1999 AH PAH AND TECTAH CREEKS WATERSHED RESTORATION TRAINING AND IMPLEMENTATION PROGRAM

EXECUTIVE SUMMARY

The purpose of this report is to summarize the restoration work completed by the Yurok Tribe, as part of the Lower Klamath Restoration Partnership's 1999 projects. From July through October 1999, the Yurok Tribe conducted a Watershed Restoration Training and Implementation Program within the Ah Pah and Tectah Creek drainage basins. This is part of a multi-year restoration effort, which is intended to remediate man-caused sediment sources from 30 tributary sub-basins within the Lower Klamath River Basin.

This program was part of long-term watershed restoration goals intended to fulfill two principal Tribal objectives:

1. Return the Klamath River fisheries to their healthiest possible condition.
2. Create job training and employment opportunities for Tribal members.

The Ah Pah and Tectah Watershed Training and Implementation Program employed nine Tribal members, and provided them with the technical skills needed for watershed restoration work within the Tribal Fisheries' Restoration Division. The program lasted 16 weeks, and was divided into two phases, including:

1. A four-week hands-on lecture/laboratory training in the basic concepts and methodologies currently used by watershed restoration technologists. This component of the training curriculum was designed to develop watershed assessment skills to gain an overview of slope and fluvial erosional processes, road building history, silvicultural and natural disturbance regimes.

2. A twelve-week training/implementation phase, using hands-on field experience to teach the techniques utilized by ground personnel and heavy equipment operators. This training included actual implementation of the hydrologic decommissioning and biotechnical stabilization along prioritized roads and stream crossings within Ah Pah Creek watershed.

Decommissioned roads included the B-1070, B-1070A, B-1070-C, B-1700A, B-1700B, B-1882 and the S-9 roads in the Ah Pah and the T-100, T-140, T-145, T-211, T-514 and the T-510 roads in the Tectah Creek Watershed. In the Ah Pah Creek watershed, approximately 4.7 miles of roads were hydrologically decommissioned, preventing an estimated 75,175 yd^3 of road fill material from entering surrounding streams. Figures for the Tectah Creek watershed include 4.4 miles of roads for 103,282 yd^3 of fill saved from entering the streams. This gives a grand total of 9.15 miles of decommissioned roads, and 178,457 yd^3 of road fill material saved, by the entire project.

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INTRODUCTION

From July through October 1999, the Yurok Tribe conducted a watershed restoration program that was divided into two coordinated projects:

1. Training of watershed restoration techniques to Tribal members (including heavy equipment operation).

2. Implementation of the hydrologic decommissioning of roads owned by Simpson Timber Company located within the Yurok Reservation and/or ancestral Yurok territory.

This program, as part of the Lower Klamath River Partnership's long-term watershed restoration goals, was intended to fulfill two principal objectives:

1. To return the Klamath River fisheries to their healthiest possible condition, by:
   - Improving stream/riparian habitat in watersheds identified as immediate priority work areas.
   - Treating the most critical erosion and/or chronic sediment sources in each watershed in the most cost-effective way, by:
     - Hydrologic decommissioning/obliteration of road and skid trails.
     - Road upgrade/improvements for erosion control.
     - Slope stabilization.
     - Improvement of stream channel morphology.
2. Jobs training and employment opportunities.
   - Development of the technical skills and the long-term availability of watershed restoration jobs for Tribal members.

Location

The training and implementation program took place within the Ah Pah and Tectah Creek watersheds, all located in the lower portion of the Klamath River Basin, a 12,000 square mile drainage basin extending through Northern California and Southern Oregon (see Figure 1). Ah Pah Creek lies within the Lower Klamath River sub-basin between Ranges R1E-2E and Township T11N-12N. The Tectah Creek watershed area is located on top of Bald Hills Road, between Johnson's Road and Holter Ridge road, approximately 10 miles east of Orick, California. Tectah Creek lies within the Lower Klamath River sub-basin between Ranges R2E-3E and Township T10N-12N. Ah Pah and Tectah Creek are both located in Humboldt County, CA.

Figure 1: Location Map of Ah Pah and Tectah Creek Watersheds

Land Status

The Yurok Tribe's ancestral lands make up an area of approximately 320,000 acres. The Yurok Klamath River Reservation is approximately 56,000 acres, and was created by Federal actions between 1853 and 1891. The Reservation encompasses a strip of land one mile wide on each side of the Klamath River, from its confluence with the Trinity River at Weitchpec, California, to its mouth at the Pacific Ocean.

Currently, 7,400 acres of the 56,000-acre Yurok Reservation is held in trust status. Simpson Timber Company and a few other private landowners control more than 85% of the land within the boundaries of the reservation. A smaller portion of the Reservation consists of public lands managed by Redwood National/State Parks, the United States Forest Services, and the Bureau of Land Management.

The Ah Pah Creek assessment area totals approximately 15.9mi (10,176 acres) and includes the entire hydrological watershed draining into Ah Pah Creek (Figure 1). Approximately 0.1 $mi.^2$ of the lower Ah Pah Creek basin is comprised of a tribal allotment. Simpson Timber Company manages the rest of the land within these 2 drainages, for commercial timber production. The lower portions of the Simpson-owned Ah Pah Creek actually lie within the Yurok Reservation boundaries. The Tectah Creek assessment area totals approximately 20.1 mi^2 (12,864 acres) and includes the entire hydrological watershed draining into Tectah Creek (Figure 1). Simpson Timber Company manages 19.9 mi^2, encompassing the entire watershed, for the commercial production of timber.

Fisheries Background

Historically, Klamath River steelhead and spawning adult salmon, including spring and fall run Chinook and Coho species, once numbered more than a million each year. The total annual salmon harvest and escapement to the Klamath Basin averaged 300,000 to 400,000 fish between 1915 and 1928 (Rankel 1978). But now these fish are in serious decline, as their abundances have fallen significantly enough to warrant Federal listings under the Endangered Species Act.

LAND USE HISTORY

Tribal Use

For centuries Yurok people have lived along the Pacific Coast and inland along the Klamath River. The river and the ocean have become the central focus of Yurok Tribal life. In the early 1900's, anthropologist Alfred Kroeber noted that the Yurok language and oral history reflected the relationship between the people and the Klamath River. Yurok myths and legends are rich with references to the river. Indeed, nearly every aspect of Yurok life was, and continues to be, bound to the river's fisheries (Yurok Strategic Plan, 1999).

Fishing

Although the first impacts of white settlers upon the valleys of the Klamath River Basin were related to gold mining and refining, those settlers quickly recognized the wealth and importance of the river's fisheries. Competition with the Yurok people over those resources soon began. By the 1930's, a booming commercial fishing industry was well established upon the river and its outlying ocean. Innumerable photographs and postcards from the '30's through the early 1960's hail Klamath, California as the "Salmon Fishing Capital of North America." Even as the commercial fishery began to decline in the 1970's and '80's, the Klamath River remained a recreational salmon fishing Mecca.

Timber Harvesting

The harvesting of timber has remained one of the main economic staples for the Lower Klamath River Basin's portion of the "Redwood Empire" for more than a century. Although logging only locally impacted the forests in the early days, the advent of powerful hydraulic technologies allowed timber cutting to quickly spread across the Klamath Basin.

By the late 1940's clear-cutting had begun within the Ah Pah and Tectah Creek basins, and by the mid 1960's approximately 50% of the drainages had been logged (Yurok Tribe, 1997). By 1988 essentially all old growth trees from both creeks had been removed (see Harvest Unit Maps, Figures 2 and 3). Roads were constructed concurrent with harvest operations in the Ah Pah and Tectah basins (see Road Construction History Maps, Figures 4 and 5). Most logging roads in the watersheds were constructed with in-sloped or crowned prisms, and with inboard ditches. These roads were built within steep inner gorge localities, as well as in gentler upland hill slope areas.

Tourism

With the dramatic decline in both the fishing and timber industries, tourism now remains the number one source of income for the Lower Klamath River region. Tourism is so intimately connected to the redwood forests and to recreational fishing that the protection and restoration of both is paramount to local economic well-being. Restoration of logged watersheds offers the greatest potential for restoration of the fisheries.

PRIORITIZATION OF THE LOWER KLAMATH WATERSHEDS

The choice of the Ah Pah and Tectah Creek drainage basins as hosts for the initial (training/implementation) phase of the Tribe's strategic plan for the Lower Klamath River was based largely upon the management decisions of Tribal, Federal, and private agencies working together.

Figure 2: Ah Pah Creek Harvest Unit Map

Figure 3: Techtah Creek Harvest Unit Map

Figure 4: Ah Pah Creek Road Construction History

Figure 5: Tectah Creek Road Construction History

Long-Range Planning

Significant long-term improvement of the anadromous Klamath River fishery is dependent upon many factors, with two major components being:

1. In-stream water flows
2. Habitat restoration and stabilization

A Long-Range Plan was developed by Kier & Associates (1991) for the Klamath Restoration Program (Public Law 99-552). Pages 3-21 to 3-25 of the plan state that, "The low number of anadromous salmonids in the Lower Klamath tributaries is directly related to sediment problems. …Only changes in land use management and large-scale watershed stabilization efforts can effectively address these problems and begin the process of recovery of the Lower Klamath tributaries. …Only by reducing the sediment supply of the entire Klamath River Basin, and allowing time for natural recovery, can the current problems be fully resolved."

A Project Advisory Committee, the Lower Klamath Restoration Partnership (LKRP), composed of representatives of the Yurok Tribe Natural Resources Department, Simpson Timber Company, and the California State Coastal Conservancy, has developed a comprehensive "Watershed Restoration and Enhancement Plan" for the Lower Klamath River Sub-basin. The Lower Klamath Sub-basin was identified as the sub-basin with the highest number of "critical" and "high priority" watershed problems requiring treatment.

The Ah Pah and Tectah Creek tributaries were prioritized as immediate candidates for restoration, both having high restoration potential and habitat that is relatively intact, with good connectivity and biological diversity (Table 1).

Table 1: Lower Klamath Watershed Restoration Plan Prioritization Table

Sub-Basin	Anadromous Salmonid Diversity (1-5)	Relative Biological Importance (1-5)	Channel & Riparian Condition (1-5)	Habitat Connectivity (1-5)	Road Density (1-5)	Stream Crossing Density (1-5)	Total (1-30)	Rank (1-30)
Salt Creek	2	2	2	2	2	1	11	26
High Prairie Creek	2	1	3	1	2	2	11	25
Hunter Creek	5	4	2	2	2	2	17	11
Hoppaw Creek	4	3	2	1	3	3	16	12
Waukell Creek	2	1	1	1	4	3	12	24
Saugep Creek	2	1	1	2	3	2	11	30
Terwer Creek	5	5	4	3	2	2	21	3
McGarvey Creek	4	4	3	4	3	2	20	5
Tarup Creek	4	2	2	1	3	2	14	22
Omagaar Creek	3	1	2	1	2	2	11	29

Blue Creek								
-Mainstem	5	5	5	5	2	2	24	1
-Westfork	3	3	3	4	2	3	18	8
-Slide Creek	1	3	4	4	1	1	14	20
-Nickowitz Creek	2	3	4	4	1	1	15	13
-Crescent City Fork	5	5	5	5	1	1	22	2
Ah Pah Creek								
-Mainstem	3	3	3	2	5	3	18	9
-North Fork	3	2	2	3	2	2	15	14
-South Fork	3	3	3	2	4	5	19	7
Bear Creek	3	2	2	2	3	3	15	15
Surpur Creek	3	1	1	2	4	3	14	21
Little Surpur Creek	1	1	1	2	3	3	11	28
Tectah Creek	4	5	3	3	2	3	20	4
Johnsons Creek	4	3	2	2	2	2	15	16
Pecwan Creek	3	2	3	2	2	2	14	18
Mettah Creek	4	4	3	4	2	2	19	6
Roaches Creek	3	3	3	3	2	3	17	10
Morek Creek	1	1	3	2	2	2	11	27
Cappell Creek	1	2	3	2	2	2	12	23
Tully Creek	1	3	3	3	2	2	14	19
Pine Creek	3	3	3	3	1	1	14	17

PHYSIOGRAPHY OF THE WATERSHEDS

Geology

Rocks of the "Franciscan (geological) Formation" underlie the Ah Pah/Tectah drainage basins. The lowest portion of the basin, from the river's mouth up to around Pecwan, is located within a belt of rocks known as the "Franciscan Formation"(Yurok Tribe/Restoration Plan 2000). This formation is a collection of rocks comprised predominantly of sandstones, shales, and minor conglomerates, which are composed of the fluvial/oceanic sediments that are commonly found along a continental shelf margin. These sediments were essentially thrust up onto the edge of North America by faulting, as part of the construction of the North Coast Ranges. This mountain building began around the end of the Jurassic Period (approximately 140 million years ago), and continues to this day.

"Splinters" of metamorphic rocks have become incorporated into the Franciscan Formation. These rocks were derived from the deep-sea volcanic and sedimentary rocks upon which the continental shelf sediments were originally deposited. High pressures and temperatures associated with deep burial beneath the continental sediments have essentially "baked" these deep-sea rocks into denser forms. These denser metamorphic rocks are more resistant to weathering than surrounding sedimentary rocks, and are therefore being exposed (by erosion) as prominent monolithic knobs known as "knockers."

Since the rocks of the Franciscan Formation were generally uplifted along the continental rim by faults, they have been broken up and pulverized along fault zones. Shearing along these zones is typically so intense that the rocks are ground into clays, which form extremely unstable hill slopes. This, coupled with heavy seasonal precipitation, greatly increases the potential for landslides within the Ah Pah/Tectah region.

Ah Pah Creek Watershed

The Ah Pah Creek watershed encompasses approximately 15.9 mi.^{2} (10,944 acres) and includes the entire hydrologic watershed draining into Ah Pah Creek, along with the east side of South Fork Ridge, which drains directly into the Klamath River (Figure 1). Simpson Timber Company manages approximately 15.8 mi2, encompassing the entire upper watershed, for commercial timber production. Approximately 0.1 mi.^{2} of the lower watershed is managed as the White Sanders Tribal allotment.

Tectah Creek Watershed

The Tectah Creek watershed encompasses approximately 20.1 mi^2 (12,736 acres) of the watershed and includes the entire hydrological watershed draining into Tectah Creek (Figure 1). Simpson Timber Company manages 20.1 mi^2, encompassing the entire watershed, for commercial timber production.

PRIORITIZATION OF WORK SITES

During the winters of 1997-1999, the Yurok Tribe conducted watershed assessment surveys in the Ah Pah and Tectah Creek watersheds. Recommendations from these detailed assessment reports (Yurok Tribe, '98, '99) were considered in choosing the roads for decommissioning during 1999's Training/Implementation Program. The YWRD conducted an assessment of all potential sediment sources associated with road networks and upslope sediment sources. Some of the factors that were considered were:

- Simpson Timber Company's long-range management plans
- Location within the watershed
- Erosion potential and associated volumes
- Cost effectiveness of the work proposed
- Potential delivery to a stream channel

The result of Assessment work showed that approximately 507,294 yds of sediment could be prevented from entering Ah Pah and Tectah Creeks. Using a projected cost between $7.50 and $8.00 per cubic yard, it would cost $ 3,982,727 to treat all identified work locations within the two watersheds. Due to limited funds, work sites with the highest erosion potential are treated first in the most cost-effective way.

TRAINING PROJECT

Introduction

On July 5, 1999, a 16-week Training and Implementation Program began. Nine Tribal members were employed into the program, which was broken into 2 phases:

1. A four-week long lecture/laboratory phase that taught the basic principles and assessment methodologies currently used by watershed restoration technologists.
2. A twelve-week long training/implementation phase consisting of practical (hands-on) field experience utilizing heavy equipment.

The initial four weeks of lecture/laboratory training ended on July 30th, after which the twelve-week field training/implementation project began. This secondary training officially ended on October 20, 1999. The Yurok Watershed Restoration Department in-house geologist, Dee Randolph, and Craig Benson Consulting Services provided the lecture/laboratory training. The twelve-week heavy equipment field training was provided through a collaborative effort of the aforementioned individuals, and three contracted Tribal Elders with 120 years combined heavy equipment operation and maintenance experience.

Training Approach

The collaborative team training was designed around the principles and standards employed by the Watershed Restoration Division of Redwood National Park. The goal of the training was to produce individuals able to take on the previously separately defined roles of ground personnel and heavy equipment operator. The team training stressed an interdisciplinary approach to watershed restoration; in which ground personnel, heavy equipment operators, site managers, and program managers (administrators) were all given a basic understanding of each other's skills, goals, and duties so that they became a more integrated team.

As compared to past training designs, the 1999 training was somewhat reduced in scope to the "bare bones" essential practical training elements. Each week of the first phase of training had a lecture/laboratory, which was fully supported by a series of 2.5-hour sessions. The lecture/laboratory phase, which focused on assessment skills for ground personnel, was reduced from thirty days to twelve days. The training/implementation phase was augmented to enhance productive competence for heavy equipment operators. Past training and subsequent field experience have yielded a competent pool of assessment technicians within YWRD, while the need for well-trained heavy equipment operators has increased.

Training Site Location

The first phase of training included lecture/laboratory instruction in the general concepts of watershed assessment and restoration. Training was conducted daily, typically starting with morning classroom presentations at the YWRD office in Orick, CA, and then transitioned to mid-morning/afternoon field study sessions. Field trips were taken to sites throughout Ah Pah and Tectah Creeks, Redwood National Park, Stagecoach Hill, and Hoopa.

The twelve week second phase (hands-on field training and implementation) took place along several prioritized roads within Ah Pah Creek watershed. These roads are described in the "Project Implementation" section of this report (pg. 22).

Training

The initial four week lecture/laboratory training period focused on the basic concepts and skills involved in watershed restoration work; including ecological assessment, roads assessment, project prioritization, site layout, implementation, and monitoring. This component of the training curriculum was designed to develop watershed assessment skills of trainees. It included both air photo analysis and ground-truthing to gain an overview of slope and fluvial erosional processes, road building history, silvicultural, and natural disturbance regimes. A basic awareness of watershed reference conditions greatly enabled trainees to better recognize and assess the origins and/or trigger mechanisms of ground problems encountered in the current watershed condition. Important auxiliary information, such as identifying species and sites of cultural significance, made up an additional portion of the training.

Trainees were taught how to perform geomorphic investigations and how to prescribe, design, survey, layout, and implement labor-intensive treatments including biotechnical solutions. They were further trained to assist and supervise heavy equipment operations, and to provide logistical support during the project.

Heavy equipment operators were trained to perform restoration treatments, as prescribed by ground personnel. Thus, operators were taught how to physically affect road and skid trail decommissioning/obliteration; to excavate unstable fill in stream and/or "Humboldt" type crossings; to excavate unstable fill at potential and active slides and earth-flow locations; to scarify compacted surfaces for accelerated revegetation; and to eliminate any diversion potentials. The majority of their operational skill-level training took place during their work in the implementation phase of the program. Equipment safety and maintenance comprised a significant portion of the second phase of training.

Trainee Self-evaluation

Trainees completed both an entry level skills assessment and an exit level skills assessment form that allowed them to evaluate their competence level in fifty separate training skills. Entry-level trainees assessed their skill level from 0 (no skill) to 1 (some skill) with a few claiming 2 (moderate skill) for the fifty skill areas. At the end of training, trainees evaluated themselves as having attained 3 (good skill) to 4 (high skill) in all 50-skill areas. Confidence levels were highest in assessment skills, while heavy equipment operation skills were considered good, but not expert, by many trainees.

Post-Training

Of the nine Tribal members that were trained during the program, one had already received instruction in watershed assessment work, and three had previous experience operating heavy equipment. Three of the graduates from the training program were retained as ground personnel for winter (1999-2000) assessment work in the Blue Creek Watershed. Two graduates were contracted out to United Indian Health Services to provide erosion control and revegetation services at the Potawot Health Village project in Arcata, CA during the winter of 1999.

GENERAL METHODOLOGY

The 1999 Ah Pah and Tectah Watershed Training and Implementation Program utilized the "Ah-Pah Creek Watershed Assessment" (Yurok Tribe, 1998) and the "Tectah Creek Watershed Assessment (Yurok Tribe, 1999) reports to prioritize roads for hydrologic decommissioning. Those reports offer detailed descriptions of the assessment process that was used. The 1999 Training/Implementation Program outlined seven basic (post-assessment) steps used to target/prioritize roads, prepare them for work, and to implement their hydrologic decommissioning.

Step #1: Air Photo Analysis

The first step was to assemble and analyze aerial photographs, digital and/or relevant maps and literature available for the Ah-Pah and Tectah Creek basins. Air photos were used to determine whether hillslopes were cable yarded or tractor logged. Not as much emphasis was placed upon a hillslope if it was cable yarded, because it was less likely to have water diversions, since no tractor-skidded trails were created. Skid crossings and associated water diversions were relatively common if a hillslope had been tractor logged. Roads and skid trails were located and mapped, using stereo-pair air photo analysis. The air photographs were later used (wherever possible) as basis for the geomorphic mapping described in Step #3 below.

Step #2: Road Primary-Line Survey

Once a road was chosen for decommissioning, a field crew of two to three people measured the entire road length and bearings with a tape measure and compass. Beginning at one end of the road, the crew took compass bearings and hung station flagging every one hundred feet as they walked to the other end. Flags were ideally hung high against the cut bank, so they wouldn't be lost or destroyed when the bulldozer reopened the road. After they finished their "primary-line," the road crew transcribed their data onto graph paper (with aid of a protractor), thus creating a two-dimensional plan view of the road and its directions. Sites that were previously identified during the 1997-1999 winter assessments were added to the primary-line for relative location information.

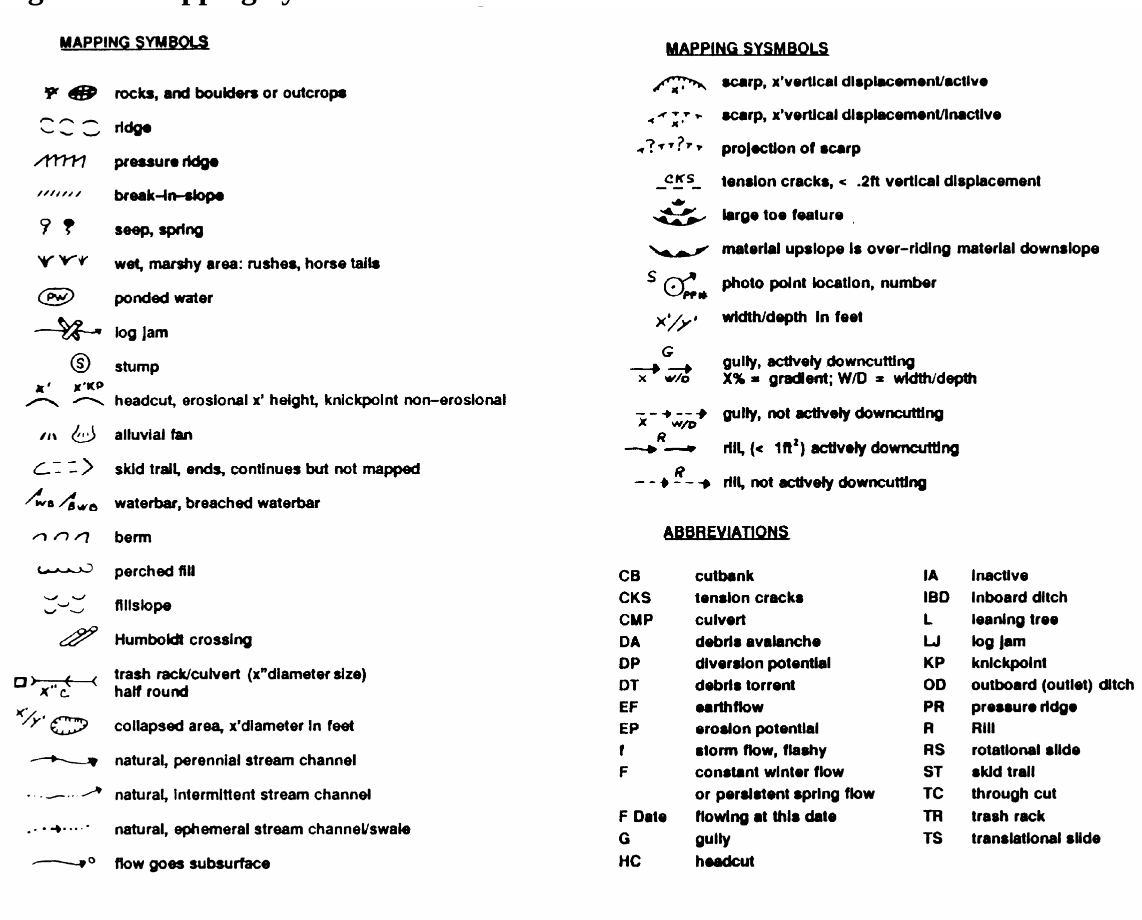
Step #3: Geomorphic Mapping

Geomorphic mapping is the mapping of locations and spatial relationships between drainage and geographical features within a given area. The mapping is used to help identify drainage diversions that are located upslope from roads to be decommissioned, so that these diversions can be corrected at their source. It would be pointless to treat a diversion problem on a road to be decommissioned, if the source of the problem is above the road and can ultimately fail back onto the road after decommissioning is completed.

During the 1998 field program, crews traversed the slopes above and below targeted roadways, then identified and mapped all road and skid trail stream crossings, as well as diverted waterways (i.e., rills & gullies). Mapping was done on Mylar overlays attached to air photos of the area. If vegetative cover obscured air photos, the features were instead recorded upon "primary-line" maps (see Step #2).

Other information recorded during geomorphic mapping included; site number/location, type of site, erosion potential, erosional features such as landslides, debris torrents, washed out stream crossings, springs/seeps, and all culvert locations (including ditch-relief culverts). Landmark-features; such as dry swales, landings, and old-growth snags/stumps were sometimes added for location-reference in the field. The symbols used for mapping these features are shown in Figure 6.

Figure 6 - Mapping Symbols



Step #4: Site Prescription and Layout

After the geomorphic investigations were completed, remedial treatments were identified for each problem site and then "prescribed" in notes, upon maps, and on survey flagging (at the site) for the heavy equipment operator to see. The limits of the excavation work were also flagged and given three-letter code designations to let the operator know his/her whereabouts within the site. For example, the top and bottom of an excavation were flagged as "TOP" and "BOT," respectively. Other three-letter designations included IBR (in-board road), OBR (outboard road), OBF (out-board fill), LEC (left edge of cut), REC (right edge of cut), CTH (cut to here), and FTH (fill to here). This procedure is generally referred to as road "layout."

The process of identifying treatments ("prescriptions") for erosional problems began at the end of the road where decommissioning would begin. Since heavy equipment cannot move across a road after it has been decommissioned (without damaging the work), decommissioning is essentially done while "backing out" of a road. Illustrations of the road prescriptions that were used during the training/implementation program are shown in Figure 7.

The field crew also measured a profile across each excavation site, using either a survey tape/clinometer or a laser range finder. The profile was run along a line from the TOP to the IBR, then across the road bench to the OBR, then down to the BOT. From this profile, a set of formulas was used to estimate the volume of road fill material that needed to be excavated during decommissioning. An example of a site profile (including the formulas used to estimate fill volume) is shown in Figure 7**.**

Step #5: Implementation

Ground personnel were in charge of site management. This included overseeing the work done by heavy equipment operators. The ground crews made certain that the operator's excavated fill down to the original natural-ground surface. This surface was approximated by:

1. Locating excavated stumps and using them as indicators of original base level.
2. Identifying discolored (organic rich) soil horizons, presumably at the level of buried topsoils.
3. Imitating the contours of surrounding natural slopes.

Ground personnel were also responsible for correcting water diversions (e.g., across or along roadways) by ensuring that all diverted surface drainage was redirected into natural channels. Ground crews monitored the work done by heavy equipment operators and their machinery. By tracking an operator's equipment work vs. downtime in their notebooks, ground personnel could perform comparative analyses of the relative efficiencies of each worker and operator team (i.e., a bulldozer and excavator working in tandem). Since heavy equipment time was the most expensive part of the project, each pair of dozer/excavator operators was taught to work as a coordinated unit, thus making them as cost-effective as possible. Both operators had to develop teamwork to ensure that they didn't move dirt more times than necessary, and to reduce the time lost waiting for each other to perform his or her respective tasks.

Road Inventory Form

Figure 7: Field Inventory Data Form (This page is landscaped)

<u>Worksheet For Stream Crossing Volumes</u> (This page also landscaped)

Initially, the bulldozers were used to brush open those roads that were chosen for hydrologic decommissioning. The dozer operators were generally sent to "prepare" the fluvial and mass movement work sites (by removing as much fill material as possible) ahead of the excavators. Next, each dozer/excavator team began working in tandem to remove all targeted fill from the site. The excavators would typically "switch-back" down to the bottom of the fill margin and then feed material up to the bulldozers. The dozer operators then pushed this material up a ramp-like road, to a disposal area off of the site. Disposal areas included the backsides of stable landings, proximal skid trails, through-cuts, and Full Out Slope sites(FOS).

Step #6: Post-Work Site Survey

At the end of the field season, a post-excavation volume inventory was taken of all stream crossings that had been removed by heavy equipment. This "post-work site survey" was used to appraise the effectiveness and accuracy of the volume-estimation process used by field workers during the initial 1997-1999 winter assessment projects.

The post-work site surveys were performed in essentially the same manner as described at the end of Step #4: Site Prescription and Layout. Using either a survey tape/clinometer or a laser range finder, the field crew measured a profile along the bottom of the (now-excavated) stream channel. This profile was run from the original TOP flag down to the BOT flag. An additional (cross-sectional) profile was measured from the LEC-to-the-REC flags, incorporating the slope angles of the channel walls and the stream-bottom channel width. Utilizing the same set of formulas used to estimate the volume of road fill material in Figure 7, the actual volume of fill material that had been excavated from each stream crossing was determined and compared with the pre-work field estimates. The percentage accuracy generated from these comparisons was recorded in the tables in Appendix A.

Step #7: Effectiveness Monitoring

All phases of the Ah Pah and Tectah implementation project were photo-documented as part of an ongoing effort to improve the effectiveness of future restoration efforts. Pre- and post-restoration photo point localities were established along the entire lengths of the roads that received work, to evaluate the results of that work, and to monitor the recovery of the watershed through time. Photos were typically taken looking down-road, from photo point-to-photo point. The photo points were sequentially located at the limit-of-view from each previous photo. Stream crossings were photographed separately, from above and below, to better illustrate their cross-sectional morphologies. All photo points are consecutively numbered and are marked in the field with yellow-flagged monuments.

PROJECT IMPLEMENTATION

Roads were chosen for implementation based upon:

1. The cost-effectiveness of the work required for their hydrologic decommissioning.
2. The erosion/delivery potential.

Prior to initiating any work, and as a result of the Lower Klamath Long-Range Plan (Kier, 1991), tribal staff and Simpson representatives set up goals and objectives for Lower Klamath

River restoration. As part of the process, a long-range road plan was generated. Roads were prioritized as either "upgrade" or "decommission" based upon location within the watershed, soil type, and future timber harvest plans (Figures 8 and 9). Upgrade roads were to be maintained for future timber harvest plans, but would require upgraded culverts and drainage structures for maximum drainage efficiency. "Decommission" roads would have their fill removed from all crossings, and from all fill failures noted to have delivery potential to a stream.

<u>Work Priority</u>

Ah Pah Creek Watershed

The roads in Ah Pah Creek Watershed that were designated as "high priority" for work included the:

- B-1100 (decommission)
- B-1070 (decommission)
- B-1882 (decommission)
- B-1200 (upgrade)
- B-1010 (upgrade)
- B-1000 (upgrade)
- S-Line (upgrade)
- B-Line (upgrade)

Tectah Creek Watershed

The roads in the Tectah Creek Watershed that were designated as "high priority" for work included the:

- T-100 (decommission)
- T-140 (decommission)
- T-145 (decommission)
- T-211 (decommission)
- T-514 (decommission)
- T-510 (decommission)

Figure 8: Ah Pah Road Classification Map

Figure 9: Tectah Creek Road Classification Map

AH PAH CREEK WATERSHED

Roads Worked
Roads worked in the Ah Pah Creek Watershed included the:

- B-1070 (decommission)
- B-1700 (decommission)
- B-1882 (decommission)
- S-9 (decommission)

B-1070 (and spurs)
The B-1070 was constructed in 1958, and was approximately 1.3 miles long. It was located in the South Fork of the Ah Pah Creek Watershed (Figure 4), within inner gorge and upper slope settings.

It was estimated that for the 1070 there would be a total of 26,207yd.^{3} of fill removed. Post-implementation work surveys estimated that 38,983yd.^{3} were actually removed. These two figures have a difference of 33%. Assessment estimates for the B-1070 were consistently low because of an unforeseen amount of large woody debris within the fill prism, adding to the complexity of the sites. Appendix A Table 4 illustrates the amount of estimated fill removal versus the actual amount removed. Some of the smaller fluvial sites (seeps and small springs) did not receive full excavation, but were instead crossroad drained.

B-1700 (and spurs)

The B-1700-A was constructed in 1966, and was approximately 1.74 miles long. It was located in the headwaters of the Mainstem Fork of the Ah Pah Creek Watershed (Figure 4), within the inner gorge and upper slope settings.

The B-1700 and its spurs were excavated as part of the training program in 1999. It was estimated there would be a total of 7,794 yd.^{3} of fill removed. Post-implementation work surveys estimated that 7,307 yd.^{3} were actually removed, for a difference of 6%.

B-1882
The B-1882 was constructed in 1958, and was approximately .5 miles long. It was located in the headwaters of the South Fork of the Ah Pah Creek Watershed (Figure 3), within the inner gorge.

It was estimated there would be a total of 7,065 yd.^{3} of fill removed. Post-implementation work surveys estimated that 12,700 yd.^{3} were actually removed. These figures have a difference of 44%.

S-9
The S-9 was constructed in 1958, and was approximately 1.08 miles long. It was located in the

headwaters of the North Fork of the Ah Pah Creek Watershed (Figure 3), within the inner gorge.

It was estimated there would be a total of 14,321 of fill removed. Post-implementation work surveys estimated that 16,185 yd^3. were actually removed. These figures have a difference of 12%.

Figure 10: Ah Pah Creek Road Site Work Map

TECTAH CREEK WATERSHED

Roads worked in the Tectah Creek Watershed include the:

- T-100
- T-140
- T-145
- T-211
- T-514
- T-510

T-100

The T-100 was constructed in 1966, and was approximately .53 miles long. It was located in the headwaters of the Tectah Creek Watershed (Figure 5). It was estimated there would be a total of 10,408 yd^3 of fill removed. Post-implementation work surveys estimated that 11,921 yd^3 were actually removed. These figures have a difference of 13%.

T-140

The T-140 was constructed in 1966, and was approximately .3 miles long. It was located in the headwaters of the Tectah Creek Watershed (Figure 5). It was estimated there would be a total of 4,411 yd^3 of fill removed. Post-implementation work surveys estimated that 3,728 yd^3 were actually removed. These figures have a difference of 15%.

T-145

The T-145 was constructed in 1975, and was approximately .6 miles long. It was located in the headwaters of the Tectah Creek Watershed (Figure 5). It was estimated there would be a total of 21,820 yd^3 of fill removed. Post-implementation work surveys estimated that 13,541yd^3 were actually removed. These figures have a difference of 38%.

T-211 (and spurs)

The T-211 was constructed in 1958, and was approximately 1.9 miles long. It was located in the headwaters of the Tectah Creek Watershed (Figure 5). It was estimated there would be a total of 35,982 yd^3 of fill removed. Post-implementation work surveys estimated that 42,472 yd^3 were actually removed. These figures have a difference of 15%.

T-510

The T-510 was constructed in 1966, and was approximately 1.0 mile long. It was located in the headwaters of the Tectah Creek Watershed (Figure 5). It was estimated there would be a total of 27,226 yd^3 of fill removed. Post-implementation work surveys estimated that 31,020 yd^3

were actually removed. These figures have a difference of 12%.

T-514

The T-514 was constructed in 1966, and was approximately .1 miles long. It was located in the headwaters of the Tectah Creek Watershed (Figure 5). It was estimated there would be a total of 651 yd^3 of fill removed. Post-implementation work surveys estimated that 600 yd^3 were actually removed. These figures have a difference of 8%.

Figure 11: Tectah Creek Watershed Road Site Work Map

FUNDING

Multiple agency grant funds were utilized for the overall project, as presented in the following table:

Table 2: Funding			
Project.	**Agency**	**Contribution**	**Area Worked**
	Fish & Wildlife Service (Jobs in the Woods) Fish & Wildlife Service (Jobs in the Woods) Fish & Wildlife Service (Klamath River Basin Fisheries Task Force)	$96,212.00 $99,943.00 $64,315.00	B-1882, B-1070 T-510 T-211 & Spurs

		Simpson	
Funding Agency	**Contribution**	**In-Kind**	**Cost-Share**
Fish & Wildlife Service (Jobs in the Woods)	**$96,212.00**		**$35,400.00**
Fish & Wildlife Service (Jobs in the Woods)	**$99,943.00**		**$50,000.00**
Fish & Wildlife Service (Klamath River Basin Fisheries Task Force)	**$64,315.00**	**$2000.00***	

*** S**impson Timber Company contributed the use of their lowboy truck to transport Tribal heavy equipment to and from the project site.

FUTURE WORK

Future work for the upcoming field season (2000/2001) will include projects in the Ah Pah and Tectah Creek Watersheds.

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APPENDICES

APPENDIX A: Roads Survey Data

APPENDIX B: Glossary

APPENDIX C: Photos

APPENDIX A: Roads Survey Data

Ah Pah Creek Watershed:

Table 4: PRE/POST-WORK DONE ON THE *B-1070*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
8.5	FLUVIAL EROSION	300	670	55%
8.6	ROAD REACH	1826	1,826	0%
9.0	FLUVIAL EROSION	370	2,306	84%
9.5	ROAD REACH	6,155	6,155	0%
10.0	FLUVIAL EROSION	510	1,607	68%
10.5	ROAD REACH	466	466	0%
11.0	FLUVIAL EROSION	-	-	0%
11.5	ROAD REACH	375	375	0%
12.0	FLUVIAL EROSION	-	-	0%
12.4	ROAD REACH	319	319	0%
12.5	FLUVIAL EROSION	268	1,262	79%
12.6	ROAD REACH	284	284	0%
13.0	FLUVIAL EROSION	281	1,219	77%
13.5	ROAD REACH	870	870	0%
14.0	FLUVIAL EROSION	22	520	96%
14.5	ROAD REACH	471	471	0%
15.0	FLUVIAL EROSION	237	91	62%
15.5	ROAD REACH	657	657	0%
	TOTALS	**13,411**	**19,098**	**30%**

Table 5: PRE/POST-WORK DONE ON THE *B-1070-A*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	FLUVIAL EROSION	976	976	0%
0.6	ROAD REACH	70	70	0%
1.0	FLUVIAL EROSION	401	1,624	75%
1.4	ROAD REACH	210	210	0%
1.5	MASS MOVEMENT	329	329	0%
1.6	ROAD REACH	168	168	0%
2.0	FLUVIAL EROSION	535	3,527	85%
2.4	ROAD REACH	235	235	0%
2.5	MASS MOVEMENT	699	699	0%
2.6	ROAD REACH	213	213	0%
3.0	FLUVIAL EROSION	384	2,741	86%
3.5	ROAD REACH	322	322	0%
4.0	MASS MOVEMENT	370	370	0%
4.5	ROAD REACH	1,481	1,481	0%
5.0	MASS MOVEMENT	122	122	0%
5.5	ROAD REACH	289	289	0%
	TOTALS	**6,804**	**13,376**	**49%**

<u>Table 6</u>: PRE/POST-WORK DONE ON THE *B-1070-C*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	244	244	0%
1.0	FLUVIAL EROSION	713	1,474	52%
1.5	ROAD REACH	571	571	0%
2.0	FLUVIAL EROSION	970	970	0%
2.5	ROAD REACH	1,176	1,176	0%
3.0	FLUVIAL EROSION	716	716	0%
3.5	ROAD REACH	267	267	0%
4.0	FLUVIAL EROSION	640	640	0%
4.5	ROAD REACH	695	695	0%
	TOTALS	**5,992**	**6,509**	**8%**

<u>Table 7</u>: PRE/POST-WORK DONE ON THE *B-1700-A*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	573	573	0%
1.0	FLUVIAL EROSION	180	10	94%
1.5	ROAD REACH	195	195	0%
2.0	FLUVIAL EROSION	1,421	1,059	25%
2.3	ROAD REACH	209	209	0%
2.5	ROAD REACH	182	182	0%
2.6	ROAD REACH	262	262	0%
3.0	FLUVIAL EROSION	242	372	35%
3.5	ROAD REACH	157	157	0%
4.0	MASS MOVEMENT	77	77	0%
4.5	ROAD REACH	192	192	0%
5.0	FLUVIAL EROSION	67	24	64%
5.5	ROAD REACH	93	93	0%
6.0	MASS MOVEMENT	141	141	0%
6.5	ROAD REACH	90	90	0%
7.0	MASS MOVEMENT	392	392	0%
7.5	ROAD REACH	76	76	0%
8.0	MASS MOVEMENT	178	178	0%
8.5	ROAD REACH	115	115	0%
9.0	FLUVIAL EROSION	13	126	90%
9.5	ROAD REACH	108	108	0%
10.0	MASS MOVEMENT	49	49	0%
10.5	ROAD REACH	94	94	0%
11.0	FLUVIAL EROSION	442	154	65%
11.5	ROAD REACH	104	104	0%
12.0	FLUVIAL EROSION	216	14	94%
12.5	ROAD REACH	149	149	0%
13.0	FLUVIAL EROSION	131	140	6%
13.5	ROAD REACH	137	137	0%
14.0	FLUVIAL EROSION	12	147	92%
14.5	ROAD REACH	151	151	0%
15.0	FLUVIAL EROSION	131	334	61%
	TOTALS	**6,579**	**6,104**	**7%**

Table 8: PRE/POST-WORK DONE ON THE *B-1700-B*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	114	114	0%
1.0	MASS MOVEMENT	122	122	0%
1.5	ROAD REACH	122	122	0%
2.0	FLUVIAL EROSION	294	282	4%
2.5	ROAD REACH	349	349	0%
3.0	FLUVIAL EROSION	67	67	0%
3.5	ROAD REACH	147	147	0%
	TOTALS	**1,215**	**1,203**	**1%**

Table 9: PRE/POST-WORK DONE ON THE *B-1882*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
24.0	FLUVIAL EROSION	485	3,736	87%
24.5	ROAD REACH	1,578	1,578	0%
25.0	FLUVIAL EROSION	223	894	75%
25.5	ROAD REACH	409	409	0%
26.0	FLUVIAL EROSION	1,248	2,018	38%
26.5	ROAD REACH	386	386	0%
27.0	FLUVIAL EROSION	618	1,072	42%
27.5	ROAD REACH	1,000	1,000	0%
28.0	FLUVIAL EROSION	320	571	44%
28.5	ROAD REACH	144	144	0%
29.0	FLUVIAL EROSION	155	892	83%
29.5	ROAD REACH	499	499	0%
	TOTALS	**7,065**	**12,700**	**44%**

Table 10: PRE/POST-WORK DONE ON THE *S-9*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd3)	Post-Work (yd3)	% Difference
0.5	ROAD REACH	187	187	0%
1.0	FLUVIAL EROSION	2,085	1,916	8%
1.5	ROAD REACH	1.191	1,191	0%
2.0	FLUVIAL EROSION	18	15	17%
2.5	ROAD REACH	445	445	0%
3.0	FLUVIAL EROSION	1,307	1,582	17%
3.5	ROAD REACH	1,450	1,450	0%
4.0	FLUVIAL EROSION	1,171	2,179	46%
4.5	ROAD REACH	1,970	1,970	0%
5.0	FLUVIAL EROSION	1,445	1,405	3%
5.5	ROAD REACH	1,015	1,015	0%
6.0	FLUVIAL EROSION	340	648	48%
6.5	ROAD REACH	1,132	1,132	0%
7.0	FLUVIAL EROSION	565	1,050	46%
	TOTALS	**14,321**	**16,185**	**12%**

AH PAH TOTAL	**55,387**	**77,309**	**28%**

Tectah Creek Watershed:

<u>Table 11:</u> PRE/POST-WORK DONE ON THE *T-100*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
52.5	ROAD REACH	496	496	0%
53.0	FLUVIAL EROSION	260	320	19%
53.5	ROAD REACH	211	211	0%
54.0	FLUVIAL EROSION	1,633	2,904	44%
54.5	ROAD REACH	126	126	0%
55.0	MASS MOVEMENT	526	405	23%
55.5	ROAD REACH	160	160	0%
56.0	FLUVIAL EROSION	260	574	55%
56.5	ROAD REACH	228	228	0%
57.0	FLUVIAL EROSION	0	0	0%
57.5	ROAD REACH	245	245	0%
58.0	MASS MOVEMENT	1,042	1,042	0%
58.5	ROAD REACH	330	330	0%
60.0	MASS MOVEMENT	1,250	1,250	0%
60.5	ROAD REACH	568	568	0%
61.0	FLUVIAL EROSION	208	208	0%
61.5	ROAD REACH	687	687	0%
62.0	FLUVIAL EROSION	41	124	67%
62.4	ROAD REACH	1,248	1,248	0%
62.5	FLUVIAL EROSION	226	132	42%
62.6	ROAD REACH	663	663	0%
	TOTALS	**10,408**	**11,921**	**13%**

<u>Table 12:</u> PRE/POST-WORK DONE ON THE *T-140*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
1.0	FLUVIAL EROSION	270	270	0%
2.0	MASS MOVEMENT	176	176	0%
2.5	ROAD REACH	338	338	0%
3.0	FLUVIAL EROSION	492	318	35%
3.5	ROAD REACH	112	112	0%
4.0	MASS MOVEMENT	346	346	0%
4.5	ROAD REACH	169	169	0%
5.0	FLUVIAL EROSION	221	141	36%
6.0	FLUVIAL EROSION	236	283	17%
7.0	DISPOSAL SITE	N/A	N/A	N/A
8.0	FLUVIAL EROSION	108	40	63%
9.0	MASS MOVEMENT	342	342	0%
9.5	ROAD REACH	162	162	0%
10.0	MASS MOVEMENT	86	86	0%
10.5	ROAD REACH	277	277	0%
11.0	FLUVIAL EROSION	431	100	77%
11.5	ROAD REACH	322	322	0%
12.0	FLUVIAL EROSION	323	246	24%
	TOTALS	**4,411**	**3,728**	**15%**

Table 13: **PRE/POST-WORK DONE ON THE *T-145***
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
1.0	FLUVIAL EROSION	144	144	0%
2.0	MASS MOVEMENT	100	100	0%
3.0	FLUVIAL EROSION	115	112	3%
3.5	ROAD REACH	336	336	0%
4.0	FLUVIAL EROSION	357	103	71%
4.5	ROAD REACH	486	486	0%
5.0	MASS MOVEMENT	4,150	500	88%
5.5	ROAD REACH	646	646	0%
6.0	FLUVIAL EROSION	661	360	46%
7.0	FLUVIAL EROSION	189	0	100%
8.0	MASS MOVEMENT	476	476	0%
9.0	FLUVIAL EROSION	953	752	21%
9.5	FLUVIAL EROSION	463	461	0%
10.0	MASS MOVEMENT	2,697	2,697	0%
11.0	FLUVIAL EROSION	1,099	0	100%
12.0	FLUVIAL EROSION	1,540	513	67%
13.0	FLUVIAL EROSION	263	200	24%
14.0	MASS MOVEMENT	640	640	0%
15.0	MASS MOVEMENT	230	230	0%
	TOTALS	**15,545**	**8,756**	**44%**

Table 14: **PRE/POST-WORK DONE ON THE *T-145-A***
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	1,560	1,560	0%
1.0	MASS MOVEMENT	2,578	1,088	58%
1.5	ROAD REACH	2,137	2,137	0%
	TOTALS	**6,275**	**4,785**	**24%**

<u>Table 15:</u> PRE/POST-WORK DONE ON THE *T-211*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	352	352	0%
1.0	FLUVIAL EROSION	7	7	0%
1.5	ROAD REACH	1,920	1,920	0%
2.0	FLUVIAL EROSION	37	37	0%
2.4	ROAD REACH	768	768	0%
2.5	FLUVIAL EROSION	99	99	0%
2.6	ROAD REACH	816	816	0%
3.0	FLUVIAL EROSION	29	29	0%
3.5	ROAD REACH	2,682	2,682	0%
4.0	FLUVIAL EROSION	184	184	0%
4.5	ROAD REACH	384	384	0%
5.0	FLUVIAL EROSION	273	1,109	75%
5.5	ROAD REACH	2,416	2,416	0%
6.0	FLUVIAL EROSION	115	679	63%
7.0	FLUVIAL EROSION	136		
7.5	ROAD REACH	720	720	0%
8.0	FLUVIAL EROSION	112	982	89%
8.5	ROAD REACH	704	704	0%
9.0	FLUVIAL EROSION	263	587	55%
	TOTALS	**12,017**	**14,475**	**17%**

<u>Table 16:</u> PRE/POST-WORK DONE ON THE *T-211-A*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	777	777	0%
1.0	FLUVIAL EROSION	121	1,165	70%
2.0	FLUVIAL EROSION	230		
2.5	ROAD REACH	2,440	2,440	0%
3.0	FLUVIAL EROSION	321	373	14%
3.4	ROAD REACH	701	701	0%
3.5	FLUVIAL EROSION	88	392	78%
3.6	ROAD REACH	1,663	1,663	0%
4.0	FLUVIAL EROSION	131	131	0%
4.5	ROAD REACH	1,226	1,226	0%
5.0	DISPOSAL SITE	0	0	0%
5.5	ROAD REACH	550	550	0%
6.0	FLUVIAL EROSION	156	690	77%
6.5	ROAD REACH	932	932	0%
	TOTALS	**7,627**	**9,331**	**18%**

<u>Table 17:</u> PRE/POST-WORK DONE ON THE *T-211-B*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	361	361	0%
1.0	FLUVIAL EROSION	67	166	60%
1.5	ROAD REACH	185	185	0%
2.0	FLUVIAL EROSION	33	608	95%
2.5	ROAD REACH	202	202	0%
3.0	FLUVIAL EROSION	327	557	41%
3.5	ROAD REACH	237	237	0%
4.0	FLUVIAL EROSION	1,105	471	57%
4.5	ROAD REACH	1,264	1,264	0%
5.0	FLUVIAL EROSION	197	1,108	82%
5.5	ROAD REACH	1,172	1,172	0%
6.0	FLUVIAL EROSION	104	125	17%
6.5	ROAD REACH	218	218	0%
7.0	FLUVIAL EROSION	108	50	54%
7.5	ROAD REACH	403	403	0%
8.0	FLUVIAL EROSION	83	80	4%
8.5	ROAD REACH	1,275	1,275	0%
9.0	FLUVIAL EROSION	414	374	10%
9.5	ROAD REACH	216	216	0%
10.0	FLUVIAL EROSION	219	650	66%
10.5	ROAD REACH	468	468	0%
	TOTALS	**8,658**	**10,190**	**15%**

<u>Table 18:</u> PRE/POST-WORK DONE ON THE *T-211-C*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	633	633	0%
1.0	FLUVIAL EROSION	446	449	1%
1.5	ROAD REACH	1,025	1,025	0%
	TOTALS	**2,104**	**2,107**	**0%**

<u>Table 19:</u> PRE/POST-WORK DONE ON THE T-211-D
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	1,044	1,044	0%
1.0	FLUVIAL EROSION	215	464	54%
1.5	ROAD REACH	403	403	0%
	TOTALS	**1,662**	**1,911**	**13%**

<u>Table 20:</u> PRE/POST-WORK DONE ON THE *T-211-E*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
0.5	ROAD REACH	1,336	1,336	0%
1.0	FLUVIAL EROSION	187		
1.5	ROAD REACH	320	320	0%
2.0	FLUVIAL EROSION	359	1,090	67%
2.5	ROAD REACH	1,712	1,712	0%
	TOTALS	**3,914**	**4,458**	**12%**

<u>Table 21:</u> PRE/POST-WORK DONE ON THE *T-510*
(SUMMER OF 1999)

Site	Site Type	Pre-Work (yd^3)	Post-Work (yd^3)	% Difference
22.0	FLUVIAL EROSION	2,484	3,968	37%
22.5	ROAD REACH	3,618	3,618	0%
23.0	DISPOSAL SITE			0%
23.5	ROAD REACH	692	692	0%
24.0	FLUVIAL EROSION	182	510	64%
24.5	ROAD REACH	188	188	0%
25.0	FLUVIAL EROSION	155	166	7%
25.5	ROAD REACH	202	202	0%
26.0	FLUVIAL EROSION	304	868	65%
26.5	ROAD REACH	230	230	0%
27.0	DISPOSAL SITE			0%
27.5	ROAD REACH	272	272	0%
28.0	FLUVIAL EROSION	357	594	40%
28.5	ROAD REACH	216	216	0%
29.0	MASS MOVEMENT	427	427	0%
29.5	ROAD REACH	230	230	0%
30.0	FLUVIAL EROSION	143	124	13%
30.5	ROAD REACH	202	202	0%
31.0	FLUVIAL EROSION	100	40	60%
31.5	ROAD REACH	118	118	0%
32.0	MASS MOVEMENT	978	978	0%
32.5	ROAD REACH	146	146	0%
33.0	FLUVIAL EROSION	8,744	9,306	6%
33.5	ROAD REACH	1,599	1,599	0%
34.0	MASS MOVEMENT	480	480	0%
34.5	ROAD REACH	2,584	2,584	0%
35.0	FLUVIAL EROSION	29	36	19%
36.0	FLUVIAL EROSION	1,560	2,240	30%
36.5	ROAD REACH	986	986	0%
	TOTALS	**27,226**	**31,020**	**12%**

Table 22: PRE/POST-WORK DONE ON THE *T-514 SKID*
(SUMMER OF 1999)

Site #	Site Type	Pre-work (yd^3)	Post-work (yd^3)	% Difference
0.5	ROAD REA CH	189	189	0%
1.0	FLUVIAL EROSION	76	68	11%
1.5	ROAD REACH	153	153	0%
2.0	FLUVIAL EROSION	71	28	61%
2.5	ROAD REACH	162	162	0%
	TOTALS	**651**	**600**	**8%**

TECTAH TOTALS	**100,498**	**103,282**	**3%**

APPENDIX B: PHOTOS

Pair of excavators

Photo

Stream crossing has been pulled.

APPENDIX C: Glossary

Abandoned Road: A road is considered "abandoned" when there is no evidence of maintenance or current use.
Anadromous: Fish that leave freshwater and migrate to the ocean to mature then return to freshwater to spawn.
Bottom Flag: A survey flag, which marks the bottom (BOT) of an excavation, at the lower extent of the fill slope at a stream crossing.
Cable Yarded: A modern type of power logging, where logs are attached to cables and dragged to a landing by means of a block-and-tackle, hung on a spar tree or steel tower or pole.
Channel Width: The estimated stream channel width during a 100-year flow event.
CLP: Refers to the "Centerline (of a) Profile". At stream crossings, this line is concurrent with the stream profile.
Complexity: Based upon the amount of large organic material within a road fill, &/or how much vegetation surrounds a work site; this refers to the difficulty of the work needed from heavy equipment.
Conglomerate: A sedimentary rock type, which is composed predominantly of cemented gravels.
Continental Shelf: A gently sloping, shallowly submerged platform of sediments that extends from the shoreline to the edge of the continental slope.
Continental Slope: The steeply sloping continental margin, which extends from the edge of the continental shelf down into the oceanic abyss.
Cracks: A crack is a break or split, usually without a complete separation of parts. These may be continuous or discontinuous, within a road reach.
Cross-road Drain: A ditch-like channel, excavated across a road fill prism, to drain a spring or seep. The fill material is not entirely excavated for an XRD.
Culvert: A transverse drain, usually a metal pipe set beneath the road surface, which drains water from the inside of the road to the outside of the road. Culverts are used to drain ditches, springs, and streams across the road alignment.
Cutbank: A steep embankment located immediately above a road bench that was created during road construction.
CTH: Acronym for "Cut-to-Here." This is a reference point, usually located at the bottom of the fill.
Debris Slide: A slow to rapid slide, involving down-slope translation of relatively dry and predominantly unconsolidated materials, with more than half of the particles being larger than sand size.
Debris Torrent: Rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods. This generally occurs in smaller, steep stream channels and results in scouring of the streambed.
Decommissioned Road: A road along which those elements that unnaturally reroute hill slope drainage, or present slope stability hazards, have been removed.
Deep Seated: A fill failure that cuts into most of the road prism, and takes natural ground along with it.
Disposal Site: A stable location for the stockpiling of fill removed from a work site.
Ditch Relief: A drainage structure or facility that will move water from an inside road ditch to an area

outside of the edge of the road fill.

Diversion Potential (DP): If a drainage structure is plugged, or could possibly become plugged, diverting water down a road and away from its natural channel, the stream is considered to have "diversion potential."

Drivable: A road that is passable to a standard four-wheel drive vehicle without having to clear any brush or make improvements.

DS: Acronym for "Disposal Site."

Earth-flow: A mass movement landform, and slow to rapid mass movement process, characterized by down-slope translation of soil and weathered rock, over a discreet shear zone at the base. Most of the included particles are actually smaller than sand.

EOS: Acronym for "Export Outslope."

Erosion Potential: This is the likelihood of a stream crossing or landslide to erode away road/slope material.

Excavation Production Rate: The rate of production at which dirt can be moved at a particular site, by a particular type of equipment.

Export Outslope: In areas where a road prism is composed entirely of unstable fill material (i.e., no dozer cut road bench) complete exportation to a stable storage location becomes necessary.

Fault: A fracture or zone of fractures within the Earth's crust, along which there has been relative movement and resultant shearing.

Faulting the oppositional movement of 2 blocks of the Earth's crust, along a fracture.

Fill: The material that is placed in low areas, compacted, and built up to form a roadbed or landing surface.

Fill Failure: Unstable fill, along the outside edge of a road, which is considered active or waiting to move down-slope.

Fluvial: Anything pertaining to streams or rivers; also organisms that migrate between main rivers and tributaries.

Fluvial Erosion Site: Fluvial erosion sites are places where erosion by the action of water is likely, as at a stream crossing.

Future Fill Failure: The estimated volume of a mass movement along a road bench or landing, caused by gravitational erosion &/or diversion of water, and measured in cubic yards.

Future Hill Slope Failure: The estimated volume of a mass movement upon a hill slope, which is related to gravitational erosion &/or diversion of water. Generally based on observed dimensions of existing hill slope failures, in nearby terrain, that have similar characteristics (e.g., slope position, geology, etc.).

Future Stream Erosion: The predicted volume of bank and/or bed erosion and streamside landslides, attributable to diversion at a crossing, and measured in cubic yards.

Future Percent Delivery to a Channel: The percentage of a volume of mass movement material reported in the field that will be transported to a stream channel.

Geomorphic Investigations: The overall study of a landscape and its drainage features.

Geomorphic Mapping: The mapping of drainage patterns along roads and their surrounding slopes.

Gully: An erosional channel that is formed by concentrated surface runoff, which is defined as larger than 1 $ft.^2$ in cross sectional area (i.e., 1 ft. depth by 1 ft. width). Gullies often form where road surface or ditch runoff is directed onto unprotected slopes.

Headwall Height: Headwall height is measured in inches, from the bottom of a culvert inlet, to the lowest point of the road fill at a crossing. This is the vertical distance between the point where water can enter a culvert and where water will flow over a road bench. Headwall height is used to assess the culvert capacity for each site.

Humboldt: A road-crossing drainage structure made out of logs laid in (and parallel to) streams channel and then covered over with road fill.

Hydrologic Decommissioning: The removal of those elements that unnaturally reroute hill slope drainage, or present slope stability hazards.

IBD: Acronym for "Inboard Ditch," which generally runs along the IBR.

IBR: Acronym for "Inboard (edge of) Road" commonly located below a cutbank.

Igneous: Rocks formed by solidification of hot fluid material termed magma.

Inner Gorge: A stream reach bounded by steep valley walls that terminate up slope into a more gentle topography. Common in areas of rapid stream down cutting &/or geologic uplift.

Landing: Any place on or adjacent to a logging site (usually on a road), where logs are collected and assembled for further transport.

LEC: Acronym for "Left Edge of Cut:" refers to a field estimate (in feet) to the point at which the top of an excavation would extend to the left side of a CLP.

LES: Acronym for "Lower End Stake:" refers to the lowest ending point of a profile. This point is always shot downhill from the bottom of the fill.

Maintained: If a road shows evidence of recent maintenance, including grading, cleaning of culvert inlets, brushing, or upgrading, it is considered to be "maintained."

Mass Movement Site: Mass movement sites are places where failure of a hillside or road prism (by land sliding) is likely.

Metamorphic: All rocks that have changed form (from their sedimentary or igneous origin) due to the effects of high pressure/temperature &/or associated changes in chemistry.

Natural Ground: Undisturbed native soil.

Photo Number: The frame number (along a flight line) of an aerial photograph.

Plug Potential: The likelihood for sediment or woody to plug a culvert inlet. Example: If a pipe is already partially filled with sediment, its gradient is substantially less than the natural channel, &/or if the upstream channel contains large amounts of organic material likely to move at high flows, a culvert is considered to have plug potential.

OBF: Acronym for "Outer Board (edge of the) Fill" slope, which extends beyond the OBR.

OBR: Acronym for "Outboard Edge (of a) Road."

Primary-Line: A surveyed line used to identify the locations/relationships of sites along a road and/or its strip map.

REC: Acronym for the "Right Edge of Cut": refers to the field estimate (in feet) to where the top of an excavation would extend to the right side of the CLP of a road.

Rill: An erosional channel, varying in size from a rivulet up to about 1 $ft.^2$ in cross section, that typically forms where rainfall and surface runoff is concentrated on fill slopes, cut-banks, and ditches. If the channel is larger than 1sq.ft. in size, this becomes a "gully."

Road Name: The name assigned to a road along which a potential erosion site is located. If no road name is available, then the field person will improvise, using conventional methods.

Road Reach: A stretch of road (excluding landings and/or stream crossings), which has been

prescribed for a single treatment.
Rolling Dip: Rolling dips are broad, low road structures constructed to facilitate effective water drainage, while allowing passage of motor vehicles at a reduced road speed.
Rolling Outslope: An outsloped road receives a series "rolling dips" to accommodate multiple wet areas (i.e., springs/seeps)
ROS: Acronym for "Rolling Outslope."
Scarps: Cracks that show vertical displacement. These may be discontinuous and/or continuous within a road reach.
Sedimentary: Descriptive term for rock formed from sediment.
Seep: Wet areas of ground seepage; distinguishable from springs by lack of visible flow.
Shale: A sedimentary rock type that is composed predominantly of mud (a mixture of clay and silt), and which characteristically breaks into plates.
Shotgun: A pipe outlet that is elevated above the natural channel, and with no form of down spout. This time of outlet creates an erosional plunge basin.
Site: A numbered road locality that is considered to host erosional problems. Sites are numbered sequentially from one end of a road to the other.
Skid Trail: Generally a short, wide road-like trail over which tractors have dragged logs that were attached to cables.
Slope Stabilization: The removal of any and all features that may lead to slope instability and mass wasting.
Spring: A flow of water from the ground; often the source of a stream or pond.
Stream Channel Morphology: The various forms and shapes of a stream channel.
Stream Crossing: The location where a road crosses a stream channel, whether water is flowing or not. Drainage structures used in stream crossings include bridges, Humboldts, fords, culverts, and a variety of temporary crossings.
Swale: A channel-like linear depression, or small valley-like feature, that may, or may not contain any well-developed stream flow.
Top Flag: A survey flag hung at the top of an excavation site. This marks the upper limit that the excavation will extend to, and usually coincides with the upper extent of a stream crossing (including any stored sediment above a culvert inlet).
Total Fill Volume: The total volume of road fill at a potential erosion site, measured in cubic yards. At a stream crossing, this volume includes all road fill placed within the natural channel. Total fill volume is computed from field measurements made with a tape and clinometer (or Abney level). The computation requires measurements of slope angles and distance on upstream and downstream fill slopes, the width of the road surface, and the valley width at the upstream and downstream edges of the road surface. Volumes are generally computed from field measurements using scale drawings prepared in the office.
Total Volume Excavated: The amount, in cubic yards, to be excavated at a site.
Tractor Logged: A logging operation where cable-attached skidding is done with crawler tractor power.
Treatment Immediacy: The urgency of implementation of hydrologic decommissioning at a site.
Tribal Allotment: Trust lands granted by the Federal Government to individuals/families with a long-established history of occupation/ownership.
UES: Acronym for "Upper End Stake:" refers to the upper starting point of a profile line.

Underfit: Any drainage structure (e.g. a culvert, swale, floodplain, etc.) that is too small to accommodate runoff during a flood..

USGS: Abbreviation for the United States Geological Survey.

Watershed: The entire area that contributes both surface and underground water to a particular lake, river, or stream system.

XRD: Abbreviation for "Cross-Road Drain;" a ditch-like channel excavated across road fill to drain a spring or seep. The road fill prism is not entirely excavated for an XRD, as at a stream crossing.

Year of Construction: The year that a road was built. This information is usually extrapolated from historical air photo analysis.