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Summary Report
WATERSHED REHABILITATION UNIT 93-2
K&K ROAD AND SPURS

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Redwood National Park
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WATERSHED REHABILITATION UNIT 93-2 K&K ROAD

BACKGROUND

In 1978 Congress expanded the boundaries of Redwood National Park (RNP) by approximately 48,000 acres, and authorized the establishment of a watershed rehabilitation program. Prior to park expansion, these lands were the site of intense timber harvest practices and related road construction. Studies indicate these activities cause unnatural and excessive erosion that result in adverse impacts to riparian habitat, anadromous fisheries, and amphibian species (Corn and Bury, 1989; House and Boehne, 1987; Cedarholm et al., 1980; Narver, 1971). The primary goals of the rehabilitation program are to minimize man-induced erosion and speed the natural revegetation process by restoring the hillslope hydrology to conditions that existed prior to man's influence.

Since the establishment of the watershed rehabilitation program at RNP, the concept of reclaiming disturbed lands has come into vogue. Numerous other programs have evolved with slightly differing goals. This has resulted in significant confusion concerning semantics. The philosophy of the program at RNP is oriented towards total restoration of a watershed (i.e. the exact conditions of a site before disturbance are replicated as much as possible). Throughout this report the terms rehabilitation and restoration are used interchangeably in this context.

PROJECT DESCRIPTION

Watershed Rehabilitation Unit 93-2 constitutes the fifth phase of a multi-year strategy to remove the K&K Road within Redwood National Park. Work in previous years completed the lower portion of the road (Steensen and Bundros, 1993; Steensen, 1992a, 1992b, 1989), and the 1993 project initiates work on the middle section. Unit 93-2 is located on the east side of Redwood Creek, approximately 12 miles southeast of Orick, California (Figure 1). The project addressed accelerated erosion problems along 2.2 miles of major haul road, secondary road, and adjacent skid trails. Rehabilitation work performed in 1980 and 1981 dealt with erosion problems on the slopes above and below the 1993 site (Spreiter and Johnson, 1981; Bundros and Huber, 1981; Wosika, 1980).

The 1993 project involved the excavation of over 81000 yds³ of fill material, including 23000 yds³ associated with nine stream crossings and a hillslope drain. The project was executed through IFB Contract (CX# 1443CX8480-93-003), and work was performed by Barber Construction Company of Blue Lake, California. Costs for the work are summarized in Table 1.

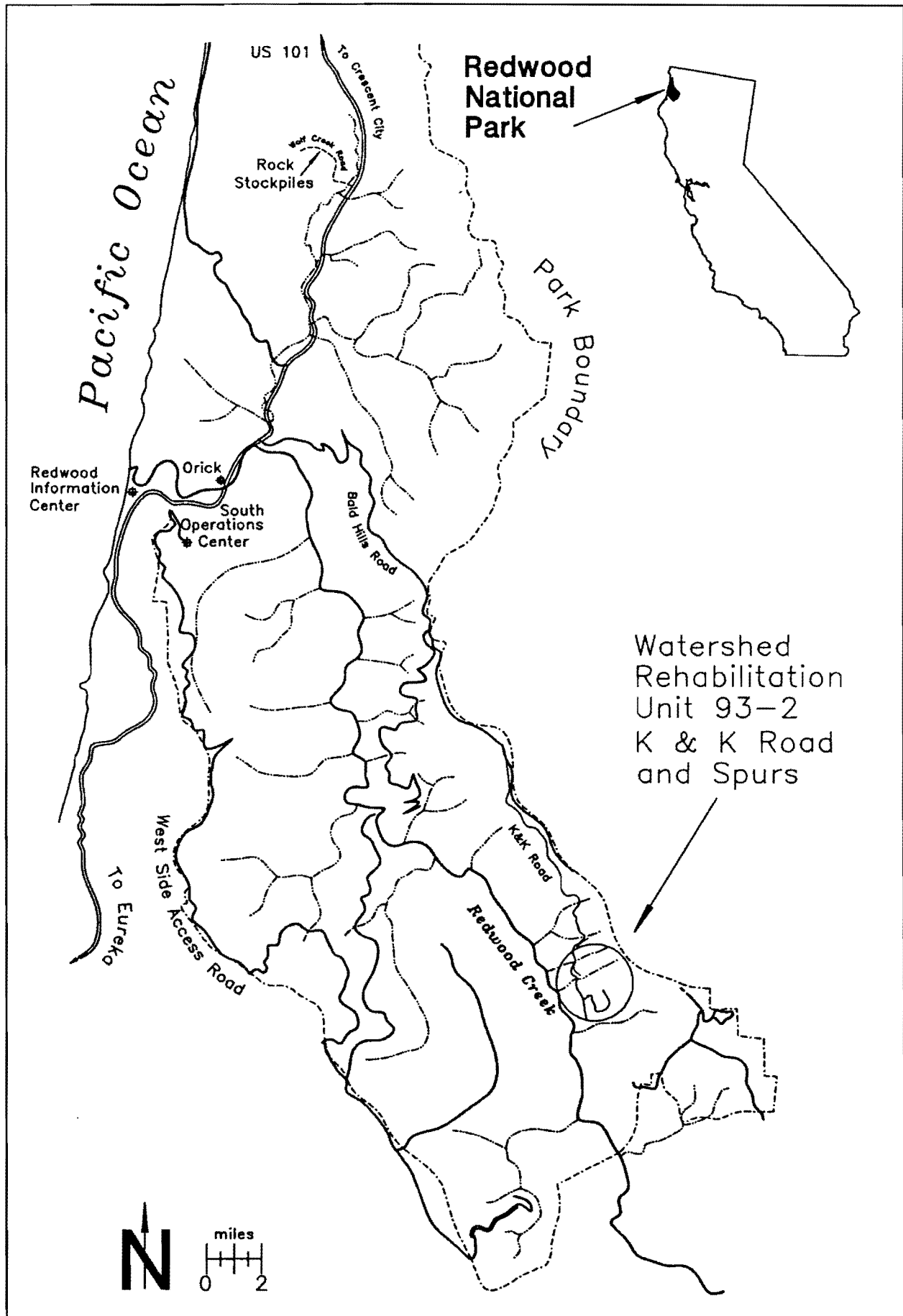


FIGURE 1. SITE LOCATION MAP

TABLE 1							
REHABILITATION WORK COST SUMMARY FOR UNIT 93-2 K&K ROAD AND SPURS							
TREATMENT	QUANTITY	# of JOBS	TOTAL COSTS		% OF GRAND TOTAL USING H.E.R.E. ^(a)	UNIT COSTS	
			CONTRACT	H.E.R.E. ^(a)		CONTRACT	H.E.R.E. ^(a)
HEAVY EQUIPMENT							
STREAM CROSSING	21245 yds ³	9	\$42,490	\$36,803	18	\$2.00	\$1.73
EXPORT OUTSLOPE	31110 yds ³	14	\$99,552	\$43,473	21	\$3.20	\$1.40
OUTSLOPE	27535 yds ³	14	\$55,070	\$24,865	12	\$2.00	\$0.90
MISC BID ITEMS ^(b)	—	9	\$33,780	\$9,584	4	—	—
MISC NON-BID ITEMS ^(c)	—	5	\$0	\$34,555	17	—	—
SUB-TOTAL:			\$230,892	\$149,280	72	—	—
LABOR INTENSIVE							
BRUSHING ^(d)	430 hrs	ALL	\$5,850		3		
STRAW	84 bales	10	\$420		0.2		
DISTRIBUTE STRAW	135 hrs	10	\$2,535		1		
T&E SURVEYS	e	—	\$8,250		4		
SUB-TOTAL:			\$17,055		8		
PROJECT IMPLEMENTATION ^(e)							
MAPPING	300 hrs	—	\$5,400		3		
PRESCRIBE	425 hrs	—	\$7,650		4		
SURVEY	650 hrs	—	\$9,425		4		
CONTRACT PREP	250 hrs	—	\$4,500		2		
CONTRACT SUPERVISION	625 hrs	—	\$11,250		5		
PHOTO DOC	85 hrs	—	\$1,235		1		
REPORT	150 hrs	—	\$2,700		1		
SUB-TOTAL:	2455 hrs	—	\$42,160		20		
GRAND TOTAL:							
			\$289,567	\$208,495	100		

(a) Heavy Equipment Rental Equivalent (H.E.R.E) is the cost to complete each job based on the actual hours worked. These costs are computed using current equipment rental rates, and include the cost of an operator: D9 dozer @ \$140/hr; D6 dozer @ \$90/hr; 245 excavator @ \$165/hr; 225 excavator @ \$100/hr; 631 scraper @ \$150/hr; 988 loader @ \$135/hr; and Dump Truck (DT) @ \$50/hr.

(b) See Table 5 for detailed information on miscellaneous bid items.

(c) Costs for idle or standby time are omitted here. See Table 6 for detailed information on non-bid items.

(d) Brushing includes clearing brush for survey lines at all sites, clearing Wolf Creek road for access to rock, and preparing z-deck for storage of aluminum culverts, salvaged logs, etc. Costs do not include those incurred in the '91 K&K Road Brushing Project (Abel, 1992).

(e) Costs are project specific, and depend on proximity to habitat and survey findings. For approximately 1 mile of K&K road; murrelet surveys - \$6000, spotted owl surveys - \$2000, and F.W.S. consultation - \$250.

(f) Implementation of this project was atypical compared to previous rehab sites. Most of the detailed geomorphic mapping was completed in previous years. Prescriptions/surveying responsibilities were divided among 4 geologists; one senior level geologist oversaw the project, and three other geologists were responsible for specific sections of the site. Costs are based on salaries & benefits for a GS-9 and GS-6 step 1 employee.

LAND USE HISTORY

The project area has been dominated by two major types of land use since the arrival of European traders and homesteaders to this region. Initially, cattle and sheep grazing were the most important activities. These occurred along the prairies and grass-oak woodlands that dominate ridge tops and extend downslope as finger-like projections. Manezes Barn, a structure used for winter storage of feed, was located at the upper end of Manezes road within the project area. It was removed in the early 1980's.

Timber harvest soon overtook ranching as the major activity, and resulted in the construction of the K&K road. The road was built between 1955 and 1958 by Simpson Timber Company primarily to provide a direct route from the Klamath River basin to the mills in Korbel. It also provided access to timber in the Redwood Creek basin.

The logging history within Unit 93-2 is characterized by a succession of multiple entries followed by a major clear cut effort (Figure 2). Tractor yarding techniques were utilized for all timber harvesting with the exception of several cable yarded areas below the 2004 and 2005 roads. Along the slopes above the K&K road, select cut and seed tree leave methods were utilized beginning around 1962. This area was then clear cut in 1971 except for small sections in the headwaters of Manezes Creek and No Name Creek. A similar cut history is typical between the K&K and 2005 roads. However, most areas downslope of the K&K road were clear cut in the mid to late 1970's without any prior selective cutting. The slopes comprising the Quarter Section Slide were clear cut above the 2004 road, and selectively cut in the heart of the slide below the road.

GEOLOGY

The Redwood Creek basin is almost entirely underlain by the Jurassic-Cretaceous Franciscan Formation. In general, rocks on the west side of the basin consist of quartz-mica schist whereas unmetamorphosed sedimentary rocks are found on the east side. These two major lithologies are separated by the Grogan Fault, which has a surface trace roughly coincident with the valley of Redwood Creek. This fault is notably straighter than other major NNW trending faults in the region which suggests a near vertical dip (Hardin et al., 1982).

Rehabilitation Unit 93-2 is situated on the east side of the Redwood Creek basin, and is underlain by the Coherent Lacks Creek Unit and the Incoherent Coyote Creek Unit of the Franciscan Formation. These rock units are composed of unmetamorphosed sandstones and mudstones. The Coherent Unit contains a higher sandstone:mudstone ratio, and massive sandstone beds are present. Zones of shearing and brecciation are more common in the Incoherent

Unit, particularly near the Grogan Fault. The Incoherent Unit also contains tectonic blocks of chert, greenstone, and sandstone.

The contact between these two rock units is gradational. However, they exhibit distinguishing morphologic characteristics. Steep slopes and deep v-shaped tributaries are distinctive of the Coherent Unit. In contrast, the Incoherent Unit displays a more subdued morphology with less deeply incised drainages, and the tectonic blocks form large conspicuous outcrops along a generally rolling landscape. Within the project area, Hardin et al. (1982) place the contact in the vicinity of the K&K road (the Coherent Unit upslope and the Incoherent Unit downslope of the road) with a right angle bend near the intersection with Manezes road (Figure 3). The area southeast of this intersection is mapped as the Incoherent Unit, and Wildcat Rock is interpreted as a tectonic block.

Due to the Grogan Fault's location along the inner gorge of Redwood Creek, along with the rehabilitation unit's middle hillslope position, there is little direct affect of the fault zone on the project area.

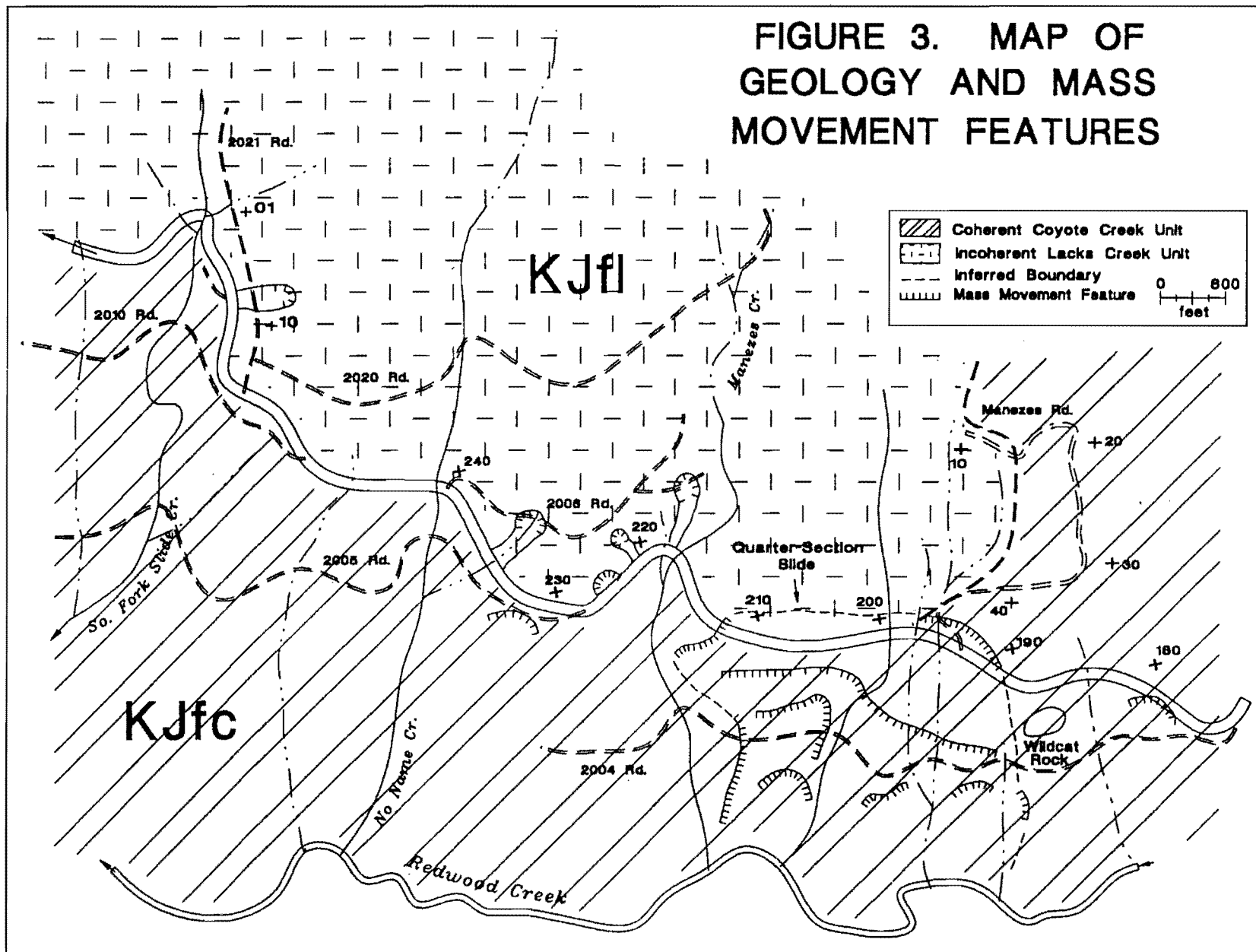
EROSIONAL FEATURES

For the most part, erosional features associated with the slopes above and below Unit 93-2 were addressed in previous rehabilitation projects (Spreiter and Johnson, 1981; Bundros and Huber, 1981; Wosika, 1980). However, potential erosion sites along the corridor of the K&K road in this reach were not fully treated until this year (Figure 3).

Erosion of natural streambanks, stream crossing failures, and stream diversions were all important potential sources of sediment. Post harvest influx of sediment and logging slash during storm events caused channels to aggrade and become choked with large organic debris. In many places, the debris has deflected flow into channel sides resulting in undercutting of the natural stream banks. This process added more material into a system which was already overwhelmed by logging activity. The input of large organic debris, along with an increased bedload component, heightened the potential of plugged culvert inlets which could lead to overtopping and gullyng of the fillslope, saturation and partial evacuation of the fill prism, or diversion of the flow down the road surface or inboard ditch.

In several instances, road maintenance had become an issue prior to implementation of this project. In 1980 rehabilitation work in the Manezes Creek drainage included the replacement of several culverts on the K&K road because of their decayed condition and the potential for stream diversion (Short, personal communication). Then, as part of the 1990 rehabilitation work on the Lower K&K

**FIGURE 3. MAP OF
GEOLOGY AND MASS
MOVEMENT FEATURES**



road, the Manezes Creek culvert (RX 216+60) had to be replaced due to its extremely rusted condition (Steensen, 1992b). Holes in the culvert were intercepting flow resulting in saturation and erosion of material beneath the outlet. In the winter of 1992, a coupling on the culvert at RX 199+75 failed, and led to the evacuation of a portion of the fill prism. The fill from underneath the crossing eroded such that an overhang existed along the outboard edge of the road. A temporary culvert was installed in the spring of 1993 to bypass the failing pipe, and ensure heavy equipment access for this project.

Mass movement features were also a prevalent problem within the project area. The 2006 and K&K roads were built across a moderately sized debris slide along EOS 234+56. The seepy, mobile hillslope associated with this slide produced a road failure along the 2006 road near station 00+06. Another debris slide extended upslope to just below the K&K road at EOS 230+85. Oversteepened landings were responsible for a debris slide above the 2021 road near station 00+10, and a debris torrent (along the 2006 road) which directly impacted the right bank of Manezes Creek. In addition to these, several large cutbank failures were present along OS 219+21 (right drainage divide of Manezes Creek) due to undercutting the slope during road building. These features originated between 1966 and 1968 except for the debris torrent which occurred between 1972 and 1974. A small fill failure was present at EOS 177+09, and resulted from the K&K road intercepting minor seeps along the cutbank. No significant evidence of this failure existed prior to the spring of 1993 when cracks, and eventually small scarps, developed along the sagging road reach.

By far the most impressive mass movement feature in this area is the Quarter Section Slide. It is a large, ancient slide that continues to show adjustments in the form of smaller scale active scarps within the boundaries of the main slide (Wosika, 1980). Harden et al. (1978) place the upper portion of the slide in the vicinity of the 2004 road. However geomorphic mapping (Wosika, 1980) and air photo analysis suggest that large scarps (up to 15') are extensive upslope of the 2004 road and diminish (1 to 2') above the K&K road.

For the purposes of this project, the Quarter Section Slide is interpreted as extending downslope from an area just above the K&K road. A 1-2' scarp represents the slide's most upslope expression, and was evidenced by a sag on Manezes road around station 43+00. The slide's right boundary was well defined along the K&K road by a 1-2' scarp near station 211+50. The left margin is less obvious, but air photo analysis indicates its location to be in the vicinity of Wildcat Rock.

WILDLIFE CONCERNS/WORK SCHEDULE

Watershed rehabilitation projects during the 1993 calendar year were the first to be affected by considerations for threatened and endangered species. The northern spotted owl was listed as threatened in 1990, and the marbled murrelet in 1992, under the Endangered Species Act. Because old growth forests serve as critical habitat for these species, the park is considered a crucial conservation area for their survival.

The U.S. Fish & 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 both the northern spotted owl and the marbled murrelet. These restrictions are designed to reduce human impact to nesting sites during the breeding season. If surveys performed under FWS protocol indicate the project area is unoccupied then the project may proceed with no restrictions. However, if no surveys are performed, or nesting/occupying behavior is documented, then noise restrictions will apply for sites within 1/4 mile of old growth forest. These restrictions limit any activity from generating noise above ambient levels between specified dates. The dates vary between the two species, and change as more up to date information is learned about the biology of these birds. If the project must occur during the restrictive dates, and it will produce noise above accepted levels, then formal consultation with the FWS is required.

Surveys for spotted owls and marbled murrelets were conducted for the 93-2 K&K rehabilitation project (costs given in Table 1). No spotted owl nests were found within 1/4 mile of the project site. However, murrelets were found to be exhibiting occupying behavior in a stand below the 2010 Rock Pit. These surveys, along with formal consultation with FWS, resulted in the heavy equipment work being restricted to after August 5th in certain areas within the project site. Also, work between August 5th and September 15th had to be completed between 2 hours after sunrise to 2 hours before sunset.

Even though clearance was given to initiate work as early as August 6th, the contractor did not begin earth moving until September 17th. NPS administrative delays and obligations to other contracts by the contractor led to a mutually agreed upon "notice to proceed date" of September 13th. A total of 100 calendar days were given to complete the work. Because of wet weather conditions, work was suspended for a total of six days (November 26 thru December 1). All bid items, with the exception of "move out", were completed in 95 calendar days on December 22, 1993.

PROJECT IMPLEMENTATION

Implementation of this project was atypical compared to previous rehabilitation sites. Costs are summarized in Table 1. Most of the detailed geomorphic mapping was completed during previous years in association with Units 81-3, 81-2, and 80-2 (Spreiter and Johnson, 1981; Bundros and Huber, 1981; Wosika, 1980). This was supplemented by a minor amount of mapping in the spring of 1993 along the 2021 road and around the 2006 road. Site morphology was mapped in the field on enlarged aerial photography.

Evaluation and formulation of rehabilitation prescriptions was divided among four geologists. D. Short oversaw the project, and was responsible for the Manezes road area and stations 174 to 193 along the K&K road. J. Dame was responsible for the reach between stations 193 & 231, and P. Armato for stations 231 to 244 on the K&K road. T. Abel was in charge of the 2021 road. Surveying and photo-documentation was handled in a similar manner. The site was broken down this way to provide on the job training for geologists who were new to the program. Heavy equipment work was principally supervised by J. Dame (project inspector) and D. Short (contracting officer's representative). P. Armato also served as inspector for a portion of the project.

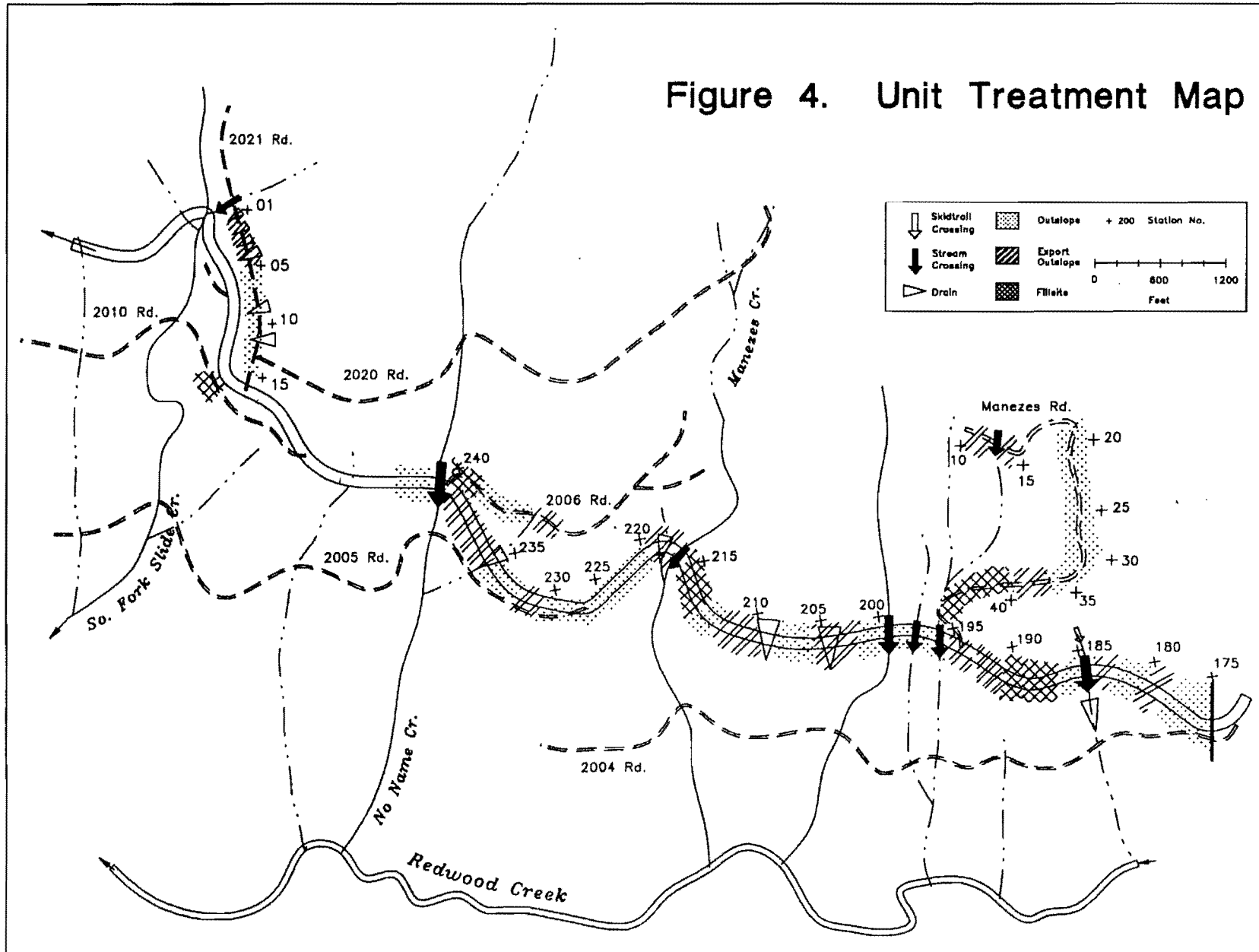
Primary rehabilitation treatments included the excavation of nine stream crossings, 3031 feet of exported outsloping (fill material is endhauled), and 7028 feet of outsloping (Fig 4). Miscellaneous bid items included the following: construction of a hillslope channel; salvage and hauling of aluminum culverts, logs, and rock; placement of rock in finished stream channels; removal and burial of asphalt surfacing; ripping roads; winterization of site.

This project, along with Unit 93-1, involved the largest heavy equipment used to date for watershed rehabilitation work within Redwood National Park. All equipment was manufactured by Caterpillar, and owned by the contractor (Barber Construction). D9 and D6 bulldozers, 245 and 225 excavators, a 631 scraper, and a 988 loader were utilized to complete the contract. Rich Barber was the contractor's project supervisor, and the operators were Randy Moore (245, 225), Mike Moore (631, D6, 225), and Butch Brundin (D9). Hauling rock to the work site from the Wolf Creek area was facilitated by a sub-contractor (Nicholls Trucking) who supplied four 10 yd³ dump trucks.

Stream Crossings

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

Figure 4. Unit Treatment Map



of fill from buried stream channels removes immediate sediment sources and eliminates the potential for diverted flows to gully natural slopes.

On previous K&K rehabilitation projects original channel elements were normally not encountered in stream crossing excavations (Steenson and Bundros, 1993; Steenson, 1992a, 1992b, 1989). For the most part, this was true for the 93-2 project area. No stream gravel lag was uncovered in any of the nine crossings. However, logs and a small amount of organic material were encountered in the middle portion of RX 199+75, and original channel morphology was revealed in three crossings (RX 00+80, RX 184+00, RX 196+69) by uncovering in-place stumps along channel banks. The presence of these indicators could be due to less earthflow activity along this reach of the K&K as compared to lower sections of the road.

As is typical, each stream crossing produced its own unique set of circumstances. For example, SX 188+00 is located immediately upslope of RX 184+30. Construction of the K&K road had undercut the channel along the road's cutbank such that a 7 foot headwall would remain between these two crossings after excavation. In order to prevent headward erosion, the contract called for rock to be placed between the crossings.

The critical point in the excavation of RX 196+69 occurred early when a stump was uncovered near the bottom of the crossing. The "flair" indicated original channel to be on the left side of the stump, and the presence of minor flow during the excavation helped to further define channel configuration. The final result is a crescent shaped channel located up to 25 feet to the left of design.

Because of the proximity of RX 197+77 to the right bank of RX 196+69, this adjustment allowed for a larger interfluvium between the two crossings and an overall more stable configuration than the initial design. This was fortunate because the material that makes up this interfluvium (and the right side of RX 196+69) is wet with several springs and seeps giving the general appearance of an earthflow. The change in configuration resulted in 890 yds³ of material less being excavated than the original estimate.

The excavation of RX 199+75 included a skid trail crossing above the K&K road. The stream channel upslope is highly aggraded with large organic debris protruding from gullied channel banks. The upper portion of the excavation, roughly defined by the skid trail crossing, appeared to be a zone of aggradation. Large organics, including stumps and sawed logs, were so abundant that rock salvaged from the upper part of RX 196+69 was placed at the base of this zone to inhibit headcut erosion. Because this material was encountered, depths of cut were deepened and the excavation volume was approximately 730 yds³ greater than design.

Past failures at RX 199+75 had produced a plug of sediment that caused flow to bend to the right at the bottom of the crossing. This material was not excavated because the channel was well-rocked and appeared to be stabilized. Rock was salvaged from the excavation, and placed at the bottom of the crossing and along the outside of this bend to add protection during high flow events.

RX 216+60 (Manezes Creek) was the largest stream crossing excavation on this project (7960 yds³). In spite of the well incised valley form, the original channel was not encountered during excavation. Very highly sheared bedrock helped to define the bottom part of the crossing, but the middle and upper portions were ambiguous due to the abundance of colluvial material. The right bank in this area consists of a debris torrent deposit that resulted from a failed landing on the 2006 road. A break in slope at the top of the crossing (50% upslope, 25% downslope) further indicates this area is a zone of aggradation.

A channel width of 30 feet at the top, tapering to 12 feet, was designed to reduce channel bank erosion resulting from large organics and rock that will eventually accumulate at this break in slope. Rock salvaged from the culvert outlet was placed at the bottom of the excavation to limit erosion of the friable bedrock during high flow events.

The excavation volume at RX 216+60 was approximately 875 yds³ greater than design. This was due in part to not finding original channel elements which required a greater depth of cut. It was believed more bedrock would be encountered during the excavation, and would better define the original channel bottom. Also, the lower left bank was over-excavated due to the approach used by the contractor. Material excavated from RX 216+60 was push-endhailed to a thru-cut located immediately adjacent to the left edge of the crossing. In order to allow the dozer to be more efficient in its push out of the crossing, the lower left side was overcut to flatten the grade.

Rx 240+72 (No Name Creek) has a large bedrock outcrop controlling the lower left side of the crossing, and the channel is highly aggraded upstream. Approximately 130 yds³ of rock, transported from the Wolf Creek area (Figure 1), were placed in the finished crossing to minimize channel adjustments over time. Armato (1994) notes that in retrospect, rock was probably not necessary to stabilize the channel because the stream armored itself rapidly after the first significant rainstorm.

In general, stream crossing excavation rates were relatively low (Table 2). This is mainly attributed to site specific conditions, but the operator's lack of experience with restoration work was a factor at each site. Excavation of RX 216+60 was the most efficient because it did not require a scraper for endhauling. Fill was

TABLE 2
STREAM CROSSING EXCAVATION COSTS FOR UNIT 93-2 K&K ROAD AND SPURS

BID ITEM	WORKSITE ^(a)	VOLUME (yds ³)	HEAVY EQUIPMENT HOURS						H.E.R.E. ^(b)		DIST. TO FILLSITE ^(c) (feet)	EXCAV. RATE (yds ³ /hr)
			D9	D6	245	225	631	988	TOTAL COSTS	UNIT COSTS		
10	RX 11+56 MAN	125	0	0	2.75	0	0	0	\$453.75	\$3.63	100 - P	45
36B	RX 00+80 2021	2835	5.25	0.25	17	0	13	0	\$5,512.5	\$1.94	3600 - S	80
19	RX 184+30	1345	0	0	6.25	6.25	4.25	0.5	\$2,361.25	\$1.76	400 - S	78
22	SX 188+00	495	0	2.5	0	7.5	0	0	\$975	\$1.97	50 - P	50
26	RX 196+69	3400	14.25	1	25.75	0	17.25	0	\$8,921.25	\$2.62	600 - S	58
27	RX 197+77	560	0	0.5	5.5	0	3.5	0	\$1,477.5	\$2.64	400 - S	59
29	RX 199+75	3325	3.75	1.25	25	3.5	15.75	0.75	\$7,576.25	\$2.28	1300 - S	67
35	RX 216+60	7960	42	1	8.5	0	0	0	\$7,372.5	\$0.93	150 - P	155
52	RX 240+72	1200	6	1	6.5	0	1	0	\$2,152.5	\$1.79	200 - P	83
TOTALS			71.25	7.5	97.25	17.25	54.75	1.25	\$36,802.5	\$1.73		

(a) Bid item 10 is located on Manezes road, and bid item 36B on the 2021 road.

(b) Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These costs are computed using current equipment rental rates, and include the cost of an operator: D9 dozer @ \$140/hr, D6 dozer @ \$90/hr, 245 excavator @ \$165/hr, 225 excavator @ \$100/hr, 631 scraper @ \$150/hr, and 988 loader @ \$135/hr.

(c) (P) indicates the fill was push endhaunched, and (S) indicates it was endhaunched by the 631 scraper.

pushed by the D9 dozer to a nearby fillsite. RX 240+72 was similar; however, the excavation rate dropped due to placement of rock in the finished channel. Rock placement, coupled with the use of a scraper, also slowed down the excavations of RX 00+80 (2021), RX 184+30, and RX 199+75.

Another element that cut efficiency was the depth of excavation along the outboard edge of road. Even though the 245 excavator had a reach of 40 feet, the excavation of RX 196+69 and RX 199+75 required a "benching" technique that resulted in fill being handled several times. Because the 245 was used to both excavate fill and load the scraper, the deep cut resulted in the scraper standing idle for several minutes between cycles while the 245 repositioned itself for loading. These delays could have been avoided by using another excavator, or stockpiling fill from the lower portion of the crossing until endhauling became time efficient.

Other factors that affected excavation rates included the enhancement of the interfluvial between RX 196+69 and RX 199+77, lack of space to maneuver a 245 at RX 11+56 (Manezes Rd.), and lack of operator's experience at SX 188+00.

Outsloping

Outsloping (OS) involves the removal of fill from the outboard edge of a road and placing it along the cutbank. It essentially entails reconstructing the original contours along a road corridor. As with all treatments, a major concern is to encourage and accelerate natural revegetation. By recovering the original sidecast topsoil from the outboard edge of the road and distributing it across the finished excavation, the process of revegetation is enhanced dramatically (Popenoe and Martin, 1990). Within Unit 93-2, OS was used to stabilize road reaches containing perched fill, and to recontour areas that were not necessarily an erosional threat.

Excavation rates along OS reaches were highly variable (Table 3). The highest rates occurred when both the D9 dozer and the 245 excavator were the main pieces of equipment utilized. First, the D9 removed the bulk of material from the outboard edge of road and spread it along the cutbank. The 245 was then used to excavate any hard to reach fill, and to "dress" the site. Excavation rates were diminished where the D6 and/or D9 was utilized to complete the "finish work". Often, too much "finish work" was performed, and the operator/equipment could have been working on a different site. Another factor that affected excavation rates was the lack of space to maneuver equipment along the Manezes and 2006 roads.

Export Outsloping

Export outslope (EOS) treatments are performed where the road fill needs to be endhauling (transported) some distance to a stable fillsite. Endhauling can either be performed by a truck, scraper,

TABLE 3. OUTSLOPING COSTS FOR UNIT 93-2 K&K ROAD AND SPURS

BID ITEM	WORKSITE ^(a)	VOLUME (yds ³)	EQUIPMENT HOURS				H.E.R.E. ^(b)		EXCAV. RATE (yds ³ /hr)
			D9	D6	245	225	TOTAL COSTS	UNIT COSTS	
12	OS 19+00 MAN	2000	7.5	0	10.5	0	\$2,782.5	\$1.39	111
13	OS 29+56 MAN	1585	5.5	1.25	11.5	0	\$2,780	\$1.75	87
36D	OS 04+59 2021	2575	1.25	3.5	10	0	\$2,140	\$0.83	181
49	OS 00+40 2006	305	0	0.5	0	5.25	\$570	\$1.87	53
15	OS 174+02	1125	5.5	7.25	3.5	0	\$2,000	\$1.78	69
17	OS 180+86	1965	1.75	0	6	0.75	\$1,310	\$0.67	231
21	OS 184+72	1080	0	4.75	5.5	0.5	\$1,385	\$1.28	100
28	OS 197+94	405	0	1	1.75	0	\$378.75	\$0.94	147
30	OS 200+25	780	0	0.75	3.5	0	\$645	\$0.83	184
32	OS 206+26	730	1.5	4.75	1.75	0	\$926.25	\$1.27	91
34	OS 211+45	95	0	0	0.75	0	\$123.75	\$1.30	127
40	OS 219+21	9770	6.75	5.25	21	0	\$4,882.5	\$0.50	296
44	OS 232+32	3530	6	6.5	13.5	0	\$3,652.5	\$1.03	136
54	OS 241+06	1590	3.5	2	4.5	0	\$1,412.5	\$0.89	159
TOTALS:			39.25	37.5	93	6.5	\$24,865	\$0.90	

(a) Bid items 12 & 13 are located on Manezes road, bid item 36D on the 2021 road, and bid item 49 on the 2006 road.

(b) Heavy Equipment Rental Equivalent (H.E.R.E) is the cost to complete each job based on the actual hours worked. These costs are computed using current equipment rental rates, and include the cost of an operator: D9 dozer @ \$140/hr, D6 dozer @ \$90/hr, 245 excavator @ \$165/hr, and 225 excavator @ \$100/hr.

loader, or dozer (in which case the material is pushed). EOS reaches can involve the removal of the entire road bench, or only the outboard portion.

In most cases an EOS was prescribed where springs or seeps in the cutbank inhibited placement of fill along the road's inboard edge. Where mass movement features made it impractical to outslope, the EOS was excavated such that a 10 to 15 foot free draining bench remained. Along the Quarter Section Slide (EOS 202+00 & EOS 209+32) this technique was utilized because the failure plane is so deep seated that it was not economically feasible to remove the entire 30-40 foot road bench in such a naturally unstable area. In other places, the free draining bench coincided with original ground.

Drains were specified for a number of locations within the EOS treatments. These are essentially small channels constructed to accommodate concentrated flow from springs and seeps across EOS areas and into appropriate locations below the excavation.

Costs, and associated excavation rates, for EOS treatments within Unit 93-2 are given in Table 4. As with stream crossings, the highest rates occurred where fillsites were close enough that fill could be push endhauled by a dozer. Two sites (193+53 & 217+36) were actually treated as an outslope, but were prescribed as an EOS to give the contractor more flexibility. Exceptions to this occurred where additional factors slowed efficiency: lack of space to maneuver equipment (Manezes and 2006 roads) and unfamiliarity with restoration work.

In general, excavation rates were less when a scraper was used for endhauling. However if the scraper was push loaded by the D9 dozer (as opposed to top loaded by the 245 excavator), excavation rates were comparable to sites where a scraper was not needed. EOS 01+16 (2021), EOS 230+85, and EOS 234+56 are exceptions because their fillsites were located between 2-3 times farther from the excavation site. Also, excavation of EOS 234+56 was slowed by the construction of several minor fillsites and a relatively large drain within the reach.

Miscellaneous Bid Items

The 93-2 project required several jobs that are not typical of past rehabilitation projects (Table 5). One such job was the construction of a hillslope channel below RX 184+30. The stream crossing drains several springs in a small 12 acre watershed that were exhumed by timber harvest activities. The flow from these springs had been diverted to a culvert approximately 200' down the K&K road. A gully had formed in the natural hillslope below this culvert. For the most part, logging activities had obliterated any significant sign of the original flow course downslope of the K&K road. A highly disturbed swale existed directly below the road, and small remnant sections of the swale were found along a nearly

TABLE 4. EXPORT OUTSLOPING COSTS FOR UNIT 93-2 K&K ROAD AND SPURS

BID ITEM	WORKSITE ^(a)	VOLUME (yds ³)	HEAVY EQUIPMENT HOURS					H.E.R.E. ^(b)		DIST. TO FILLSITE ^(c) (feet)	EXCAV. RATE (yds ³ /hr.)
			D9	D6	245	225	631	TOTAL COSTS	UNIT COSTS		
9	EOS 09+00 MAN	470	1.75	0	2	0	0	\$575	\$1.22	100 - P	125
11	EOS 12+95 MAN	170	1	0	2	0	0	\$470	\$2.76	100 - P	57
14	EOS 37+27 MAN	125	0	2.75	0	0	0	\$247.5	\$1.98	200 - P	45
36C	EOS 01+16 2021	2955	7.5	0	15	0	11	\$5,175	\$1.75	3500 - S	88
48	EOS 00+06 2006	45	0	0.5	0	0.75	0	\$120	\$2.67	100 - P	36
16	EOS 177+09	2950	2	0.25	19.25	0	23.25	\$6,966.25	\$2.36	1000 - S	66
18	EOS 182+78	2020	0	0.75	8.25	1.75	7.25	\$2,691.25	\$1.33	600 - S	112
23	EOS 192+20	1355	6.25	1.75	0.25	0	0	\$1,073.75	\$0.79	100 - P	164
24	EOS 193+53 ^(d)	2165	4.25	4	4	0	0	\$1,615	\$0.75	50 - P	177
31	EOS 202+00	5925	16.75	2.25	3.75	0	17	\$5,716.25	\$0.96	1000 - S	149
33	EOS 209+32	2775	7.5	6	2	0	5.75	\$2,782.5	\$1.00	400 - S	131
36	EOS 217+36 ^(d)	3415	1.75	6	4.75	0	0	\$1,568.75	\$0.46	50 - P	273
43	EOS 230+85	1640	12	0	1	0	12	\$3,645	\$2.22	2900 - S	66
47	EOS 234+56	5100	24.75	1.25	15.75	0	31	\$10,826.25	\$2.12	2400 - S	70
TOTALS:											
		31110	85.5	25.5	78	2.5	107.25	\$43,472.5	\$1.40		

(a) Bid items 9, 11, and 14 are located on the Manezes road, bid item 36C on the 2021 road, and bid item 48 on the 2006 road.

(b) Heavy Equipment Rental Equivalent (H.E.R.E) is the cost to complete each job based on the actual hours worked. These costs are computed using current equipment rental rates, and include the cost of an operator: D9 dozer @ \$140/hr, D6 dozer @ \$90/hr, 245 excavator @ \$165/hr, 225 excavator @ \$100/hr, and 631 scraper @ \$150/hr.

(c) (P) indicates the fill was push endhaunched, and (S) indicates it was endhaunched by the 631 scraper.

(d) Bid items 24 & 36 were treated as an OS. They were contracted as EOS to provide the contractor greater flexibility with fillsites.

TABLE 5. COSTS FOR MISCELLANEOUS BID ITEMS ON UNIT 93-2 K&K ROAD AND SPURS

BID ITEM	JOB	QUANTITY	HEAVY EQUIPMENT HOURS						TOTAL COST		UNIT COST	
			D9	D6	245	225	988	DT	CONTRACT	H.E.R.E. ^(a)	CONTRACT	H.E.R.E. ^(a)
20	Construction of hillslope channel @ sta. 184+30.	1755 yds ³	0	0.5	0	7.5	0	0	\$3,510	\$795	\$2	\$0.45
3	Salvage & hauling of selected logs to the z-deck, located approx. 5 miles from site on the K&K road.	15 logs	0	3	0	0	12.5	0	\$1,500	\$1,957.5	\$100	\$130.50
36A	Relocate logs along the 2021 road to a stable location.	40 logs	2.25	0.5	0	0	0	0	\$400	\$360	\$10	\$9.00
4	Haul rock from the 200 road to the z-deck (distance of approx. 16 miles).	300 yds ³	0	0	0	7	7	28	\$5,000	\$3,045	\$17	\$10.15
8	Salvage rock from drain @ sta. 8+50 on Maneza road.	30 yds ³	0.25	0	1.25	0	0	0	\$500	\$241.25	\$17	\$8.04
53	RX 240+72 rock placement	130 yds ³	0	0.5	2	0	0	0	\$1,500	\$375	\$12	\$2.88
5,37,45	Rip roads. ^(a)	2.2 miles	13.5	0	2.25	0	0	0	\$2,920	\$2,261.25	\$1,327	\$1028
6,38,56	Salvage & transport Al culverts to z-deck.	8 culverts	0.25	0	1	0	0	0	\$550	\$200	\$69	\$25.00
7,46,57	Removal & burial of old asphalt surfacing.	1.35 miles	(b)						\$2,500	(b)	\$1,259	(b)
---	Winterize site ^(c)	---	0	2.5	0.75	0	0	0	\$400	\$348.75	---	---
1,2	Move in / Move out	---	---	---	---	---	---	---	\$15,000	---	---	---
TOTALS:			16.5	4.25	4.75	14.5	18.25	28	\$33,780	\$9,583.75	N/A	N/A

(a) The D9 utilized a hydraulically activated, rear mounted, single toothed ripper.

(b) Disposal of this material did not require any additional work beyond normal rehab operations. After the road surface was ripped and used to access points further down-station, the asphalt had broken down significantly in size and in most cases disintegrated altogether. For the most part, disposal occurred along outslope reaches.

(c) Site winterization was left out of the initial contract, and later added as a modification. A lump sum price was agreed upon to install 1 waterbar on the K&K road, 4 waterbars on the 2021 road, and 4 shoulder drains on the 2021 road.

(d) Heavy Equipment Rental Equivalent (H.E.R.E) is the cost to complete each job based on the actual hours worked. These costs are computed using current equipment rental rates, and include the cost of an operator: D9 dozer @ \$140/hr, D6 dozer @ \$90/hr, 245 excavator @ \$165/hr, 225 excavator @ \$100/hr, 988 loader @ \$135/hr, and Dump Truck (DT) @ \$50/hr.

straight line between the K&K and 2004 roads. A 490 foot channel was constructed to limit gullying of the hillslope by tying the bottom of the RX into a crossing on the 2004 road via these remnant channel features.

Another atypical job called for the salvage of selected logs that were discarded during timber harvest activities, and hauling them to the z-deck (located approximately 5 miles from site on the K&K road). These logs are to be used as the raw material for fencing projects designed to reduce the use of Park lands by domestic stock.

The salvage of aluminum culverts that were excavated from Unit 93-2 was another miscellaneous bid item. They were transported to the z-deck and stockpiled until a sufficient amount of aluminum is available to make recycling cost effective.

The removal and burial of old asphalt along the K&K road was included in the contract because of the potential for petroleum products to leach into surface waters. Disposal of this material did not require any additional work. After the road surface was ripped and used to access points further down-station, the asphalt had broken down significantly in size and in most cases disintegrated altogether. For the most part, disposal occurred along outslope reaches.

DISCUSSION

The 1993 K&K project met the goals of the rehabilitation program by removing active and potential sources of sediment to the stream system, restoring hillslope hydrology, and encouraging revegetation. Stream crossing excavations removed road fill from stream channels and eliminated the potential for stream diversions. As much as was possible, excavations along OS and EOS reaches restored original contours, and enhanced the process of revegetation by uncovering topsoil during excavation and placing woody debris on finished slopes.

The success of this project did not come without problems. Minor stream channel adjustments are expected after an excavation, and occurred in all crossings. However, a relatively minor 5 inch rainstorm in early December produced significant erosion in Manezes Creek. Though the lower portion of the crossing down cut only 1 foot, the middle and upper portions gullied 3-5 feet with an 8 foot headcut forming at the top. The headcut is held in check by a 6 foot boulder. It is estimated that between 200-300 yds³ have eroded since excavation. Though further rains have failed to produce more adjustments, it is only a matter of time before the channel sides lay back to a more stable configuration.

The lower part of the crossing underwent minor adjustment due to the presence of bedrock controlling the depth of cut. However, the middle to upper portions of the channel contained a seemingly endless amount of colluvial material. These rather dramatic channel adjustments could have been avoided in either of two ways. One, deepen the depth of cut in the middle and upper sections. This would require the side banks to be laid back further, and would flatten the channel grade. The latter would necessitate rock placement at the top of the crossing to prevent headward erosion. Two, do not alter the excavation but place rock along the channel and right banks in the middle and upper sections. Proper rock placement would prevent channel downcutting and headward erosion. In any event, it must be noted that the total volume estimated to erode from this crossing is less than 6% of the total amount excavated.

When comparing the costs of this project with other rehabilitation work, the size of equipment used must be considered. This project involved some of the largest heavy equipment used to date for watershed rehabilitation work within Redwood National Park (RNP) (e.g. D9 dozer, 245 excavator, and 631 scraper). It was exactly the right match for the large bench widths (30-40 feet) and associated fills along a major haul road such as the K&K. However when working on the Manezes road the equipment was too large, and required too much room to maneuver.

Another issue that must be considered is the amount of experience the contractor had with restoration work. A lack of familiarity with the procedures and goals of the program was apparent throughout the project. However the operators were very competent, and caught on quickly. In general, the work was performed satisfactorily as long as a geologist was on site to inspect a job as it was completed. It is not felt that the project necessarily suffered from the contractor's lack of experience, but it did cut down on efficiency and therefore contractor's earnings. This is a significant point because the excavation rates for several of the worksites are quite impressive (Tables 2-4). In most cases, excavation rates dropped where the approach to a site was unorthodox. For example, where fill was handled several times or where an operator spent too much time performing "finish work" instead of working on another site.

The contractor's earnings were also diminished due to equipment break-downs (Table 6). The two key pieces of equipment used for this project (631 scraper and 245 excavator) accounted for over 93% of the total down time. These break-downs resulted in altering daily work plans on numerous occasions. However the contractor had various pieces of equipment on site, and this gave much needed flexibility in day to day planning. At the same time, it resulted in long road reaches and several stream crossings in various stages of completion being worked on simultaneously. These situations were

TABLE 6. COSTS FOR NON BID ITEMS ON UNIT 93-2 K&K ROAD AND SPURS							
JOB	HEAVY EQUIPMENT HOURS						H.E.R.E. COSTS ^(a)
	D9	D6	245	225	631	988	
DISCUSSION	4.5	1.75	7	2.5	0	0	\$2,193
FUEL & SERVICE	5	2.75	8	0.5	1.75	1	\$2,715
DOWN ^(b)	2.5	1	60	7	97	1	\$25,725
ROAD IMPROVEMENT	2.25	1	0	0	0	0	\$405
WALK	5.5	5	10.25	3.25	0.75	1.25	\$3,518
SUB-TOTAL:	19.75	11.5	85.25	13.25	99.5	3.25	\$34,555
IDLE ^(c)	189.5	290.25	57.75	90.5	137.25	284.25	\$130,193
TOTAL:	209.25	301.75	143	103.75	236.75	287.5	\$164,748

(a) Heavy Equipment Rental Equivalent (H.E.R.E) is the cost to complete each job based on the actual hours worked. These costs are computed using current equipment rental rates, and include the cost of an operator: D9 dozer @ \$140/hr, D6 dozer @ \$90/hr, 245 excavator @ \$165/hr, 225 excavator @ \$100/hr, 631 scraper @ \$150/hr, and 988 loader @ \$135/hr.

(b) Down time includes being broken-down, stuck, or assisting with other pieces of equipment that are down.

(c) Idle time represents the number of hours a piece of equipment was inactive while work proceeded. The contractor for this project had numerous pieces of equipment on site, and seldom were they all working simultaneously. The extra equipment allowed the contractor greater flexibility in day to day planning, and in approaching specific worksites. RNP would not be able to enjoy this flexibility in a rental situation because of the need to pay standby costs for idle time. This should be kept in mind when comparing H.E.R.E. costs with contract costs.

potentially detrimental because of the imminent onset of winter weather.

Several lessons can be learned from this project and applied to future restoration work. First, the need for a more simplified contract should be reviewed. In many instances the operators relied on RNP inspectors to direct their work. Though this is technically outside the responsibility of Park personnel, it did facilitate the desired results. However if RNP geologists are needed on site at all time, then the contract is an unnecessary document and the work should be performed under a rental agreement. If experienced conscientious contractors are used, this will not be a problem. One approach, which was suggested by several of the operators, would be a more visual contract with drawings of each surveyed line.

Another concern for future projects involves heavy equipment restrictive dates imposed for threatened and endangered species. First, the contract should include a "start no later than" date so that the contractor does not delay the start of work. In most cases this will not be a problem, but when a contractor is over-extended they will be reluctant to rent equipment to begin a new job. Second, a site winterization clause should be included in all contracts. RNP was fortunate that winter rains held off until the completion of this project.

ACKNOWLEDGEMENTS

Numerous individuals on the staff at Redwood National Park are responsible for the restoration work that was completed within Unit 93-2. This report is a compilation of those efforts. Thanks to Darci Short and Peter Armato who provided many insightful comments and helpful suggestions on the manuscript. Also, thanks to Kelly Helstrom for help in producing the graphics, and Paul Measles who worked on the tables. Keep on outslowing...

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APPENDIX

**BID SCHEDULE FOR UNIT 93-2
K&K ROAD AND SPURS**

Barber Construction, Inc.

CX# 1443CX8480-93-003

BASE BID

1.	Move In	Lump Sum \$	<u>10,000</u>
2.	Move Out	Lump Sum \$	<u>5,000</u>
3.	Haul Logs ^b	Lump Sum \$	<u>1,500</u>
4.	Remove and Haul Rock (from Wolf Creek area)	Lump Sum \$	<u>5,000</u>
5.	Rip Roads (K&K and Manezes Rds; 1.6 miles)	Lump Sum \$	<u>1,820</u>
6.	Salvage and Transport Aluminum Culverts (6)	Lump Sum \$	<u>450</u>
7.	Remove and Bury Asphalt (.85 miles)	Lump Sum \$	<u>1,500</u>
8.	Remove and Salvage Rock (Manezes Road)	Lump Sum \$	<u>500</u>

ITEM NO.	BEGINNING STATION	ENDING STATION	JOB TITLE/ BID METHOD ^a	QUANTITY	UNIT PRICE ^b	TOTAL
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Manezes Road:

9.	9+00	10+50	EOS/LS	470 yd ³		\$ <u>1,504</u>
10.		11+56	RX/LS	125 yd ³		\$ <u>250</u>
11.	12+95	14+20	EOS/LS	170 yd ³		\$ <u>544</u>
12.	19+00	28+87	OS/LS	2000 yd ³		\$ <u>4,000</u>
13.	29+56	37+27	OS/LS	1585 yd ³		\$ <u>3,170</u>
14.	37+27	38+22	EOS/LS	125 yd ³		\$ <u>400</u>

K & K Road:

15.	174+02	177+09	OS/LS	1125 yd ³		\$ <u>2,250</u>
16.	177+09	180+86	EOS/LS	2950 yd ³		\$ <u>9,440</u>
17.	180+86	182+78	OS/LS	1965 yd ³		\$ <u>3,930</u>
18.	182+78	183+88	EOS/LS	2020 yd ³		\$ <u>6,464</u>
19.		184+30	RX/UP	1345 yd ³	\$ <u>2.00</u>	\$ <u>2,690</u>
20.		184+30	SLOPE/LS	1755 yd ³		\$ <u>3,510</u>

21.	184+72	186+71	OS/LS	1080 yd ³		\$	<u>2,160</u>
22.	188+00		SX/UP	495 yd ³	\$	<u>2.00</u>	\$ <u>990</u>
23.	192+20	193+53	EOS/LS	1355 yd ³		\$	<u>4,336</u>
24.	193+53	196+54	EOS/LS	2165 yd ³		\$	<u>6,928</u>
25.	Salvage Rock from near station 196+50					\$	<u>0</u>
26.	196+69		RX/UP	3400 yd ³	\$	<u>2.00</u>	\$ <u>6,800</u>
27.	197+77		RX/UP	560 yd ³	\$	<u>2.00</u>	\$ <u>1,120</u>
28.	197+94	199+45	OS/LS	405 yd ³		\$	<u>810</u>
29.	199+75		RX/UP	3325 yd ³	\$	<u>2.00</u>	\$ <u>6,650</u>
30.	200+25	202+00	OS/LS	780 yd ³		\$	<u>1,560</u>
31.	202+00	206+26	EOS/UP	5925 yd ³	\$	<u>3.20</u>	\$ <u>18,960</u>
32.	206+26	208+72	OS/LS	730 yd ³		\$	<u>1,460</u>
33.	209+32	211+45	EOS/UP	2775 yd ³	\$	<u>3.20</u>	\$ <u>8,800</u>
34.	211+45	211+72	OS/LS	95 yd ³		\$	<u>190</u>
35.	216+60		RX/UP	7960 yd ³	\$	<u>3.20</u>	\$ <u>15,920</u>
36.	217+36	219+21	EOS/UP	3415 yd ³	\$	<u>3.20</u>	\$ <u>10,928</u>

2021 Road:

36a.	Move logs				Lump Sum	\$	<u>400</u>
36b.	00+80		RX/UP	2835 yd ³	\$	<u>2.00</u>	\$ <u>5,670</u>
36c.	01+16	04+59	EOS/LS	2955 yd ³		\$	<u>9,456</u>
ITEM NO.	BEGINNING STATION	ENDING STATION	JOB TITLE/ BID METHOD ^a	QUANTITY	UNIT PRICE ^b	TOTAL	
36d.	04+59	14+87	OS/LS	2575 yd ³		\$	<u>5,150</u>

GRAND TOTAL BID FOR BASE BID = \$ 172,290

ADDITIVE BID #1

K&K Road:

37.	Rip Roads (0.2 miles)				Lump Sum	\$	<u>300</u>
38.	Salvage and Transport Aluminum Culvert (1)				Lump Sum	\$	<u>100</u>

39. Remove and Bury Asphalt (0.2 miles) Lump Sum \$ 400

ITEM NO.	BEGINNING STATION	ENDING STATION	JOB TITLE/ BID METHOD ^a	QUANTITY	UNIT PRICE ^b	TOTAL
40.	219+21	230+85	OS/LS	9770 yd ³		\$ <u>19,540</u>

SUB TOTAL BID THIS ADDITIVE = \$ 20,340

GRAND TOTAL BID: BASE BID, PLUS ADDITIVE BID #1 = \$ 192,630

ADDITIVE BID #2

K&K Road:

41. Rip Roads (0.1 miles) Lump Sum \$ 200

42. Remove and Bury Asphalt (0.1 miles) Lump Sum \$ 200

ITEM NO.	BEGINNING STATION	ENDING STATION	JOB TITLE/ BID METHOD ^a	QUANTITY	UNIT PRICE ^b	TOTAL
43.	230+85	232+32	EOS/LS	1640 yd ³		\$ <u>5,248</u>
44.	232+32	234+56	OS/LS	3530 yd ³		\$ <u>7,060</u>

SUB TOTAL BID THIS ADDITIVE = \$ 12,708

GRAND TOTAL BID:

BASE BID, PLUS ADDITIVE BIDS #1 AND #2 = \$ 205,338

ADDITIVE BID #3

45. Rip Roads (0.2 miles) Lump Sum \$ 400

46. Remove and Bury Asphalt (0.1 miles) Lump Sum \$ 200

ITEM NO.	BEGINNING STATION	ENDING STATION	JOB TITLE/ BID METHOD ^a	QUANTITY	UNIT PRICE ^b	TOTAL
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K&K Road:

47.	234+56	240+46	EOS/UP	5100 yd ³	\$ <u>3.20</u>	\$ <u>16,320</u>
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2006 Road:

48.	00+06	00+40	EOS/LS	45 yd ³	\$	144
49.	00+40	03+27	OS/LS	305 yd ³	\$	610

SUB TOTAL BID THIS ADDITIVE = \$ 17,674

GRAND TOTAL BID:

BASE BID, PLUS ADDITIVE BIDS #1, #2, AND #3 = \$ 223,012

ADDITIVE BID #4

K&K Road:

50.	Rip Roads (0.1 miles)	Lump Sum \$	200
51.	Remove and Bury Asphalt (0.1 miles)	Lump Sum \$	200

ITEM NO.	BEGINNING STATION	ENDING STATION	JOB TITLE/ BID METHOD ^a	QUANTITY	UNIT PRICE ^b	TOTAL
52.	240+72		RX/UP	1200 yd ³	\$ 2.00	\$ 2,400
53.	Place Rock, RX 240+72				Lump Sum \$	1,500
54.	241+06	243+76	OS/LS	1590 yd ³		\$ 3,180

SUB TOTAL BID THIS ADDITIVE = \$ 7,480

GRAND TOTAL BID:

BASE BID, PLUS ADDITIVE BIDS #1, #2, #3, AND #4 = \$ 230,492

Modification #3; winterization of site \$ 400

GRAND TOTAL CONTRACT = \$ 230,892

(a) RX - stream crossing; EOS - export outslope; OS - outslope; UP - unit price;
LS - lump sum.

(b) Software difficulties, along with post excavation survey results, required a contract modification be written to adjust the unit price bid items.