

Summary Report
WATERSHED RESTORATION PROJECT 00-05
A140 Road Removal

Meredith Manning
Redwood National and State Parks
February 2001

Table of Contents

INTRODUCTION	1
<i>Location</i>	3
<i>Road and Logging History</i>	5
<i>Geology and Physiography</i>	8
<i>Soils and Vegetation</i>	10
<i>Erosion Processes and Hydrology</i>	10
<i>Wildlife Concerns and Work Schedule</i>	11
RESTORATION WORK	13
<i>Project Implementation</i>	13
<i>Haul Road- and Skid Road-Stream Crossings (RX and SX)</i>	16
<i>Exported Outsloping (EOS)</i>	17
<i>Outsloping (OS)</i>	17
<i>Non-Work Items</i>	18
DISCUSSION	18
ACKNOWLEDGMENTS	19
REFERENCES	20
APPENDIX	21

Table of Figures

Figure 1. Site location map.....	3
Figure 2. Project area.....	4
Figure 3. Logging history.	5
Figure 4. Aerial photograph.....	7
Figure 5. Geologic map of Redwood Creek.....	8
Figure 6. Topographic map.	9
Figure 7. Old-growth residual or second-growth habitat	12
Figure 8. Treatment map for Project 00-05.	14

Table of Tables

Table 1. Restoration work cost summary	Appendix
Table 2. Skid road-stream crossing excavation cost and production rates.....	Appendix
Table 3. Export outslope excavation cost and production rates	Appendix
Table 4. Outslope excavation cost and production rates	Appendix
Table 5. Non-work item costs.....	Appendix

INTRODUCTION

Redwood National Park is located in the lower third of the 280-square-mile Redwood Creek watershed. Redwood National Park was established "in order to preserve significant examples of the primeval coastal redwood (*Sequoia sempervirens*) forests and the streams and seashores with which they are associated for purposes of public inspiration, enjoyment, and scientific study" (Public Law 90-545). Original boundaries protected 58,000 acres within a ½-mile wide corridor of forest along the lower third of Redwood Creek. Within these original boundaries approximately 10,640 acres were classified as old-growth redwood forest. Land located upslope and upstream of the boundaries remained in private ownership, primarily by timber companies.

In 1978 Congress enacted Public Law 95-250, legislation which expanded the boundaries of Redwood National Park by approximately 48,000 acres to include land up to the watershed divide in the lower third of the Redwood Creek basin. The primary goal of the expansion was to help preserve primeval old growth redwood forest threatened by upstream and upslope management. The new boundaries totalled 106,000 acres, including an additional 8,900 acres of old growth forest. Concurrently, Congress authorized the establishment of a watershed rehabilitation program in Redwood National Park (RNP) for lands added to the park. The primary goal of this program was to minimize man-induced erosion and speed the natural revegetation process by restoring the hillslope hydrology to conditions that existed prior to man's influences, and to help protect the nearly 20,000 acres of old-growth redwood forest contained within the park.

Redwood Creek and its tributary streams are subject to frequent flooding from winter storms, and soils are naturally unstable and highly erosive. Landslides and earthflows are naturally occurring and widespread. Until purchase by RNP, the additional 48,000 acres and lands upstream of RNP were the site of intense timber harvest practices and related road construction. These activities accelerated erosion rates and sediment deposition which led to degraded water quality within the entire basin. The existence of several hundred miles of major logging haul roads and thousands of miles of tractor skid trail disrupted hydrologic regimes and caused severe erosion. Studies indicate these activities caused unnatural and excessive erosion that resulted in adverse impacts to riparian habitat, anadromous fisheries, and amphibian species (Narver, 1971).

Watershed restoration project Project 00-5 was part of the program designed to restore disturbed lands within the park (Figure 1). The project was split in two contracts; the first applied to erosion problems on the L-2-2-1 road in McArthur Creek, and the second applied to the A140 road in Lost Man Creek, which this report addresses. The purpose of the project was to remove roads in order to reduce future erosion problems and restore the natural landscape along the road corridor, as near as possible, to original topography. This was accomplished mainly by using heavy equipment to excavate road fill from stream channels and pulling back side-cast road fill to recreate original land configurations such as ridges, valleys and swales. Heavy equipment work was done under Watershed Restoration Indefinite In Quantity (IDIQ) contract awarded to Z Logging, L.L.C., of Orick, California. Work was performed by subcontractor Twin Parks Logging Company of Arcata, California, on the A140 Road in Lost Man Creek, a tributary of Prairie Creek.

The road was evaluated for restoration work due to erosion caused by an eleven-year storm event in January 1997 within the Redwood Creek basin. This storm followed several months of above-average precipitation in the basin. Heavy precipitation in combination with intensely

disrupted hydrologic patterns caused significant erosion problems. The most obvious and dramatic erosion events were numerous mass failures and debris flows, most of which originated from saturated side-cast fill material on major haul roads in Redwood National Park.

On the A140 road, field reconnaissance following the January 1997 storm identified three fluvial erosion sites at road-stream crossing locations. Two had eroded less than 500 yards but showed a 3,000 cubic yard (or greater) erosion potential in the future. One erosion site had already eroded up to 3,000 cubic yards with up to a 10,000 cubic yard potential. All of these sites had non-functional culverts or Humboldt crossings installed during road construction. Humboldt crossings are constructed by placing logs in the bottom of a flowing channel, and backfilling with dirt. Eventually the backfilled dirt erodes downstream, exposing all or part of the logs. Additionally, the A140 road showed signs of failure by the entire outer road bench falling away from the inner road bench. Generally, this outer road bench is constructed of side-cast fill material, is prone to saturation following rain, and can erode away from the original slope grade in long wedges, contributing to stream sedimentation. Because of these road prism failures, the A140 road was evaluated and approved for removal under 1997 Storm Damage funding.

Location

The project is located in Redwood National and State Parks (RNSP) approximately 4.0 miles due east of Orick (FIGURE 1). It is in Township 10 North, Range 2 East, Section 5.

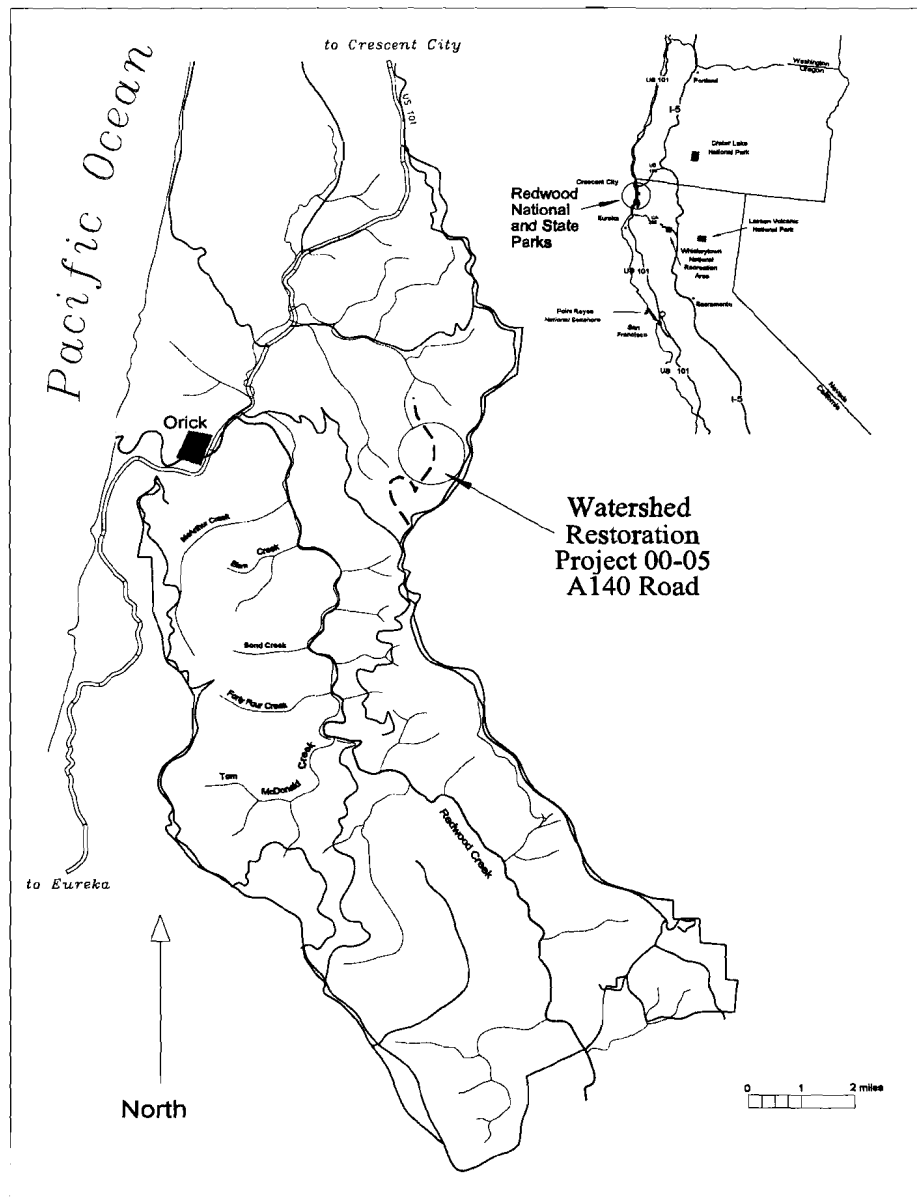


FIGURE 1. SITE LOCATION MAP.

Project 00-5 included approximately 100 acres treated in the Lost Man Creek watershed on a northwest-facing slope. "Treated" acres are defined as the acreage from the ridgetop above the road to the main stream channel below the removed road, or to the next haul road up- or down-slope of the removed road. The A140 road removal project included a 0.2 mile corridor of the main haul in addition to 1.7 miles of skid road excavations adjacent to the main road corridor. The main haul road is located mid-slope at approximately 1,700 feet elevation. Skid work was located between 1,700 to 2,080 feet elevation. This skid work connects to Holter Ridge Road at an elevation of approximately 2,100 feet. This project is located in the southernmost tributary of Lost Man Creek. The tributary originates near the intersection of Bald Hills Road and Holter Ridge Road.

The project occurred between September 16 and October 31, 2000. Work occurred entirely within nesting marbled murrelet habitat, but began after seasonal noise restrictions were lifted. (See section titled "Wildlife Concerns and Work Schedule", page 11, for a full description.) This was a relatively short-term project in which we completed road removal work on the L-2-2-1 Road in McArthur Creek (under the same project number) prior to initiating this project.

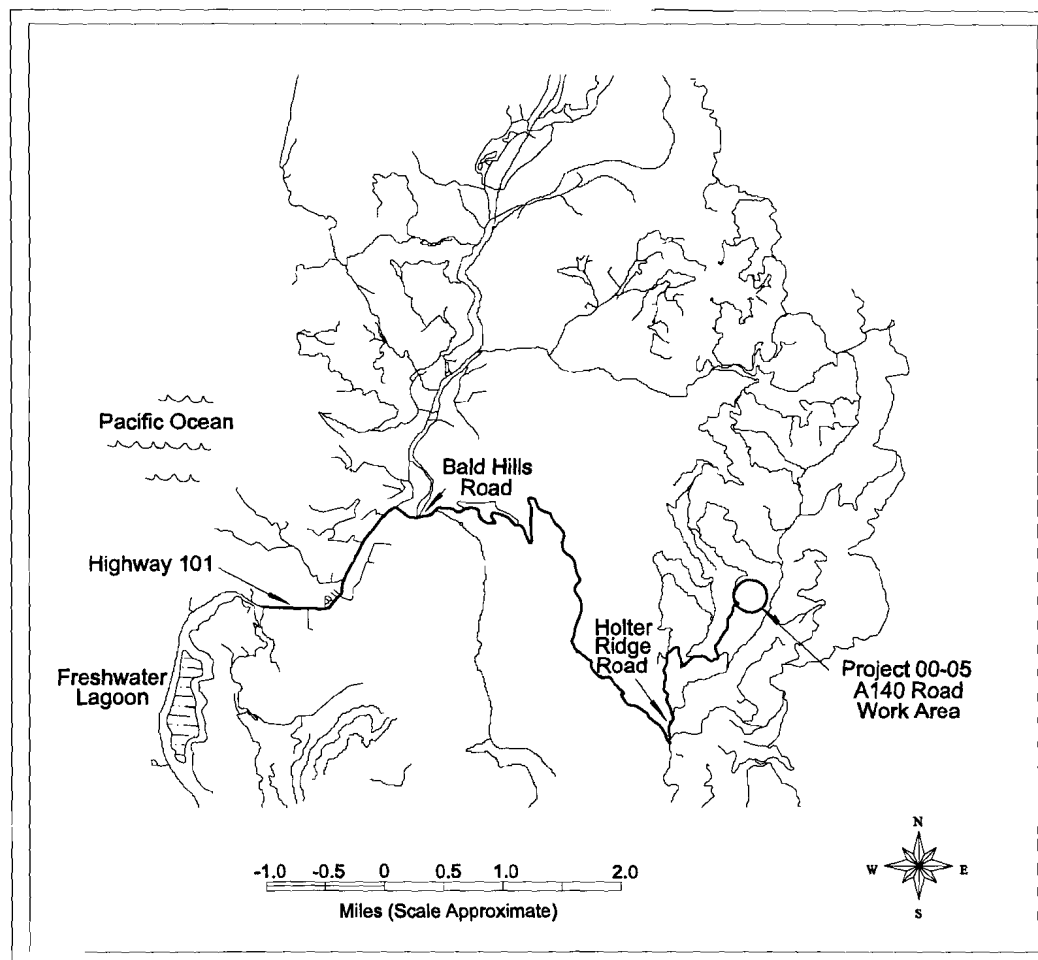


FIGURE 2. PROJECT AREA AND ACCESS FROM SOUTH OPERATIONS CENTER, ORICK.

Road and Logging History

Watershed restoration Project 00-05 on the A140 road had been harvested for timber in the early 1950's. A common practice at the time was to leave behind trees on a harvest unit that were 3-4 feet in diameter or less. Apparently this was the method used to harvest the area surrounding the A140 road. There are numerous old growth residuals (single trees) and small stands remaining in the area in addition to significant second-growth stands which have grown undisturbed for about 50 years.

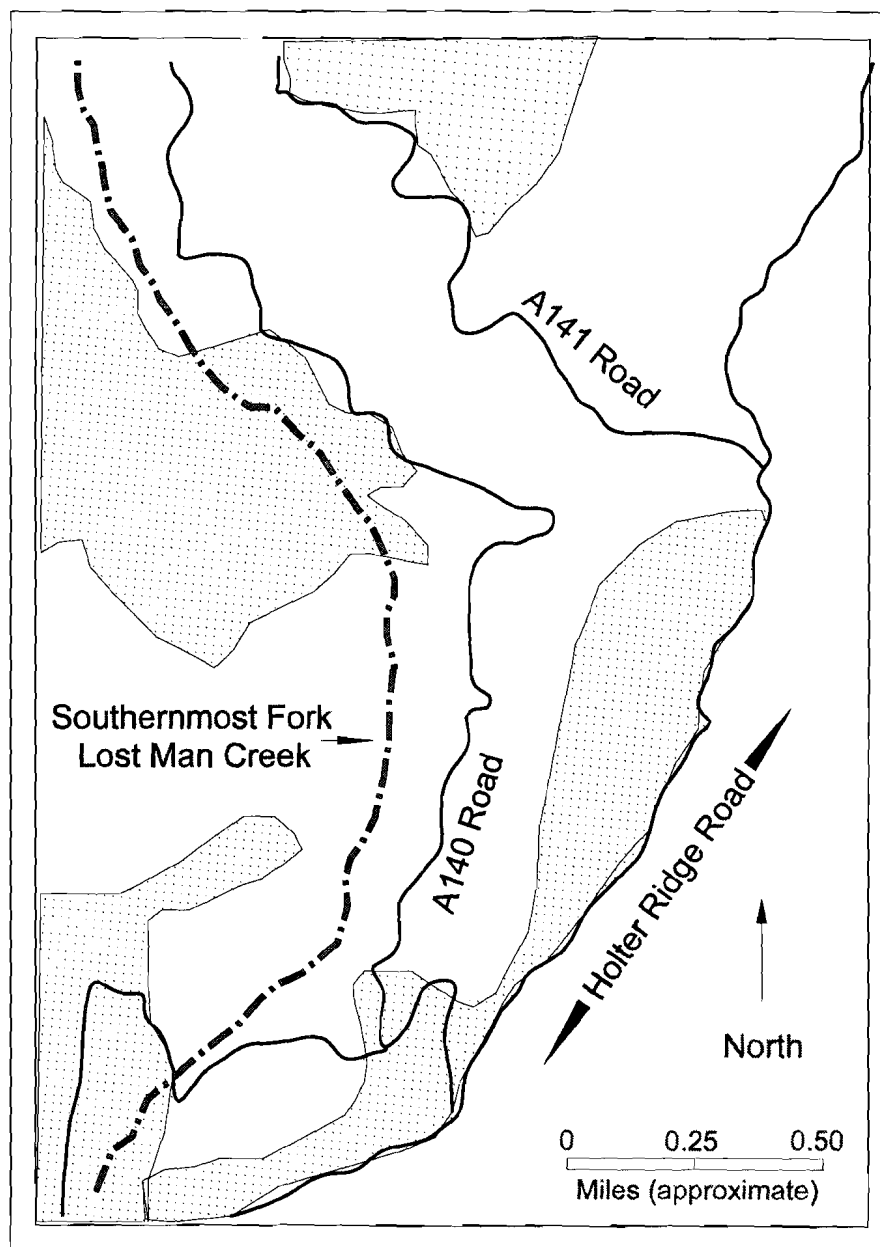


FIGURE 3. LOGGING HISTORY. SHADED AREAS REPRESENT AREAS LAST CUT IN 1950-1955. ALL OTHER AREAS WEST OF HOLTER RIDGE ROAD WERE LAST CUT BETWEEN 1960-1969.

The method of timber harvest was generally tractor yarding above the A140 and cable yarding below (FIGURE 4). While tractor yarding resulted in disruption of natural hydrologic conditions, the cable yarded areas below the road appear to function well hydrologically. There is minimal erosion where the soil was disturbed, and in large areas there are no roads to divert surface flow. Cable yarding simply refers to the method of pulling logs upslope with a high-lead cable from a stationary piece of equipment. The logs drag on the ground, but they drag parallel to the slope. There is no perpendicular disturbance on the hillslope, which is what occurs with skid roads resulting from tractor yarding.

Skid roads intercept surface water flow from the hillslope above and divert it along the road length. This causes gully erosion along the road bench. Headcuts form where water finally crosses the road bench and continues downslope on the other side, causing gully erosion. Hydrologic disruption along the L-2-2-1 road corridor is evidenced by long gullies up to six feet deep, sections of road slumping on the outboard edge, road-stream crossing failures and slope failures due to interception of ground water and diversions of surface flow.

Timber operators built bridges called "Humboldt crossings" which enabled them to cross small stream channels with their equipment. These Humboldt crossings were constructed by placing logs lengthwise in the stream channel and packing soil around them to build a road surface. There were numerous Humboldt crossings of varying size in Project 00-5, especially in SX 1300.

Packed soil in virtually all of the crossings were partially eroded downstream. This soil travels down Lost Man Creek, into Prairie Creek, and eventually reaches the Redwood Creek floodplain. Increased sedimentation in Redwood Creek and its tributaries jeopardizes the habitat and therefore the continued existence of the threatened Southern Oregon/Northern California Coast coho salmon, and the Southern Oregon and California Coastal chinook salmon.



FIGURE 4. AERIAL PHOTOGRAPH SHOWING EXTENT OF LOGGING AND RELATED ROAD CONSTRUCTION BY 1969 NEAR THE A140 ROAD. OLD GROWTH RESIDUAL REDWOOD STANDS AND INDIVIDUAL TREES (RESIDUALS) AND THEIR SHADOWS ARE VISIBLE. ALL WHITE LINES ARE EITHER HAUL ROADS OR SKID TRAILS. THE A140 ROAD RUNS NORTH TO SOUTH NEAR THE MIDDLE OF THE PHOTOGRAPH. HOLTER RIDGE ROAD RUNS NORTH TO SOUTH ON THE RIGHT SIDE OF THE PHOTOGRAPH.

Geology and Physiography

The Redwood Creek basin is almost entirely underlain by the Jurassic-Cretaceous Franciscan formation. Exposures of these rocks typically show closely spaced fractures and/or shearing. Fractures seem to have resulted from deformation from tectonic activity, likely by subduction, and from brecciation along high angle faults (FIGURE 5).

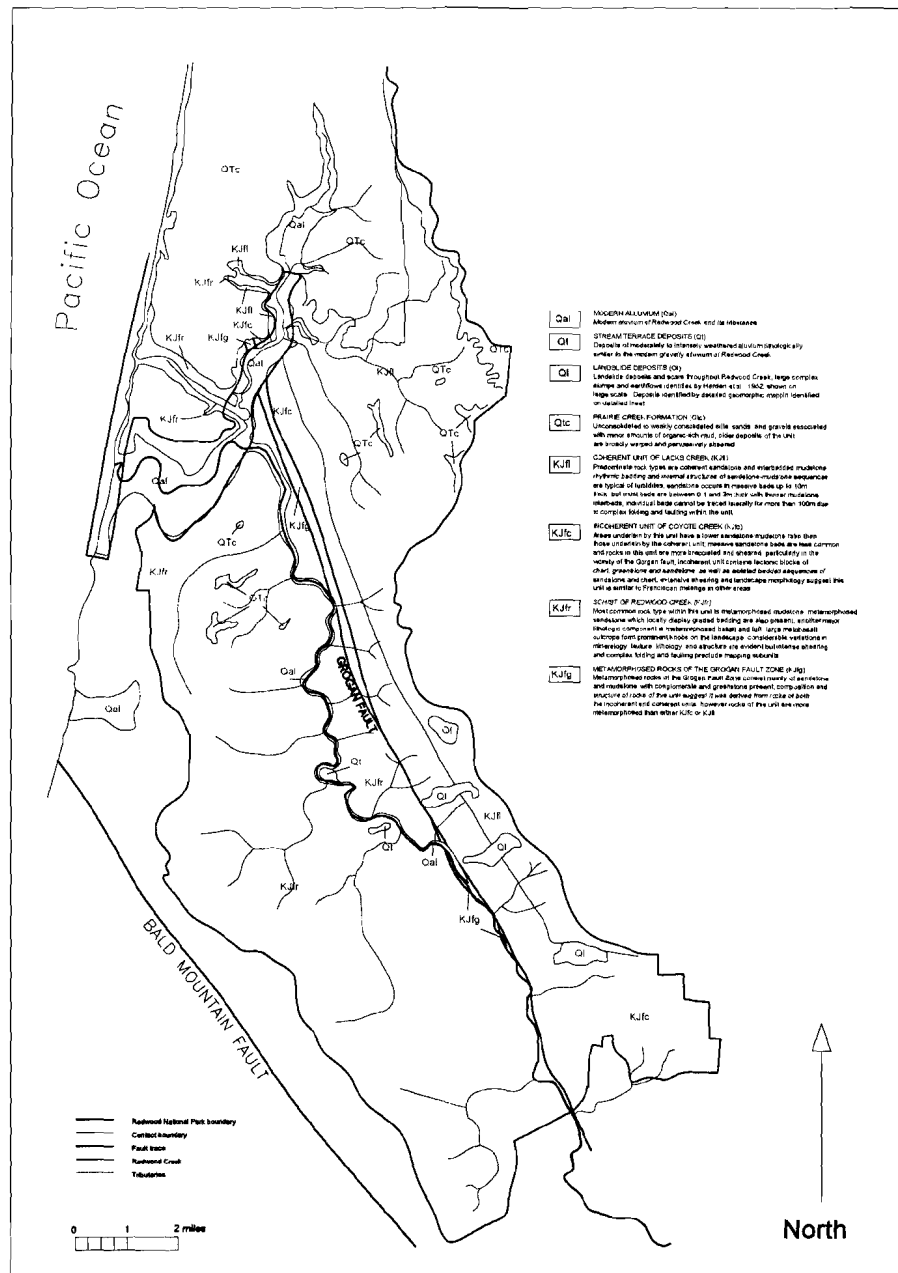


FIGURE 5. GEOLOGIC MAP OF REDWOOD CREEK

Redwood Creek is generally aligned with the Grogan Fault. The portion of Redwood Creek to the west of the fault is underlain by quartz-mica Redwood Creek schist, and the portion to the east is underlain by sandstone. Project 00-05 occurred in the coherent unit of Lacks Creek (symbol "KJfl" on map in Figure 5). Predominant rock types of the unit are coherent sandstone and interbedded sandstone and mudstone (Harden et al, 1982). The area is characterized by high sandstone content, less intense shearing and fracturing, and straighter, steeper hillslopes in areas underlain by the coherent unit relative to those in the remainder of the basin (Harden et al, 1982). This unit drains into Prairie Creek, a northern tributary of Redwood Creek.

The A140 roughly parallels the southernmost fork of Lost Man Creek which runs south to north. Project 00-05 occurred on the eastern side of the creek on a west-facing slope (FIGURE 6).

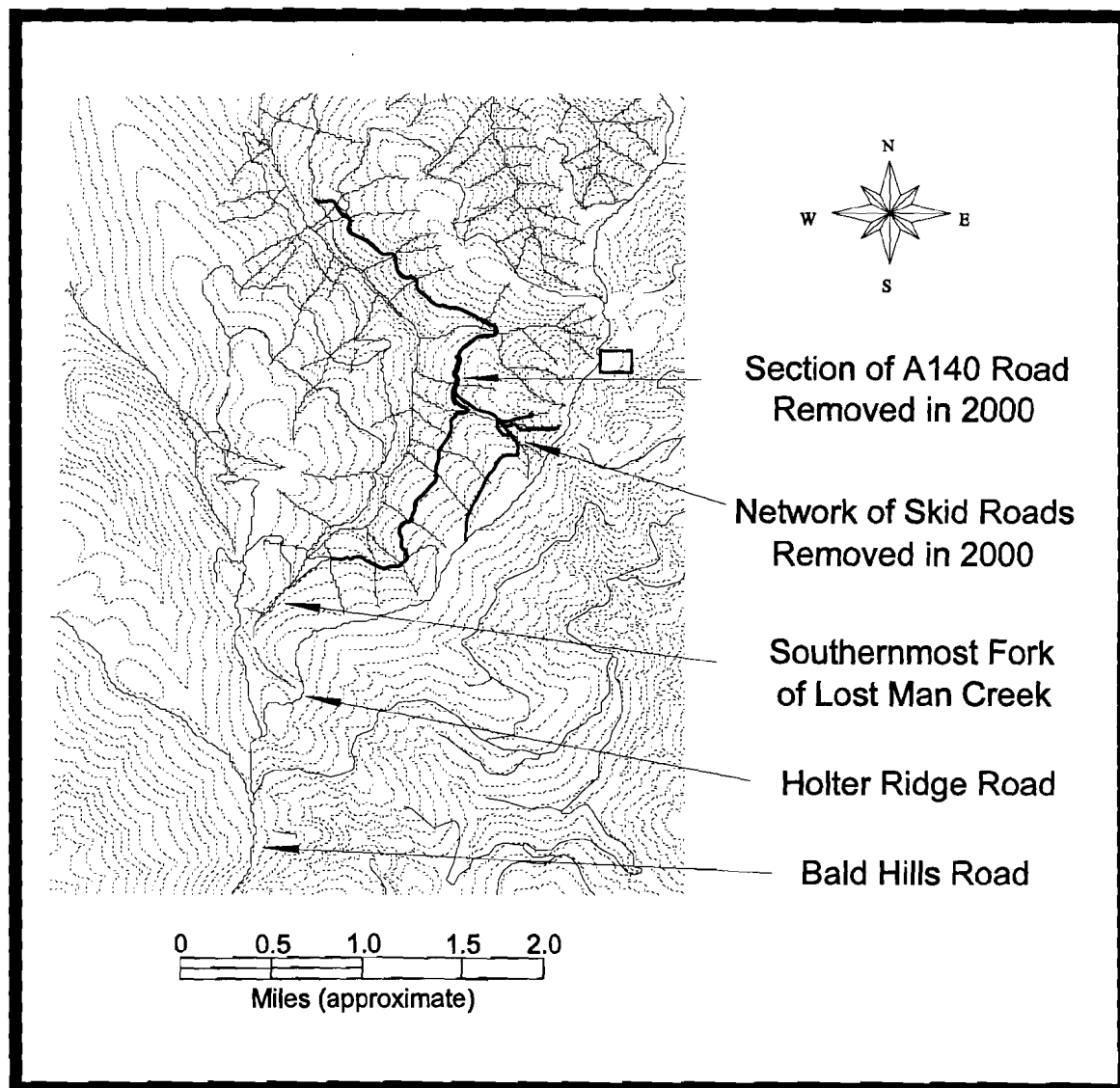


FIGURE 6. TOPOGRAPHIC MAP OF THE SOUTHERNMOST FORK OF LOST MAN CREEK.

Soils and Vegetation

Soils on the A140 road have not been classified by series. The soil is relatively friable, with good crumbly structure, rocky in places but not throughout, weathered, and moderately erodible. Soil dries out relatively quickly following rain.

Soils of this unit support vegetation that thrives in the moderate sun of west-facing slopes. Old-growth redwood, douglas-fir, tan oak and madrone grow in these soils. Remnants of old-growth forest remain on the unit. Red alder grows where soil was disturbed by logging, especially along skid road corridors. Dense stands of small, "dog hair" fir trees fill in the understory. Other understory vegetation includes salal, rhododendron, huckleberry, and salmonberry. Ridges above the project area are dry enough to support manzanita.

Erosion Processes and Hydrology

Generally, the project area has areas of confined erosion, such as at road-stream crossings. Emergent ground water is uncommon except where adjacent to stream channels. Response time between rainfall and creekflow is relatively rapid. Creeks rise and fall rapidly following rain events. Widespread debris flows are not found in this part of the basin, perhaps because the area is relatively dry. However, there are many areas where long stretches of road bench are lower on the outside edge as a result of fill material saturating and settling. Tension cracks usually have formed in these areas.

Surface erosion in the form of sheet and rill erosion appears to be minimal; however, there are many deep and narrow gullies formed from skid road diversions in the area. Where skid roads divert water there is usually a gully where the water exits the road. These gullies can be up to five or six feet deep and hundreds of feet long. Erosion between episodic events such as the January 1997 storm appears to be a slow yet constant process where soil continues to erode into stream channels in small, metered amounts.

Episodic events such as the eleven-year storm in 1997 caused erosion on the A140 road. The most obvious problems included a total collapse of road fill material at a confluence of two channels in the largest tributary within the project area. This collapse spanned several hundred feet of road length and delivered up to an estimated 3,000 cubic yards of material directly into the creek. The collapse exposed a bridge of enormous old-growth redwood logs which were constructed to act as a platform for road fill material above. High flows and intense rainfall washed away the foundation for this platform and many of the logs tumbled into the creek, bringing many tons of soil with them.

There are at least four other smaller, less spectacular road crossing failures on the section of the A140 road to be removed under Storm Damage funding. In each case, the outboard edge of the road collapsed, delivering sediment directly into the channel.

Wildlife Concerns and Work Schedule

The U.S. Fish and Wildlife Service (FWS), as administrator of the Endangered Species Act, has set noise restriction guidelines for management projects that do not remove or degrade suitable habitat for two threatened species - the northern spotted owl and the marbled murrelet. These management projects require consultation with FWS prior to project implementation. In joint cooperation, RNSP, FWS, and the National Marine Fisheries Service (NMFS) created a Biological Assessment followed by biological and conference opinions, adopted July 1998. This document outlines specific guidelines such that RNSP may continue watershed restoration work without adversely affecting critical habitat of the wildlife in question. These guidelines are designed to reduce human impact on nesting sites during the breeding season. Specifically, project areas require a noise restriction period where heavy equipment operates during the breeding season within a quarter-mile of suitable marbled murrelet nesting habitat.

Watershed restoration Project 00-5 was completely within the quarter-mile radius for suitable habitat (FIGURE 7). Therefore, a time restriction was imposed on the project. Work was not allowed to begin prior to September 16, which signals the end of the marbled murrelet breeding season. Normally for projects within suitable habitat a designated amount of "incidental take" is associated with each planned work project. Incidental take describes acres of habitat disturbed by project noise greater than ambient level. This amount depends primarily upon proximity to suitable nesting habitat. RNSP reports annually in writing to identify the amount of work accomplished under this programmatic consultation. These reports provide information that quantifies actual acres of affected marbled murrelet habitat disturbed by noise greater than ambient level. In this case, no incidental take was required as work began after the noise restrictions were lifted.

Work during this project year (2000) was planned to continue past the suitable habitat quarter-mile radius; however, we did not accomplish this goal due to equipment breakdown. Continuing work in 2001 will probably be compromised either by a late start (September 16) or restricted work hours. Restricted work hours are allowed within suitable habitat if consultations with US Fish and Wildlife Service approval. With restricted work hours, work cannot begin prior to July 10, which signals the end of the northern spotted owl breeding season. In addition, no heavy equipment may be operated prior to two hours after sunrise or after two hours before sunset between July 10 and September 15 of the project year.

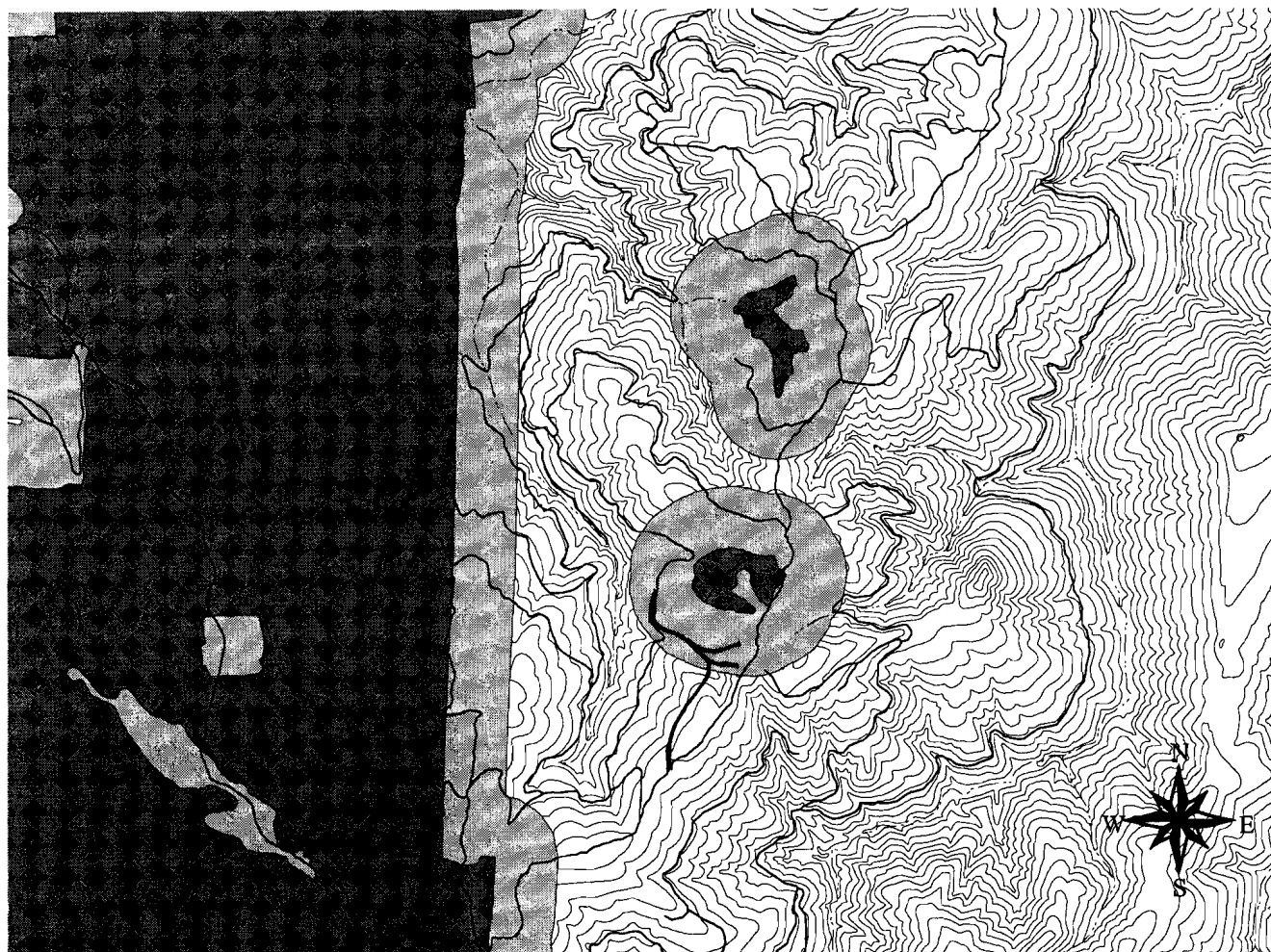


FIGURE 7. DARKEST AREAS REPRESENT OLD-GROWTH REDWOOD RESIDUAL OR SUITABLE SECOND-GROWTH REDWOOD STANDS. THESE AREAS ARE SUITABLE BREEDING HABITAT FOR MARBELED MURRELETS AND NORTHERN SPOTTED OWLS. LIGHT SHADING AROUND THESE AREAS REPRESENTS A QUARTER-MILE RADIUS AROUND HABITAT. PROJECT 00-05 ROAD REMOVAL WORK DONE ON THE A140 ROAD AND ASSOCIATED SKID ROADS IS HANDDRAWN IN BLACK.

RESTORATION WORK

Heavy equipment work was done under Indefinite In Quantity (IDIQ) contract awarded to Larry Zuber of Z Logging, L.L.C., of Orick, California for \$172,171.40 (TABLE 1). This contract was subcontracted to Jay Franke of Twin Parks Lumber Company of Arcata, California, who performed the actual implementation. Four pieces of equipment were used to complete the contract: a rented John Deere 892E-LC hydraulic excavator, and two Caterpillar D8H bulldozers and owned by the subcontractor. Within the first week of work the excavator experienced a breakdown so severe as to require a new motor. This occurrence slowed production considerably. A new Komatsu 228 excavator was finally delivered to the job site at the end of the second week. This was a new excavator design in which there is no machine overhang during swing. Usually a counterweight extends several feet beyond the edge of the tracks. The entire motor carriage and counterweight on the Komatsu 228 rotated within the dimensions of the tracks, which was extremely efficient on narrow, steep, skid roads. The machine was also so quick that even with a smaller bucket it was able to do the same amount of work as the larger excavator in the same amount of time.

In general, the subcontractor, Jay Franke, operated the bulldozers, and the excavators were operated by Patrick Williams of Arcata, California. Williams is usually a bulldozer operator and had worked in RNSP on two previous contracts, but wanted to learn excavator operations. William's first experience on an excavator was a tough proving ground, but he performed well in spite of the odds.

Heavy equipment typically operated 8-11 hours daily, five days a week, depending upon the time between sunrise and sunset. Excavation rates in Tables 2, 3, and 4 reflect earth moving hours and brushing hours only, and do not reflect time that the equipment was broken down or otherwise unemployed. "Brushing" refers to the time spent clearing vegetation from work areas, moving it to stockpile areas, breaking it down into manageable sizes (including thick stands of "dog-hair" fir trees), moving stockpiles more than once, etc. I did not count as "brushing" the time spent laying trees on the finished slope, because a much more significant time was spent preparing it for the final task of laying it on the slope. Additionally, the contractors usually do earthwork and place vegetation on the finished slope in tandem, so separating the two tasks by time would have yielded inaccurate results.

Project Implementation

The geologist responsible for this project was Meredith Manning. It was my responsibility to perform the following tasks: evaluate and formulate rehabilitation prescriptions, survey and photo-document the project, generate plansheets and technical specifications for contracting, oversee heavy equipment operations as the contracting officer's technical representative (COTR), and complete the final documentation. The Supervisory Geologist for this project was Terry Spreiter. The Storm Damage Coordinator was Darci Short. Sherri Romanini managed the budget. Kris Swofford from Point Reyes National Seashore was the Contracting Officer.

The following page shows progression of the work items for Project 00-05 (FIGURE 8). The main A140 haul road runs north-south on the diagram. The remainder are associated skid roads.

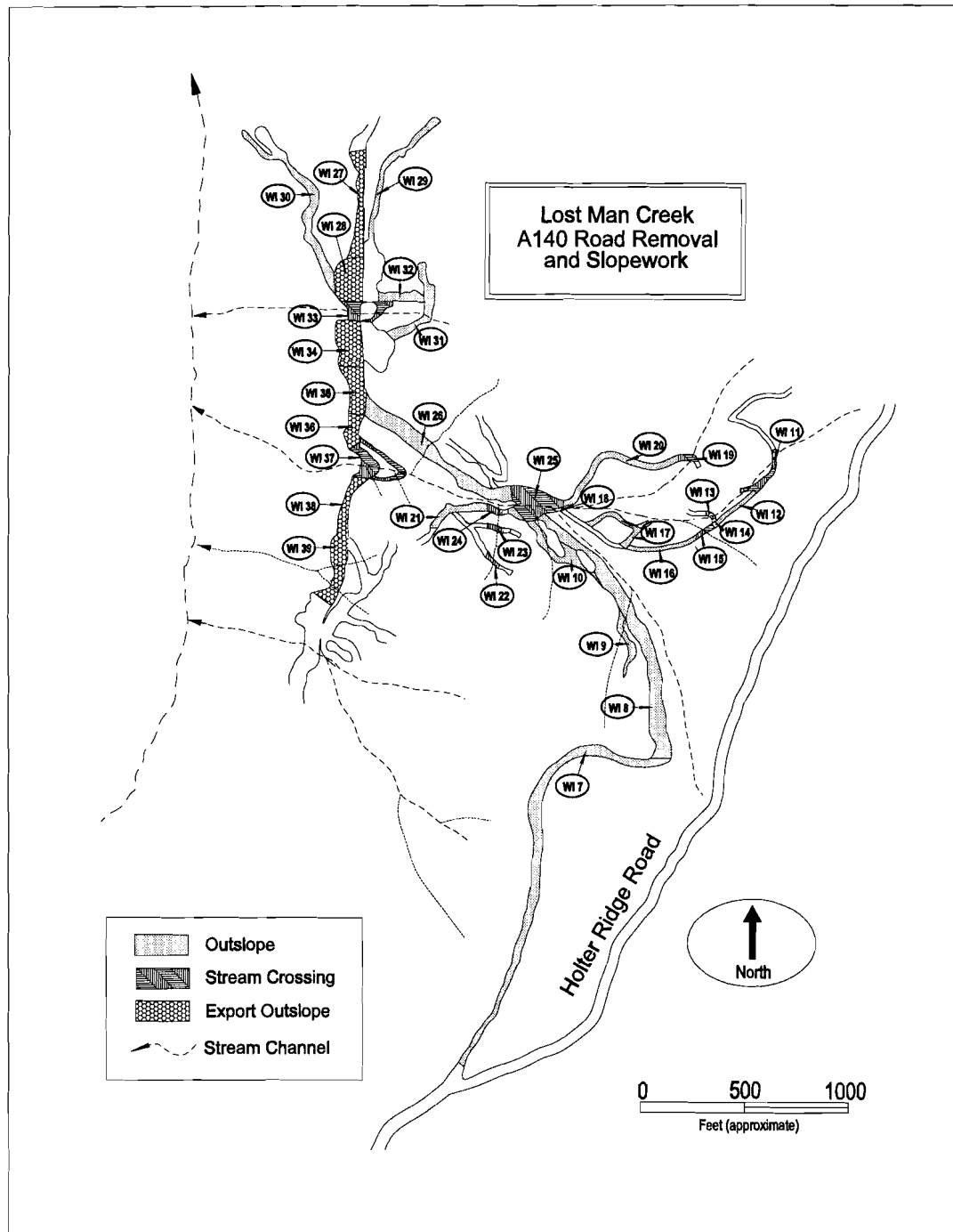


FIGURE 8. TREATMENT MAP FOR PROJECT 00-05, A140 ROAD. ARROWS PERPENDICULAR TO THE ROAD INDICATE STREAM CHANNELS.

The table below shows primary treatments for Project 00-05. This project had a large quantity of skid work associated with the main A140 haul road.

Treatment	Number	Linear Feet	% Total by Length of Road	% Total by Volume
<i>Haul Road-Stream Crossings</i>	2	230	6%	29.6%
<i>Skid Road-Stream Crossings</i>	8	450	N/A	4.4%
<i>Haul Road Export Outslope</i>	3	500	13%	13.3%
<i>Skid Road Export Outslope</i>	0	0	N/A	0%
<i>Haul Road Outslope</i>	0	2,750	72%	15%
<i>Skid Road Outslope</i>	15	6,450	N/A	37.7%

Road opening consisted mainly of clearing 50-55 year old alder and douglas-fir trees (50-60 feet tall). The bulldozer was required to "clear" them from the area and stockpile them in an "out of the way" location, so the excavator could place them on the finished slope later in the process. Piles of alder and douglas-fir trees were constantly in the way and an impediment to progress. Skid roads were very narrow, as the size of the equipment used during timber harvest five decades ago were several feet narrower than modern equipment. In one instance the contractor had to drive up one of the very narrow skids, get off the equipment to tie cable around standing trees, hook them to the bulldozer blade, and back down the hill, toppling the trees on top of the bulldozer as he went. The trees were dragged to a landing and stockpiled at that location. Dealing with these trees slowed production considerably (see the columns "Heavy Equipment Hours-Brushing Only" in Tables 2, 3 and 4).

Although trees grown since timber harvest are becoming prolific and difficult to manage due to their density and height, it is still beneficial to spread them over the finished slope with other large organic material rather than bury them in the fill material. There is a good reason for this. Buried trees may "pipe" or funnel water through fill material, and will eventually break down, causing fill material to settle and pond water. Unnaturally ponded water or any concentrated flow outside of the normal channel creates a potentially unstable hillslope and is contrary to RNSP's watershed restoration goals.

Another cause of low production on haul road-stream crossings (RX's) was the amount of large woody material buried in or at the bottom of the fill material, which had to be separated from the fill material. This large woody "debris" came from old growth redwood trees, and were typically 5-8 feet in diameter, their lengths up to 40 feet long. During road construction in the 1950's these giant logs were thrown in the bottom of the channel and then covered with fill material. They were used to fill space in the channel so less material would need to be imported to create a road bench. These logs acted as temporary culverts which allowed water to flow subsurface along the buried logs. These Humboldt crossings were built to last only as long as the timber harvest season, and began eroding the first winter following harvest.

Haul Road- and Skid Road-Stream Crossings (RX and SX)

The A140 was a primary haul road. In order to maintain grade on contour for loaded log trucks, the road was constructed across many perennial streams, only a few of which had culverts installed during construction. In addition, the timber harvest method used above the main haul road in this unit, tractor logging, created a series of skid roads. Although these skid roads were not densely spaced, many crossed stream channels and had the potential to divert or were actively diverting streamflow. During the mapping phase I determined which skid crossings should be removed with heavy equipment. My criteria were based primarily on potential for fill failure and secondarily on cost-effectiveness of removing the crossing based on cost of access.

Studies on previously harvested forest lands in the Redwood Creek basin have shown that sediment production from fluvial erosion is greater than or equal to that produced from mass movement (Hagans and Weaver, 1987; Janda et al., 1975). Man-induced fluvial erosion can best be addressed at road/stream intersections where excavation of fill from buried stream channels removes immediate sediment sources and eliminates the potential for diverted flows to gully natural slopes. On this project, haul road-stream crossings accounted for nearly 30% of total sediment excavated and skid road-stream crossings accounted for four and a half percent of total. Excavation rates for RX and SX treatments are summarized in Table 2 (Appendix).

Under the Indefinite Quantity contract (IDIQ), contractors bid on price per yard for each treatment. Price differentials are added to volume that is excessively wet, or requires long push distances to fill sites. Typically the need to apply these price differentials will be unknown until the work is in progress. On this project, I applied either excessive moisture or fillsite distance differentials (or both) to both of the haul road-stream crossing sites (RX1, SX 1300).

Haul road-stream crossing SX 1300 developed into a very wet area, which was unexpected. The final excavation took everyone by surprise. Water was flowing subsurface when the excavation began and we diverted it around the crossing once intercepted by excavation work. Even with the diversion, excavation material became so "goeey" that the excavator operator had to construct a "corduroy" road. Corduroy roads are constructed of logs laid lengthwise along a road corridor so that heavy equipment can walk across them as they float over the mud below. Otherwise, heavy equipment sinks in the mud and requires another piece of heavy equipment to pull out.

Also, the sticky mud conditions in SX 1300 prohibited the bulldozer from accessing most of the excavation. The excavator had to double-and triple-excavate the material out of the hole to an area in which the bulldozer could gain access to haul it away to a stable fillsite. The degree of difficulty of excavation due to excessive moisture drove down the production rate and drove up the price per yard excavated because a moisture differential applied to this crossing. In addition, a fillsite distance differential applied to this crossing. The finished excavation was nearly four times the original estimated volume and nearly five times the original estimated cost.

Road-stream crossing RX1 was relatively simple compared to SX 1300. The entire excavation was dry to the original topsoil, with neatly defined banks and a straight, even channel.

No before and after photographs are available for this project.

Exported Outsloping (EOS)

Export outslope (EOS) treatments are performed where sufficient fill space does not exist directly onsite so fill material needs to be moved to a more distant, stable fillsite. All material moved in this manner was performed by bulldozer; that is, all material was pushed to the fillsite instead of transported by dump truck or loader.

Along the main haul road, export outslope accounted for 13% of the total length of road treated and total volume of sediment excavated. Excavation rates for EOS treatments are summarized in Table 3 (Appendix).

The A140 cuts across several headwater swales. Headwater swale excavations commonly require EOS treatments, due to lack of fill storage onsite. Many of these EOS treatments became wide, shallow bowls upon completion of excavation, because there were many small side channels that fed the swale which had been buried during road construction.

Outsloping (OS)

Outsloping (OS) treatments involve the removal of fill from the outboard edge of a road and placing it along a stable section of cutbank, usually directly on-site. Recontouring in this manner restores natural drainage patterns and results in the recovery of original sidecast soil. Original topsoil is the first soil layer to be sidecast downslope during road construction. Long buried under fill material, the topsoil is the last to be retrieved during outsloping. This material rich in organic matter gets distributed over the finished slope, and enhances the revegetation process dramatically (Popenoe and Martin, 1990).

There were no haul road outslope treatments on this project. However, skid road outslope was the most common treatment, accounting for nearly 40% of the total volume of the project. Excavation rates for outslope treatments are summarized in Table 4 (Appendix). This project was heavy on skid work and light on haul road treatments, primarily due to access issues. The skid road work had to be completed prior to implementing haul road work or else risk losing access to the skid roads. Work done next season (2001) will treat substantially more haul road than skid roads within the A140 project area.

Non-Work Items

Non-work items are categorized as jobs that result in non-recoverable costs on the part of the contractor. These items are distinguished by requiring time that is not directly attributable to any specific work item. Non-work item times are recorded to compare the cost of contract with that of hourly rentals. Table 5 (Appendix) provides a cost breakdown for non-work items.

Discussion time is defined as periods of time where equipment operations were interrupted by discussions lasting more than 15 minutes. Typically the contractors stop work to discuss progress of a particular phase of a work item or develop strategy for the work. The COTR also interrupts the operators to discuss the current work and develop understanding of the contract specifications while the work item is in progress.

Down time occurs when equipment is unable to perform in its expected capacity. On Project 00-05, down time was most often the result of mechanical failure. Down time also included time equipment was either stuck or assisting in the rescuing of other stuck equipment. Down time was only recorded if the other piece of equipment was still working, as when the bulldozer received mechanical treatment while the excavator continued to work.

Idle time for equipment was recorded as a non-work item but is markedly different than the previous items. Idle time represents the time a piece of equipment was inactive while work proceeded. Idle time differs from down time in that the equipment can physically be used, but the contractor or operator chooses not to use it or is unable to use it while waiting for another piece of equipment to move out of an area. There was significant idle time on this project for the bulldozer on the haul road-stream crossing treatments. Idle time occurred when the excavator was separating large woody material from fill material or maneuvering within a difficult area to excavate material to deliver to the bulldozer.

Under the Indefinite In Quantity (IDIQ) contract, the contractor bids on price per foot of log remaining from timber harvest that RNSP wants to "salvage" for in-park use (usually milled into planks for walkways, etc). Table 5 (Appendix) reflects this cost for Log Salvage.

DISCUSSION

Project 00-05 met the goals of Redwood National Park's watershed restoration program by removing a portion of the A140 road and its associated skid road network. The work restored natural hydrologic patterns along the road corridor and adjacent hillslopes. Restoration work also restored natural landforms as practically as possible given the extent of damage caused by the tractor logging style of timber harvest. Both goals of restoring hydrology and landforms help minimize human-caused erosion in Lost Man Creek.

We nearly accomplished the entire Base Work Item schedule during six weeks of operation, and would have completed the work as planned if not for equipment breakdown. A total of 38,269 cubic yards of fill material was excavated from potentially unstable locations and moved

to stable fill sites. Heavy equipment cost was \$172,171.40 with an overall average cost of \$4.50 per cubic yard. The cost per yard includes the Excessive Moisture and Fillsite Distance Differentials applied to one of the crossings, rolling dips on the access road at the end of the project, and fuel reimbursement to the contractor. Fuel reimbursement was required as a result of unexpected increases in fuel costs for this project year.

Under the new IDIQ contracting, contractors do not bid on individual projects; rather, they indicate their preference for current projects, and RNSP matches contractor to project based primarily on the contractor's equipment and the size of the road to be removed. Therefore, there were no competing bidders on this project as there historically have been under the Invitation for Bid (IFB) contracts.

The subcontractor on this project, Jay Franke of Twin Parks Lumber Company, Arcata, was a joy to work with. Jay is a talented listener and he brings a wealth of knowledge to road removal projects. Jay is gifted in "reading" the landscape and understands the abilities and limitations of his equipment. If there is a way to accomplish something, Jay will figure out how, and do so in a safe manner. Jay makes the work look easy to master. Anyone who has ever operated a piece of heavy equipment knows it isn't, especially on the steep, narrow skid road benches we worked on this year. His trainee, Pat Williams, demonstrated a willingness to learn by doing, performed the work beautifully, and developed an ability to read the landscape and make good geomorphic decisions about the work with minimum supervision. It would be my pleasure to work with this talented team again in the future.

ACKNOWLEDGMENTS

Thanks to the other watershed restoration geologists for technical support from start to finish: Terry Spreiter, Becca Smith, Neal Youngblood, Phil Freiberg, Jim Howard, and Mike Sanders, from whom I borrowed prose for sections of this report.

Also thanks to Darci Short and Sheri Romanini for tackling—with patience and grace—the intricacies of funding the project; Kris Swofford for her sense of contracting humor, and Terry Hofstra for his unconditional support for doing it right the first time. Dick Mayle and Lynn Erickson-Levi graciously offer timely assistance in any way possible, especially with their generous offer of allowing us to put park volunteers to work for several months. Not enough thanks can be said for Rodney Poole for dropping everything else and helping me every time I ask. Members of the support crew (Glen Fickbohm, Tim Tanno, Harry Richey, and Darlene Buckskin) continually offer assistance on my projects. Thanks to the contractor, Larry Zuber, his subcontractor, Jay Franke, and Pat Williams, for conscientious and thoughtful work, and for making the project an enjoyable experience.

REFERENCES

- Hagans, D.K. and W.E. Weaver, 1987. Magnitude, cause and basin response to fluvial erosion, Redwood Creek basin, northern California. In: Erosion and Sedimentation in the Pacific Rim. Proceedings of the Corvallis Symposium, August, 1987. IAHS Publication # 165. p. 419-428.
- Harden, D.R., H.M. Kelsey, S.D. Morrison, and T.A. Stephens, 1982. Geologic map of the Redwood Creek drainage basin, Humboldt County, California. U.S. Geologic Survey Water Resources Investigations, Open-file Report 81-496. One sheet.
- Janda, R.J., K.M. Nolan, D.R. Harden, and S. M. Coleman, 1975. Watershed conditions in the drainage basin of Redwood Creek, Humboldt County, California, as of 1973. U.S. Geological Survey Open-file Report 75-568. 266 p.
- Narver, D.W., 1971. Effects of logging debris on fish production. In: Krygier, J.T. and J.D. Hall, eds. Forest land uses and stream environment; Proceedings of the symposium. Corvallis, Oregon. Oregon State University, Continuing Education Publications. p. 100-111.
- Popenoe, J. and R. W. Martin, 1990. An evaluation of compost and fertilizer to promote revegetation of rehabilitated road surfaces. U.S. Department of the Interior – Redwood National Park in-service report. p. 31.

APPENDIX

Excavation Cost and Production Rate Tables for Project 00-05, A140 Road

Table 1. Restoration Work Cost Summary

Table 2. Road-Stream Crossing

Table 3. Export Outslope Excavation

Table 4. Outslope Excavation

Table 5. Non-Work Item Costs

Table 1. Restoration Work Cost Summary for Unit 00-05, A140 Road

Treatment	Quantity (cubic yards)	Equipment Hours	Number of Sites	Total Cost		Percent of	Average Unit Cost	
				Actual	H.E.R.E. (a)	Grand Total (Actual cost)	Actual	H.E.R.E. (a)
Heavy Equipment								
Haul Road Stream Crossings	7,464	52.50	1	29,482.80	\$ 11,323	17	\$ 3.95	\$ 1.52
Skid Road Stream Crossings	5,557	116.00	9	28,041.55	\$ 23,979	16	\$ 5.05	\$ 4.32
Haul Road Export Outslope	5,084	69.25	3	16,569.20	\$ 14,988	10	\$ 3.26	\$ 2.95
Skid Road Export Outslope	---	---	0	-	\$ -	0	\$ -	\$ -
Haul Road Outslope	---	---	0	-	\$ -	0	\$ -	\$ -
Skid Road Outslope	20,164	180.75	15	60,926.00	37,445.00	---	---	---
Non-Bid Item	---	---	---	37,151.85	57,895.60	22	---	---
Subtotal or Weighted Average	38,269	419	28	172,171.40	\$ 145,629	65	\$ 4.50	\$ 3.81

Project Implementation (b)	COTR hours	COTR OT hrs	Personnel hrs	Cost	Percent of Grand Total (Actual cost)
Mapping	131			\$ 3,349.67	2
Prescriptions and Layout	101			\$ 2,582.57	1
Aerial Photo Interpretation	48			\$ 1,227.36	1
Brushing	35			\$ 894.95	0
Surveying & DesignCAD	144		180	\$ 6,043.68	3
Contract Preparation	74			\$ 1,879.40	1
COTR Training				\$ -	0
Contract Administration/ Heavy Equipment Supervision	387	108		\$ 13,076.19	6
Miscellaneous Administration	36			\$ 920.52	0
Photo Documentation	10			\$ 255.70	0
Report Writing	40			\$ 1,022.80	1
Subtotal	1,006			\$ 31,252.84	15
Grand Total				\$203,424.24	

- (a) Heavy Equipment Rental Equivalent (H.E.R.E.) is the estimated cost to complete each job based on actual hours worked. Costs are calculated from Cal-Trans 2000 Labor and Rental Rates and include the cost of the operator for: Caterpillar D8H dozer @ \$235/hr and John Deere excavator @ 200/hr.
- (b) Cost is based on the salary and benefits of a GS-11 employee @ \$25.57/hr plus those for a GS-6 employee @ \$13.12/hr where applicable (i.e. for surveying and photo documentation assistance).

Table 2. Road-Stream Crossing Excavation Cost and Production Rates for Unit 00-05, A140 Road

Work Item	Worksite (station numbers)	Surveyed Volume (cubic yards)	Heavy Equipment Hours (earth moving only)		Heavy Equipment Hours (brushing only)		Total Cost		Unit Cost		Original Bid (price per cubic yard)	Average Fillsite Distance (feet) (b)	Excavation Rate	
			Bulldozers	Excavators	Bulldozers	Excavators	Actual	H.E.R.E.	Actual (price per cubic yard)	H.E.R.E.			Earth + Brush Both Equip (cubic yards per hour) (c)	
HAUL ROAD														
33	05+00-06+30	7,464	23.50	29	1.5	2	\$ 29,482.80	\$ 11,322.50	\$ 3.95	\$ 1.52	\$ 3.95	100-200	133	
Total or Weighted Avg (Does not include differentials)			7,464	23.50	29.00	1.50	2.00	\$ 29,482.80	\$ 11,322.50	\$ 3.95	\$ 1.52	---	---	133
SKID ROADS														
11	SX 100	240	1.00	3.75	1.00		\$ 960.00	\$ 985.00	\$ 4.00	\$ 4.10	\$ 4.00	<100	42	
13	SX 300	100		1.50	0.25	0.50	\$ 400.00	\$ 300.00	\$ 4.00	\$ 3.00	\$ 4.00	<100	44	
15	SX 500	175		2.25	0.75		\$ 700.00	\$ 450.00	\$ 4.00	\$ 2.57	\$ 4.00	<100	58	
18	SX 700	230	1.00	3.50	1.50		\$ 920.00	\$ 935.00	\$ 4.00	\$ 4.07	\$ 4.00	<100	38	
19	SX 800	730		4.25	3.25		\$ 2,920.00	\$ 850.00	\$ 4.00	\$ 1.16	\$ 4.00	<100	97	
22	SX 1600	75		2.50	1.00	1.50	\$ 300.00	\$ 500.00	\$ 4.00	\$ 6.67	\$ 4.00	<100	15	
23	SX 1610	50		3.00	1.00	0.75	\$ 200.00	\$ 600.00	\$ 4.00	\$ 12.00	\$ 4.00	<100	11	
24	SX 1620	90		2.50	1.00	2.00	\$ 360.00	\$ 500.00	\$ 4.00	\$ 5.56	\$ 4.00	<100	16	
25	SX 1300	3,867	20.25	70.50	1.00	3.25	\$ 13,727.85	\$ 18,858.75	\$ 3.55	\$ 4.88	\$ 3.55	100-600	41	
Moisture Differential		3,867					\$ 4,253.70	\$ -	\$ 1.10					
Fillsite Dist. Differential		1,000					\$ 3,300.00	\$ -						
Total or Weighted Avg (Does not include differentials)			5,557	22.25	93.75	10.75	8.00	\$28,041.55	\$23,978.75	\$ 5.05	\$ 4.32	--	--	41

- (a) Heavy Equipment Rental Equivalent (H.E.R.E.) is the estimated cost to complete each job based on actual hours worked. Costs are calculated from Cal-Trans 2000 Rental Rates and Peterson Rents of Eureka, and include the cost of the operator for: Caterpillar D8H dozer @ \$235/hr and John Deere 892E-LC excavator @ \$200/hr.
- (b) Fill material was pushed to the fillsite by bulldozer.
- (c) Excavation rate is based on the ratio of the total yardage excavated and the total of all equipment time used to complete the individual bid item.

Table 3. Export Outslope Excavation Cost and Production Rates for Unit 00-05, A140 Road

Table 3. Export Outslope Excavation Cost and Production Rates for Unit 00-05, A140 Road													Excavation
Bid Item	Worksite (station numbers)	Surveyed Volume (cubic yards)	Heavy Equipment Hours (earth moving only)		Heavy Equipment Hours (brushing only)		Total Cost		Unit Cost		Original Bid (price per cubic yard)	Average Fillsite Distance (feet) (b)	Rate
			Bulldozers	Excavators	Bulldozers	Excavators	Actual	H.E.R.E. (a)	Actual (price per cubic yard)	H.E.R.E. (a)			Earth + Brush Both Equip (cubic yards per hour) (c)
HAUL ROAD													
27	00+00-03+70	1,502	11.75	11.00	4.75		\$ 5,106.80	\$ 4,961.25	\$ 3.40	\$ 3.30	\$ 3.40	200	55
28	03+70-05+00	2,594	7.25	6.00	1.00	1.00	\$ 8,300.80	\$ 2,903.75	\$ 3.20	\$ 1.12	\$ 3.20	100	170
34	06+30-08+25	988	13.50	19.75	0.50	4.00	\$ 3,161.60	\$ 7,122.50	\$ 3.20	\$ 7.21	\$ 3.20		26
							\$ -	\$ -		#DIV/0!			
Total or Weighted Avg		5,084	32.50	36.75	6.25	5.00	\$ 16,569.20	\$ 14,987.50	\$ 3.26	\$ 2.95	--	--	63

- (a) Heavy Equipment Rental Equivalent (H.E.R.E.) is the estimated cost to complete each job based on actual hours worked. Costs are calculated from Cal-Trans 2000 Labor and Rental Rates, and include the cost of the operator for: Caterpillar D8H dozer @ \$235/hr and John Deere 892E LC excavator @ \$200/hr.
- (b) Fill material was pushed to the fillsite by bulldozer.
- (c) Excavation rate is based on the ratio of the total yardage excavated and the total of all equipment time used to complete the individual bid item.

Table 4. Outslope Excavation Cost and Production Rates for Unit 00-05, A140 Road

Bid Item	Worksite (station numbers)	Surveyed Volume (cubic yards)	Heavy Equipment Hours (earth moving only)		Heavy Equipment Hours (brushing only)		Total Cost		Unit Cost		Original Bid (price per cubic yard)	Average Fillsite Distance (feet) (b)	Excavation Rate
			Bulldozers	Excavators	Bulldozers	Excavators	Actual	H.E.R.E.	Actual (price per cubic yard)	H.E.R.E. (a)			Earth + Brush Both Equip
													(cubic yards per hour) (c)
SKID ROAD													
7	Skid 1100	4017	26.25	20.50	4.75	5.00	\$ 9,439.95	\$ 10,268.75	\$ 2.35	\$ 2.56	\$ 2.35	<100	71
8	Skid 1000	2000		24.75	2.00		\$ 6,500.00	\$ 4,950.00	\$ 3.25	\$ 2.48	\$ 3.25	<100	75
9	Skid 1400	400		2.00	2.00		\$ 1,300.00	\$ 400.00	\$ 3.25	\$ 1.00	\$ 3.25	<100	100
10	Skid 1500	1500		11.75	1.50	1.00	\$ 4,500.00	\$ 2,350.00	\$ 3.00	\$ 1.57	\$ 3.00	<100	105
12	Skid 200	550		2.00	0.50		\$ 2,200.00	\$ 400.00	\$ 4.00	\$ 0.73	\$ 4.00	<100	220
14	Skid 400	420		1.50			\$ 1,680.00	\$ 300.00	\$ 4.00	\$ 0.71	\$ 4.00	<100	280
16	Skid 600	740		3.00	0.75		\$ 2,960.00	\$ 600.00	\$ 4.00	\$ 0.81	\$ 4.00	<100	197
17	Skid 620	775		6.50	1.00		\$ 3,100.00	\$ 1,300.00	\$ 4.00	\$ 1.68	\$ 4.00	<100	103
20	Skid 900	1,400		7.50	12.50		\$ 5,600.00	\$ 1,500.00	\$ 4.00	\$ 1.07	\$ 4.00	<100	70
21	Skid 1700	900		22.25	2.00		\$ 2,250.00	\$ 4,450.00	\$ 2.50	\$ 4.94	\$ 2.50	<100	37
26	Skid 1200	1,724	5.50	13.75		2.00	\$ 4,223.80	\$ 4,042.50	\$ 2.45	\$ 2.34	\$ 2.45	<100	81
29	Skid 1800	637	0.75	8.00	1.00	0.75	\$ 1,592.50	\$ 1,776.25	\$ 2.50	\$ 2.79	\$ 2.50	<100	61
30	Skid 2000	4,240	4.50	14.75		4.50	\$ 12,720.00	\$ 4,007.50	\$ 3.00	\$ 0.95	\$ 3.00	100-200	179
31	Skid 2100	615		4.50	1.00		\$ 1,998.75	\$ 900.00	\$ 3.25	\$ 1.46	\$ 3.25	<100	112
32	Skid 2040	246		1.00	2.00		\$ 861.00	\$ 200.00	\$ 3.50	\$ 0.81	\$ 3.50	<100	82
Total or Weighted Avg		20,164	37.00	143.75	31.00	13.25	\$ 60,926.00	\$ 37,445.00	\$ 3.02	\$ 1.86	--	--	90

- (a) Heavy Equipment Rental Equivalent (H.E.R.E.) is the estimated cost to complete each job based on actual hours worked. Costs are calculated from Cal-Trans 2000 Labor and Rental Rates, and include the cost of the operator for: Caterpillar D8H dozer @ \$235/hr and John Deere 892E-LC excavator @ \$200/hr.
- (b) Fill material was pushed to the fillsite by bulldozer.
- (c) Excavation rate is based on the ratio of the total yardage excavated and the total of all equipment time used to complete the individual bid item.

Table 5. Non-Bid Item Costs for Unit 00-05, A140 Road

Item	Heavy Equipment Hours		Actual Costs	H.E.R.E. Costs (a)
	Bulldozers	Excavators		
Move In	---	---	\$ -	---
Misc. Move In	---	---	\$ 10,340.00	\$ 10,340.00
Move Out	---	---	\$ 3,430.00	\$ 3,430.00
Misc. Move Out	---	---	\$ 20,581.85	\$ 20,581.85
Culvert Installation	---	---	\$ 2,500.00	\$ 2,500.00
Discussion	9.25	14.50	\$ -	\$ 5,073.75
Idle/Maintenance	25.5	14.50	\$ -	\$ 8,892.50
Down	15.00	16.00	\$ -	\$ 6,725.00
Log Salvage	1.50	0.00	\$ 300.00	\$ 352.50
Total	51.25	45.00	\$ 37,151.85	\$ 57,895.60

(a) Heavy Equipment Rental Equivalent (H.E.R.E.) is the estimated cost to complete each job based on actual hours worked.

Costs are calculated from Cal-Trans 2000 Rental Rates and Peterson Rents of Eureka.

Cost includes the cost of the operator for: Caterpillar D8H dozer @ \$235/hr and John Deere excavator @ \$200/hr.

