870	5.1%
Gully	3	1,070	0.2%
Landslide* (cutbank)	2	1,244	0.2%
Landslide* (fillslope)	7	23,610	3.3%
Landslide* (hillslope)	1	14,375	2.0%
Other problem	14	16,893	2.4%
Road ditch	57	8,082	1.1%
Spring	14	769	0.1%
Stream crossing	870	604,833	85.6%
Total	**1,334**	**706,746**	**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		29	41,150	5.8%
H	High	184	142,574	20.2%
HM	High-Moderate	337	273,956	38.8%
M	Moderate	517	147,982	20.9%
ML	Moderate-Low	233	98,331	13.9%
L	Low	34	2,754	0.4%
Total		**1,334**	**706,746**	**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). The intricate network of County, state, federal, and private road systems within the Five Counties contributes to water quality and habitat degradation. Roads modify natural hillslope drainage networks and accelerate erosion, altering physical processes and leading to changes in stream flow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and stability of slopes adjacent to streams. These changes can have biological consequences that affect virtually all components of stream ecosystems (Furniss et al. 1991)[1]. Within the 5C, there are 4,787 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 that have the potential to deliver sediment to streams. 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.

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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.

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	866	495	1,361
Trinity	455	245	700
Total	**3,236 (68%)**	**1,551 (32%)**	**4,787**

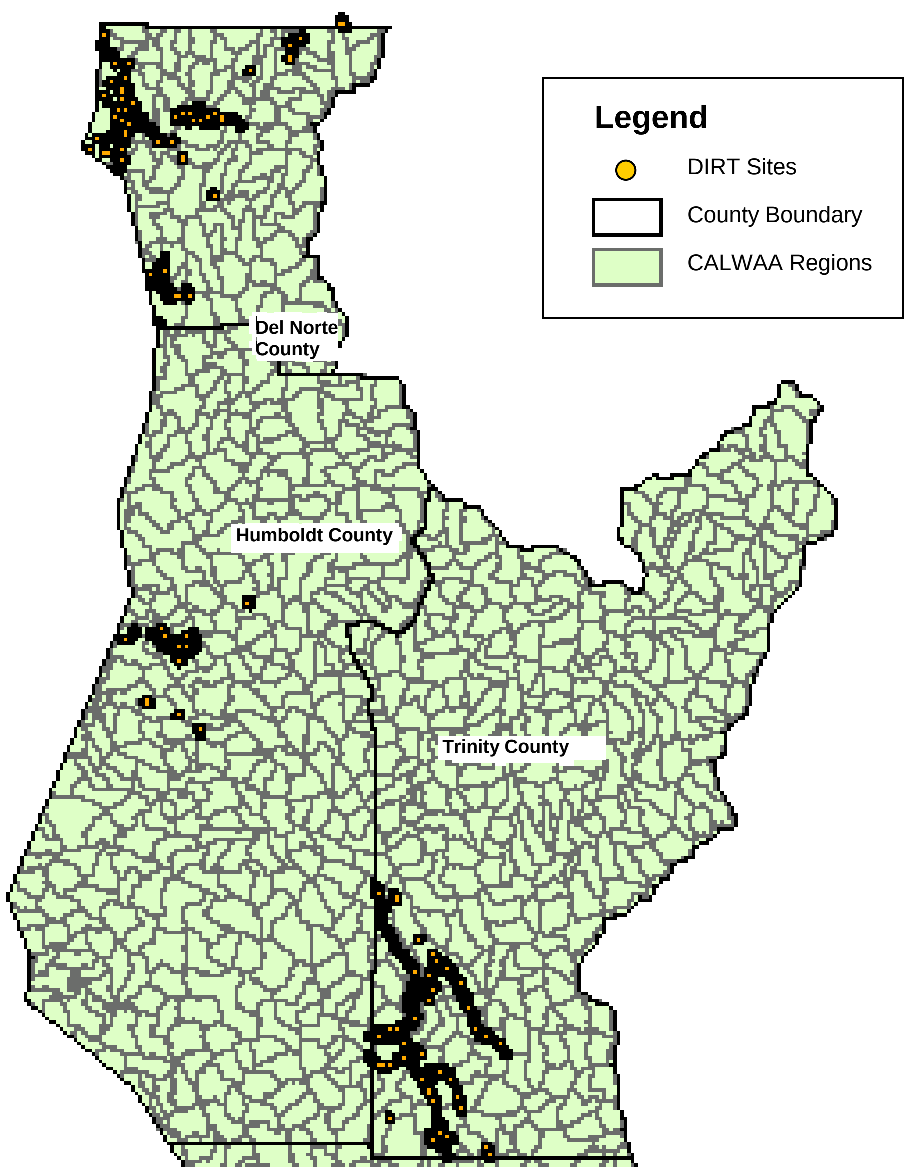
Table 2: Estimated County Maintained Culverts & Stream Crossings

County	Culverts	Bridges	Low Water Crossings
Del Norte	~2000	32	0
Humboldt	~3000	162	3
Mendocino	~3500	157	19
Siskiyou	~4000	175	0
Trinity	~4100	93	9
Total	**16,600**	**619**	**31**

IV. Project Area Description

The areas targeted in this inventory were based on 5C areas not covered in previous inventories. Prior to this inventory, all of Siskiyou and only portions of Del Norte, Humboldt, and Trinity Counties remained. The remaining portions of Del Norte County and southern Trinity County were the primary focus here. It was proposed that any funding remaining after inventory of these two large areas would be used to partially inventory the Mad River watershed within Humboldt County.

Figure 1: Inventory Area Map



Watershed and Regulatory Factors Related to Erosion Inventory

There are many plans and 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. The more relevant 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. Federal Endangered Species Act

The project areas are included within the federally designated Southern Oregon/Northern California 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. Also included in the project areas are the California Coastal ESU for chinook salmon and the Northern California ESU for steelhead trout. Refer to Table 3 below for listing statuses.

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. Accelerated erosion from land management, past mining, roads, and altered flows all affect migration, spawning, reproduction, and early development of cold water fish such as coho and chinook salmon and steelhead trout in the rivers and streams.

Neither Trinity County Department of Transportation, Humboldt County Public Works Department, nor Del Norte County Community Development Department (includes the Transportation Department) has a Section 10 Habitat Conservation Plan for management activities that could take, or indirectly take, coho and chinook salmon and steelhead trout. There are no Section 4(d) take limits established for routine road maintenance activities or capital improvement projects within these ESU's. However, the 5C Program's road maintenance manual is currently submitted for programmatic coverage under the 4(d) rule. 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.

C. California Endangered Species Act

In February 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. Under the normal listing process, the determination is currently under review by the Office of Administrative Law. "The Recovery Strategy for California Coho Salmon; Report to the California Fish and Game Commission" 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. Its recommendations include implementing the DIRT road erosion inventory and subsequent sediment reduction projects (RW-VI-A-02, RW-VI-D-01 and others) as follows:

> *TR-HU-10 Support continued State and Federal funding for the implementation of sediment reduction programs for private lands and the implementation of DIRT-prioritized sediment source sites treatment funding on County roads.*
>
> *D TR-HU-08 Support continued State and Federal funding for the implementation of sediment reduction programs for private lands and the implementation and funding of treatment of sediment source sites on County roads using the prioritization of the Direct Inventory of Roads and Their Treatment (DIRT).*
>
> *EP-HU-06q Reduce input of fine sediments into the stream system by the following actions:*
> - *a. Conduct comprehensive road inventory;*
> - *b. Carry out priority road related sediment reduction;*
> - *c. Implement priorities for road-related sediment reduction projects identified in existing road inventories projects;*
> - *d. Identify areas still needing road/erosion inventories;*
> - *e. Identify ongoing road maintenance needs;*

Table 3: Federal and State Endangered Species Act- Status of Listings of Salmon & Steelhead in the Inventory Region (updated January 2005)

Species / ESU	Listing Status	ESU Area
Coho Salmon		
So. Oregon / No. California ESU	*Threatened / *Interim 4(d) rule*	Elk River, OR to Mattole River / Klamath & Trinity Basins
Northern California	*Threatened	Punta Gorda to Oregon
Chinook Salmon		
Calif. Coastal ESU	Threatened	Redwood Creek through Russian River basin
Southern Oregon / Northern California ESU	Not listed	Cape Blanco south *to lower Klamath R. downstream* of Trinity River
Steelhead		
No. Calif. Coast ESU	Threatened	Redwood Cr. through Gualala River
Klamath Mtn. Province	Not listed	Cape Blanco, OR to South Fork Trinity Basin
Statewide	Proposed Endangered/Threatened	All Areas within the 5C region
Green Sturgeon		
Klamath Mtn. Province	Candidate species, Petition Accepted	Klamath & Trinity Rivers

*The Fish & Game Commission has recommended these species for Threatened or Endangered status. As part of the normal listing process, the determination is currently under review by the Office of Administrative Law.

D. 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. A 2004 update to California's current 2002 Section 303(d) List of Water Quality Limited Segments is underway. 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.

E. 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.

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.

Within the North Coast Region, sediment TMDLs have been established for sixteen water bodies. Within the project area, listed waterbodies are: Klamath River, Mad River, Van Duzen River, Redwood Creek, Freshwater Creek and Jacoby Creek. Of these six, Redwood Creek and the Van Duzen River have completed Final Sediment TMDLs by the EPA and the other five are in process.

Table 4: Total Maximum Daily Load Allocation and/or Implementation Requirements of Section 303(d) of the Federal Clean Water Act

River Name	County Location	Listed Pollutant	Due Date
Eel R. – North Fork.	Mendocino/Trinity	Sediment & Temperature	12/02
Eel R. – South Fork	**Mend/ Humboldt**	**Sediment & Temperature**	**12/99**
Freshwater Creek	Humboldt	Sediment	12/10
Klamath River – all	Siskiyou /Humboldt /Del Norte	Nutrients & Temperature	4/04
Klamath - mainstem	Siskiyou /Humboldt /Del Norte	Low Dissolved Oxygen	12/04
Mad River	Humboldt / Trinity	Sediment & Turbidity	2/07
Redwood Creek	**Humboldt**	**Sediment**	**12/98**
Van Duzen River	**Humboldt**	**Sediment**	**12/99**

Bold indicates Allocation Plan has been complete.

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.

The next step in the TMDL process is development of implementation plans to achieve allocated targets for the different sources. No such plans yet exist for the watersheds included in this inventory.

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 the field data sheet 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.

Treatment Options:

- 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 25 miles per hour. These safety considerations limited the use of certain treatments that would be appropriate for private ranch and forest roads.
- Inventory crews were instructed to consider use of treatment protocols such as cross drains, ditch relief culverts, and other drainage treatments (which return water to Class III drainages of origin) only where downslope landowner permission was anticipated. In many areas the original watercourses have been eliminated with 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.

Treatment Costs:

- 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. This 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 PWA, in cooperation with county representatives, 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. Three versions were used in past inventories. For this inventory, a further upgraded version was developed (2.0) that is compatible with prior versions and contains more information including a new section to facilitate project implementation tracking and monitoring.

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 $20yd^3$. However, all stream crossings, regardless of total potential volume, are recorded into the DIRT database. Those stream crossings without a culvert or with an undersized culvert are calculated to fail at some point. 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.

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 C for a copy of the database form). On virtually all stream crossings, tape and/or electronic distance measurers and clinometer longitudinal profile surveys were completed. 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.). For crossings where the upstream watershed area was less than 100 acres in size, the 100-year storm flow was calculated in the Access data sheet. The Rational Method formula, Q=CIA, was used in these small watersheds. Once the flow was known, a culvert diameter capable of passing the 100-year flow through the crossing was included in the treatment recommendation portion of the data sheet. A second method developed by Redwood National and State Parks was utilized at larger crossings (CulvQ). It computes design flows using the Rational Formula and empirical formulas developed by Waananen & Crippen for California. For very large watersheds, the surveyor recommended that the replacement culvert size be calculated by a Registered Engineer.

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. 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 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. An overall suitability rating is also assigned by the field crew 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 cleanup at the end (unlike past inventories), 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 IX, Treatment Prioritization below and shown in Appendix G.

VI. Erosion Source Inventory Results

A. Summary of Sites

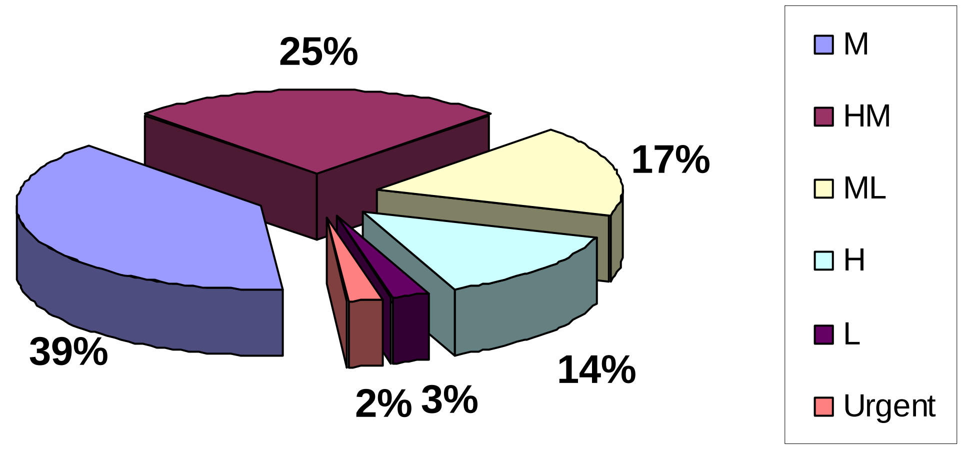
In this inventory, 367 miles were surveyed with 1,570 total sites recorded, including erosion sources with the potential to deliver sediment to streams and potential spoils disposal sites. Of these sites, 1,334 are recommended for treatment and are estimated to yield 706,746 yd^3 of total sediment to streams within a ten-year period. Twenty-five of the sites are potential spoils sites with 786,800 yd^3 total estimated storage capacity. All treatment sites are summarized below by immediacy with total potential volumes.

Given that a total 367 miles of road was inventoried, there is an average of 3.6 potential erosion sites per mile of county road with each site averaging 530 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 urban areas had very few or even no sites with a potential for sediment delivery to streams.

Table 6: Summary of Sites by Treatment Immediacy

Treatment Immediacy		Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Urgent		29	41,150	5.8%
H	High	184	142,574	20.2%
HM	High-Moderate	337	273,956	38.8%
M	Moderate	517	147,982	20.9%
ML	Moderate-Low	233	98,331	13.9%
L	Low	34	2,754	0.4%
Total		**1,334**	**706,746**	**100%**

Figure 2: Summary 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	149,163	21.1%
Landslide	46,165	6.5%
Stream Crossing	511,418	72.4%
Total Volume	**706,746**	**100%**

Chronic Erosion

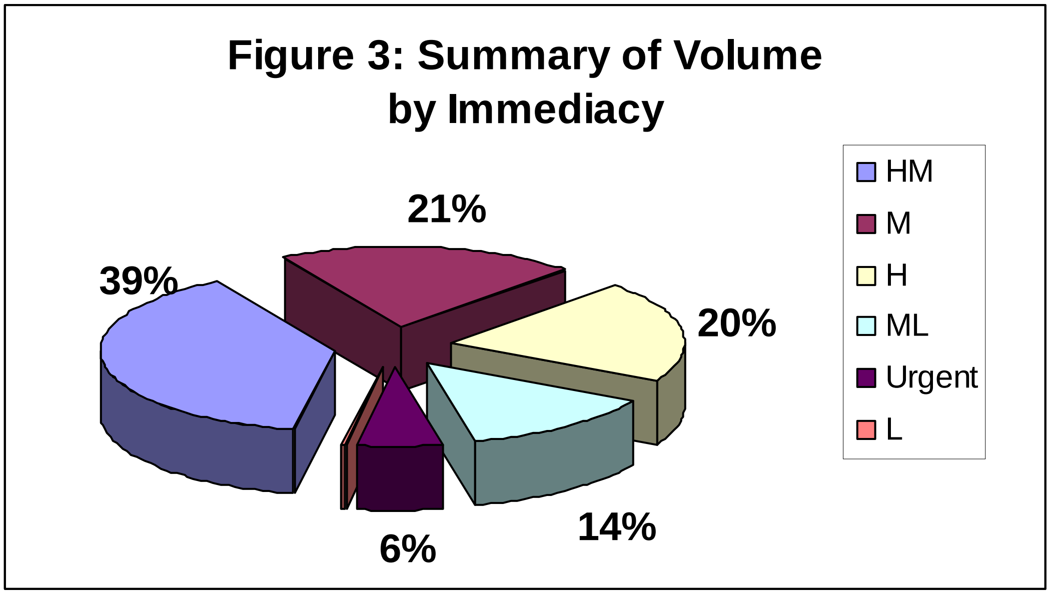
Chronic erosion is what constantly erodes, mostly from cutbanks, ditches, and the road surface, and is analyzed over a ten year period. It is a result of a number of types of erosion sources continually yielding sediment to streams. The types of erosion sources within this category include: ditch down-cutting/enlargement 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 149,163 yd^3 of sediment will be delivered to streams over a period of ten years from chronic sources.

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.

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.



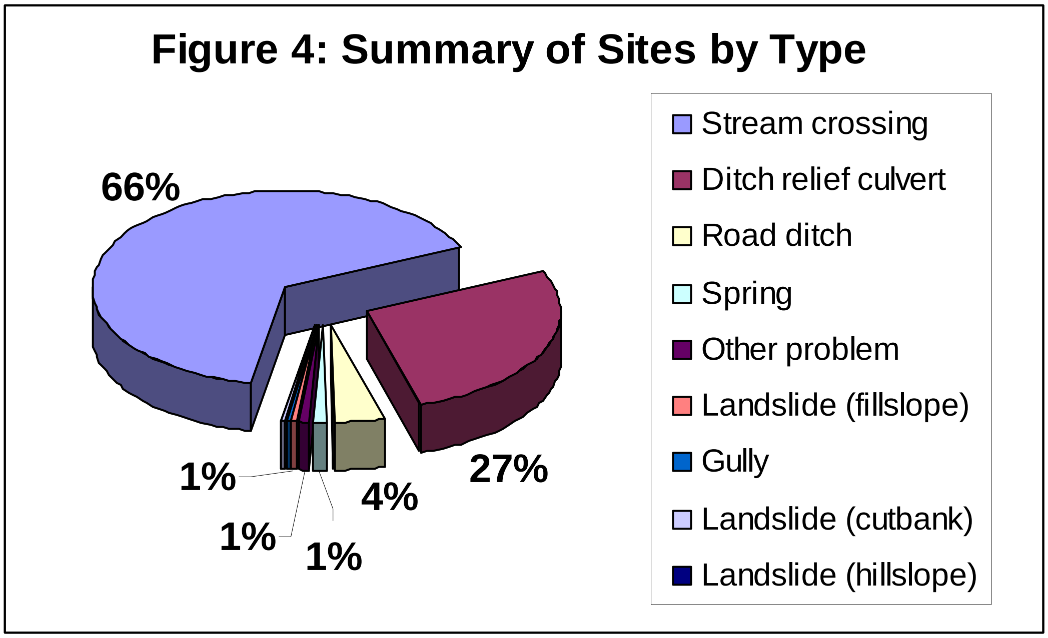
C. Summary of Site Types

Each site is classified by the type of erosion source and physical structure where the sediment is being generated and delivered. The following table summarizes the types of sites with the total potential delivery volumes for each type. Note that 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 & Volume

Site Type	Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Ditch relief culvert	366	35,870	5.1%
Gully	3	1,070	0.2%
Landslide* (cutbank)	2	1,244	0.2%
Landslide* (fillslope)	7	23,610	3.3%
Landslide* (hillslope)	1	14,375	2.0%
Other problem	14	16,893	2.4%
Road ditch	57	8,082	1.1%
Spring	14	769	0.1%
Stream crossing	870	604,833	85.6%
Total	**1,334**	**706,746**	**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 870 stream crossing sites were inventoried and recommended for treatment. They could potentially generate a total of approximately 604,833 yd^3 of future road related sediment, over 85% 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	20	37,234	6.2%
H	125	91,602	15.1%
HM	240	246,983	40.8%
M	326	131,691	21.8%
ML	139	94,808	15.7%
L	20	2,515	0.4%
Total	**870**	**604,833**	**100%**

Ditch relief culverts are the second most predominant type of site. There are a total of 366 sites that have the potential to deliver 35,870 yd^3 of sediment to streams. Although they far outnumber landslides, the total potential delivery volumes from landslides rival that of ditch relief culverts. This is apparent when you consider that on average, each ditch relief culvert can potentially deliver 98yd^3 of sediment to streams while landslides can potentially deliver 3,923 yd^3 over the same period.

Table 10: Ditch Relief Culverts by Immediacy

Treatment Immediacy	Number of Sites	Total Sediment Delivery Volume (yd^3)	% of Total Volume
Urgent	8	835	2.3%
H	46	13,771	38.4%
HM	72	10,217	28.5%
M	149	7,992	22.3%
ML	80	2,872	8.0%
L	11	182	0.5%
Total	**366**	**35,870**	**100%**

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 upgrading undersized or deteriorated culverts and/or 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. A summary of treatments prescribed in this inventory is shown below.

Table 11: Treatments by Immediacy

Treatment	%Urgent	%H	%HM	%M	%ML	%L	Units	Total
Number of Sites	2.2	13.8	25.3	38.7	17.5	2.6	#	1,333
Clean or cut ditch length	0.0	0.0	24.7	68.3	7.0	0.0	ft	527
Outslope & retain ditch length	0.0	56.9	10.7	32.4	0.0	0.0	ft	2,053
Outslope & fill ditch length	2.2	14.4	31.6	37.2	12.1	2.5	ft	75,913
Install rolling dips	3.1	19.0	28.2	34.9	12.8	2.1	#	195
Remove berm length	0.0	12.2	37.3	34.9	13.8	1.8	ft	29,771
Breach berm	0.0	0.0	24.6	64.9	10.5	0.0	#	57
Volume berm to remove	0.0	42.0	18.3	24.8	14.8	0.2	yd^3	3,198
Fill ditch length	0.0	8.3	26.2	42.7	15.9	6.9	ft	27,849
Pave road length	0.0	0.0	90.8	0.0	9.2	0.0	ft	1,222
Rock road length	0.0	0.0	100	0.0	0.0	0.0	ft	1,420
Pave or rock surface area	0.0	0.0	90.3	0.0	9.7	0.0	ft^2	39,696
Install ditch relief culverts (DRC)	1.8	19.9	31.0	38.5	8.6	0.3	#	397
Install DRC length	2.0	20.7	35.1	37.3	4.5	0.3	ft	14,995
Replace DRC length	2.6	14.7	24.8	38.4	17.9	1.7	ft	9,770
Install downspouts	4.1	24.6	28.1	33.3	9.9	0.0	#	171
Downspout length	6.5	21.9	40.9	23.4	7.3	0.0	ft	7,458
Install culvert	2.5	5.9	26.9	51.3	11.8	1.7	#	119
Replace culvert	0.0	20.7	34.1	43.0	0.0	2.2	#	458
Culvert maintenance	5.0	10.8	22.3	36.7	21.6	3.6	#	139
Install emergency overflow (EOF)	0.0	9.1	27.3	18.2	45.5	0.0	#	11
EOF length	4.1	24.5	37.4	2.7	31.3	0.0	ft	1,470
Install crossing downspouts	4.4	23.7	26.3	33.3	12.3	0.0	#	114
Crossing downspout length	10.3	18.1	29.6	32.1	9.9	0.0	ft	4,360
Install critical dip	0.6	9.1	21.4	42.9	21.4	4.5	#	152
Install armored ford	0.0	16.7	0.0	66.7	0.0	16.7	#	6
Armor area	3.7	26.8	42.4	24.5	2.6	0.1	ft^2	226,084
Volume of fill to reconstruct	0.0	99.2	0.0	0.0	0.8	0.0	yd^3	5,381
Volume of soil to excavate	2.1	87.3	7.5	3.0	0.0	0.0	yd^3	101,221
Other treatment	2.6	20.0	28.7	36.1	11.7	0.9	#	230
Engineer must verify recommended treatments	11.6	29.1	29.1	23.3	7.0	0.0	#	66
Requires treatment of nearby site(s)	3.5	21.7	34.1	32.6	7.0	1.2	#	240
Decadal Erosion Volume	1.4	25.6	48.8	18.5	5.2	0.6	yd^3	149,163
Crossing Volume Total	6.9	12.8	39.1	23.1	17.7	0.4	yd^3	511,418
Landslide Volume Total	8.4	84.0	2.2	5.2	0.3	0.0	yd^3	46,165
Total Erosion Volume	5.8	20.2	38.8	20.9	13.9	0.4	yd^3	706,746

VII. Treatment Costs

The total treatment cost for all sites amounts to over $20,761,861. When comparing the total cost of all treatments to the total volume of potential sediment delivery for all sites, the average cost per cubic yard is $29.38. Individual site cost estimates were generated based on the treatment recommendations entered during data collection (refer to Appendix E). A unit cost table, based on information originally produced by Mendocino County Water Agency Staff and updated based on recent cost estimates where possible, was applied to all treatments in order to determine individual site costs (refer to Appendix F). Some sites have treatments whose cost could not be estimated while other sites require engineer review before treatments can be determined. Therefore, the total cost calculated does not reflect all treatments required to fix all sites. 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. For the purposes of analyzing the data practically, the table below summarizes the approximate cost of DIRT prescribed treatments.

Table 12: Treatment Costs/yd^3 of Potentially Deliverable Sediment†

Cost/yd^3	Number of Sites	Total Volume yd^3	Total Cost	Average Cost	Average $/yd^3
<1*	43	137,129	$16,729	$389	$0
1 - <5	156	154,347	$367,912	$2,358	$2
5 - <10	116	130,968	$923,403	$7,960	$7
10 - <15	98	74,458	$874,264	$8,921	$12
15 - <20	83	34,250	$575,085	$6,929	$17
20 - <25	76	22,659	$497,662	$6,548	$22
25 - <30	65	17,315	$468,231	$7,204	$27
30 - <35	66	21,535	$679,318	$10,293	$32
35 - <45	89	22,169	$878,299	$9,869	$39
45 - <55	80	10,642	$528,131	$6,602	$49
55 - <70	83	8,484	$529,881	$6,384	$63
70 - <100	115	11,904	$959,345	$8,342	$83
100+	264	60,879	$13,463,585	$50,998	$406
All	**1,334**	**706,746**	**$20,761,861**		

* For some of these sites, there may be treatments whose cost could not be estimated because recommended treatments were not entered during data collection or there were specialized treatments for which cost could not be estimated. Many of these sites are pending engineer review.

† Sites with <20yd^3 total potential sediment delivery will likely not be treated, but are a part of this dataset. In most cases, these sites are stream crossings recorded despite the total potential volume as per the DIRT methodology (as described in section V above).

VIII. Treatment Prioritization

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 A.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. How these factors, listed below, are brought together with DIRT factors is further explained in subsection A.

- 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.
- 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. 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, Controllability and Complexity, indicate the practicality of implementing the recommended treatments.

- 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. Two additional factors assigned in the field that indicate the practicality and likely success of prescribed treatments, specifically Controllability and Complexity.
- Controllability is a measure of how successful the prescribed treatments for any site will be in preventing sediment delivery. For example, landslide treatments are notorious for being difficult to determine and may have a lower effectiveness rate than treatments for more conventional problems. Treatments for landslides where the source of water responsible for destabilization of the soil cannot be removed because it is outside of the road right-of-way generally are 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, 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 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 selected for implementation, prescribed treatments must be reviewed to ensure that adjacent landowner concerns and county road and safety standards have been properly addressed.

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 this inventory is $20,761,861. 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. Refer to Section VII Treatment Costs above. 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 established a process where counties could recommend the allocation of a portion of federal funds to counties. 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.
- Through Chapter 8 guidelines of Proposition 50 have set aside $380 million in projects designed to improve water supply reliability and quality. Under the terms, sediment reduction projects may be eligible for funding.
- Klamath River Management Council: This program supports watershed mitigation and restoration activities in the Klamath River (Siskiyou, Humboldt and Del Norte Counties). The funding for the program is distributed through the US Fish and Wildlife Service as part of 1986 legislation authorizing the Klamath Restoration Program.
- Coastal Conservancy Funding: Coastal Counties and Trinity County are eligible for this funding source.
- Coastal Assessment and Impact Program: Only Del Norte, Humboldt, and Mendocino Counties are eligible for this funding source. It is funded by Congress and is based on offshore oil field revenues.
- Private Foundations: Private foundations can be approached for project or conservation plan funding. For example, the McConnell Foundation financially supports some projects within Shasta and Siskiyou Counties.
- Additional public funding sources are available for areas outside of this inventory but within the 5C program region.

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 and treatment costs. Biological factors were not looked at because of the large nature of the dataset. This initial prioritization is included as Appendix G. It serves as a platform for further prioritization analysis that includes biological, more economic, and maintenance and capital improvement planning factors.

IX. Project Implementation

Projects are implemented based on available funding and prioritization results as described in the previous section. 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, four partially grant funded implementation projects have been implemented based on the Trinity River watershed inventory and two based on the coastal county inventory. All together, these projects are estimated to have treated over 25,800 yd^3 of potential erosion. 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 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, ideal 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 twenty-five potential spoils disposal sites were identified with a total theoretical capacity of 786,800 yd^3.

Table 14: Summary of Potential Spoils Disposal Sites

Available Term	Number of Sites	Total Capacity Volume (yd3)
P	16	725,860
E	1	33,185
T	8	27,755
All	**25**	**786,800**

Potential Spoils Disposal Site

X. Conclusion

Approximately 367 miles of county road were inventoried under this contract in Del Norte, southern Trinity, and a small part of the Mad River within Humboldt Counties. A total of 1,570 sites were recorded, including erosion sources with the potential to deliver sediment to streams and potential spoils disposal sites. Of these sites, 1,334 are recommended for treatment and are estimated to yield 706,746 yd^3 of total erosion over a ten-year period. The total estimated cost for treatment of all sites was $20,761,861. Twenty-five of the sites are potential spoils sites with 786,800 yd^3 total estimated storage capacity.

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, each local department of transportation included in the inventory will be provided with a list of structures, culverts, and other stream crossings. Each road department will also have 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.

This project was completed between May 2003 and March 2005. Approximately 5,068 personnel staff, grant funded hours and an additional 260 hours of in-kind personnel hours were expended for a total cost of approximately $125,132. The total project cost is approximately $149,727, 76.1% of which comes from this contract, 14.4% from matching grant sources, and 9.5% from in-kind contributions.

XI. References

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