

REHABILITATION UNIT 91-2 - SUMMARY

UNIT NAME: K&K Road PROJECT LEADERS: David L. Steensen
Gregory J. Bundros

LOCATION DESCRIPTION: T10N R2E S23 (Map A, pg 2). Within the Copper Creek basin, 12 miles from Orick, California.

TOTAL ACREAGE: Road corridor; 0.8 mile treated.

TOTAL REHABILITATION COSTS: \$166,429 (Table 1, page 3)

GEOLOGY DESCRIPTION: Incoherent Coyote Creek Unit of the Jurassic-Cretaceous Franciscan Formation comprised of unmetamorphosed mudstones and sandstones, with a low sandstone/mudstone ratio.

GEOMORPHIC DESCRIPTION: almost entirely within the inner gorge of Copper Creek characterized by steep ($\geq 75\%$) north aspect and relatively dry south aspect slopes. The drainage area of Copper Creek at the former bridge site is 1,590 acres and the estimated Q_{25} is 600 cfs. Copper Creek has a steep gradient (0.01), a cobble-boulder bed and large organics contribute to channel structure.

SOIL DESCRIPTION: Elfcreek Soils are common within the inner gorge region of Copper Creek. Elfcreek soils are youthful, grayish soils formed in deep colluvium. These soils are found with imperfectly drained conditions, lack mottles and have a 10%-20% clay content with a 35%-60% gravel fraction. Elfcreek soils are usually associated with debris sliding and local slumping of over-steepened fill prisms. Copper Creek soils are found towards the north end of the unit and are brown, deep (> 60 in.), well-drained soils, containing 15%-35% gravel and cobble-size rock fragments and are quite prone to fluvial erosion. Mass failure generally occurs in areas where fill material has been over steepened, or where slopes have been undercut by bank erosion in Copper Creek.

LAND USE HISTORY:

The K&K Road was constructed through the Copper Creek basin between 1955 and 1958. The bridge spanning Copper Creek at the time of rehabilitation was the third bridge at this location. Timber harvest above the K&K began in the late 1950's primarily as selective cuts. These cuts were later re-entered (seed-tree removal and clearcut). Tractor yarding methods were common, but cable methods may have been used in some downslope areas. All areas downslope of the K&K, and down to Copper Creek, were clearcut by 1972.

EROSION FEATURES:

Erosional processes are presently dominated by shallow debris sliding, mostly consisting of road fill or sidecast, cutbank failures and wet cutslope debris sliding. The north facing slope is wetter than the south facing slope. Fillslopes on north aspect slopes toe-out in Copper Creek for nearly 700 feet downstream from the bridge site. Significant amounts of road fill eroded during major storms. The south aspect slope is dominated by shallow debris slides that appear to be more related to the slow retreat of cutbanks rather than concentrated runoff. (pg. 7)

REHABILITATION WORK SUMMARY

I. Total Heavy Equipment Cost: \$140,197 IFB CX 8480-1-0001
(Table 1, page 3)

Equipment used: two Bucyrus-Erie hydraulic excavators (300H and 350H), an International TD-20E bulldozer, a Case 850B bulldozer, and three 10 yd³ dump trucks. Most everything was endhailed by trucks.

#	Type of Treatment	Total Cost	Quantity	Unit Cost	Rate
1	Bridge Dismantling, RX21	\$6600	1 job	.-	.-
1	Haul Rd Stream Xing Exc	6003	1450 yds ³	\$4.14/yd ³	54 yds/hr
5	Exported Outslope	92,669	23,520 yds ³	3.94/yd ³	52 yds/hr
5	Outslope	12,656	6360 yds ³	1.99/yd ³	83 yds/hr
1	Deep Drain	2738	965 yds ³	2.84/yd ³	84 yds/hr
2	Cross-Road Drains	156	107 ft	1.46/ft	54 ft/hr
2	Improve IPD	369	253 ft	1.46/ft	125 ft/hr
-	Rip Roads ¹	570	0.6 mi	950/mi	.03 mi/hr
3	Rock Armor ²	3280	180 yds ³	18.22/yd ³	12 yd/hr
1	Log Placement, RX21	4000	1 job	.-	.-
-	Miscellaneous	11,656	.-	.-	.-

II. Total Labor Intensive Costs: \$9520 (Table 1, page 3)

Work Summary:

Brush worksites:	43 person-hours	\$659
Salvage decking:	34 person-hours	521
Const. silt fence:	33 person-hours	505
Straw mulch:	500 bales	7835

DISCUSSION³: Work was completed in an efficient manner. Ripping methods were atypical; values should not be used. Other costs seem good and can be used to estimate similar work.

REVIEWER'S NAME:

COMMENTS:

¹Contractor used a pull-behind, single tooth ripper that was not only archaic, but extremely slow.

²Includes rock salvage, transport and placement.

³Detailed in report.

SUMMARY REPORT

EROSION CONTROL WORK PERFORMED ON

THE K&K ROAD, COPPER CREEK

UNIT 91-2

by

David L. Steensen

Gregory J. Bundros

April 21, 1993

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WATERSHED REHABILITATION UNIT 91-2
Lower K&K Road: Copper Creek

Introduction

The 1991 Rehabilitation Project addressed erosion problems along the K&K Road in the Copper Creek basin. The K&K Road is one of the largest man-caused sources of sediment within the Redwood Creek watershed and the portion through Redwood National Park passes through some of the most erodible terrain within the basin. Rehabilitation work on the K&K road began in the summer of 1988 and 4.9 miles of road, including an unnamed ranch road, and portions of the 1600, 1610, 1700, 1800, 1900, and Camp Roads, had been completed prior to the implementation of Unit 91-2. Previous work permanently treated about 520 acres of watershed area. K&K rehabilitation Units 88-2, 89-2, and 90-2 are summarized by Steensen (1989, 1992a, 1992b). Adjacent projects to Unit 91-2 include South Copper Creek (Unit 79-4, Weaver et al., 1987) and North Copper Creek (Unit 81-1, Utley, 1982).

Located about 12 miles southeast of Orick, California (Map A), rehabilitation work on Unit 91-2 was the fourth year of erosion control work along the K&K Road. Previous work plus Unit 91-2 has completed what is referred to as the Lower K&K. From the end of Unit 91-2 to Counts Hill Prairie is referred to as the Middle K&K. From Counts Hill to the gate at the Bald Hills Road is considered the Upper K&K.

Erosion control work treated 0.8 miles of the K&K Road, and 0.1 mile of the Copper Creek Rock Pit access road. Two haul road stream crossings were treated, including the removal of a 25-foot high double flatcar bridge with abutments. One stream crossing and one deep drain were armored with rock to control potential erosion in extremely erodible materials. Over 32,000 cubic yards of unstable fill material was excavated and 80% of that volume was hauled by truck to stable storage sites.

The 1991 project was performed as an IFB Contract (CX #8480-1-0001) and work was performed by Carl M. Kjer and Sons of Arcata, California. Contract costs for erosion control work utilizing heavy equipment was \$140,697. Labor cost for brushing and site preparation was \$9520. Labor and materials cost for straw mulch application was \$7835. Personnel costs associated with site evaluation, planning, contract administration, and documentation was \$6410. The total project cost was \$166,429 and is itemized in Table 1. Rehabilitation treatments are shown in Map B.

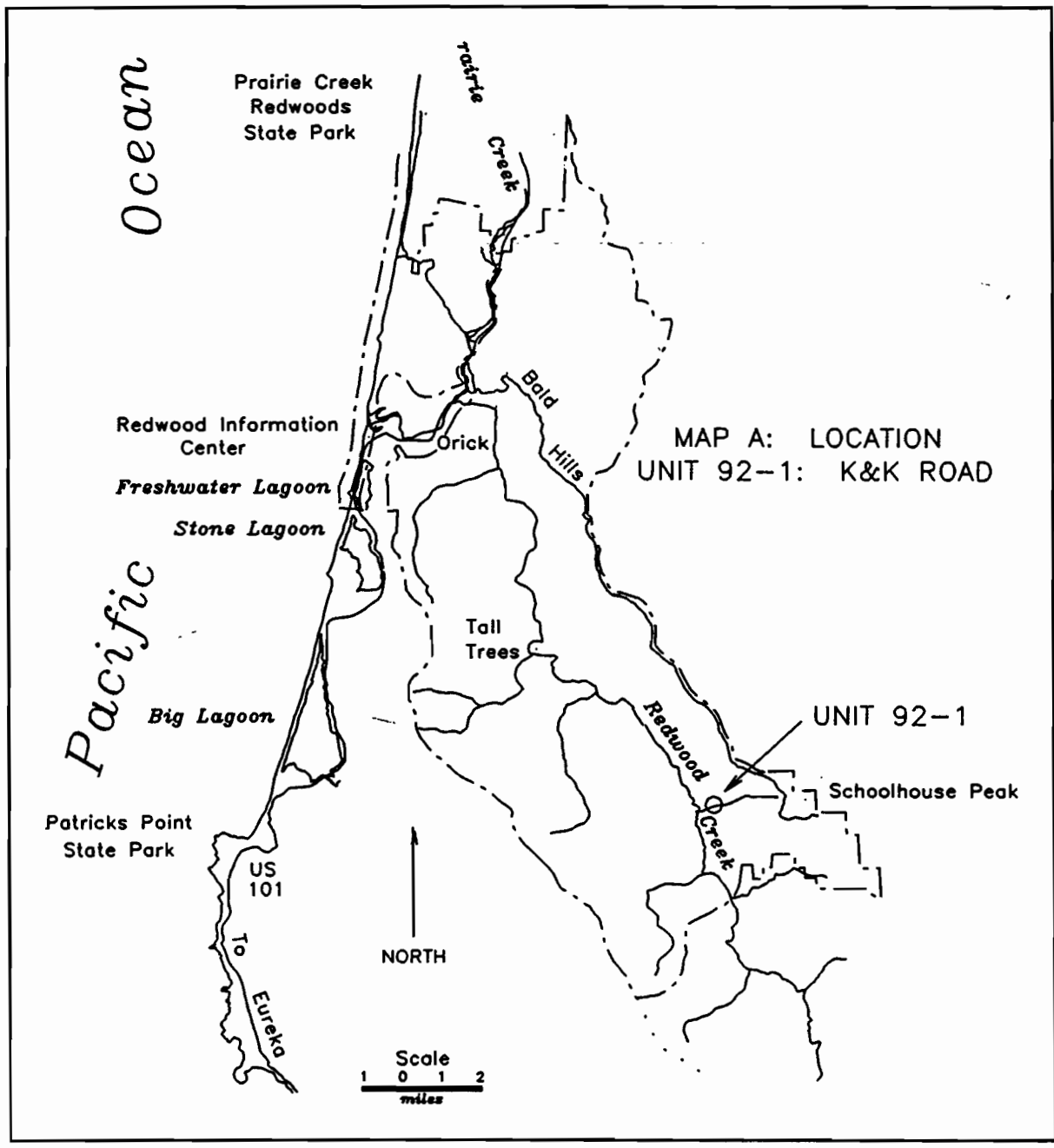


Table 1.
REHABILITATION WORK COST SUMMARY
UNIT 91-2; K&K ROAD

Treatment	Total Quantity	Total Cost	Ave. Unit Cost
HEAVY EQUIPMENT WORK¹			
<u>Primary Treatments:</u>			
Haul road crossings	1450 yds ³	\$6003	\$4.14/yd ³
Dismantle bridge RX21	1 job	6600	-.-
Exported outslope	23,520 yds ³	92,669	\$3.94/yd ³
Outslope	6360 yds ³	12,656	\$1.99/yd ³
Deep drains (exported)	965 yds ³	2738	\$2.84/yd ³
Cross-road drains	107 feet	156	\$1.46/ft
Improve ditches	253 feet	369	\$1.46/ft
Rip roads	0.6 mile	570	\$950/mi
<u>Secondary Treatments</u>			
Rock armor	180 yds ³	3280	\$18.22/yd ³
Log placement (RX21)	1 job	4000	-.-
<u>Miscellaneous Treatments</u>			
Straw distribution	276 bales	1656	\$6.00/bale
Flatcar/log transport	1 job	4000	-.-
Record keeping	1 job	1000	-.-
move-in/move-out	1 job	5000	-.-

TOTAL HEAVY EQUIPMENT COST = \$140,697

LABOR INTENSIVE WORK

Primary Treatments - none

Secondary Treatments

Straw mulch ²	500 bales	\$7835	\$15.67/bale
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Miscellaneous

Brush worksites	43 person-hours	659	-.-
Silt fence const.	2 sites	505	\$253/site
Salvage bridge decking ³	1 job	521	-.-

TOTAL LABOR INTENSIVE COSTS = \$9520

¹Heavy equipment work was performed under fixed-price contract CX 8480-1-0001. Heavy equipment costs in this table reflect contract (bid item) costs. Table 2 compares these costs with an H.E.R.E based upon actual hours worked for each treatment. Appendix A contains the Abstract of Bids for this contract.

²Includes cost of straw (\$3.85/bale), distribution (224 bales) and spreading (500 bales).

³Approximately \$3000 of Douglas-fir 4"x12" beams were salvaged from the deck before demolition of the bridge occurred.

Table 1. (continued)
REHABILITATION WORK COST SUMMARY
UNIT 91-2; K&K ROAD

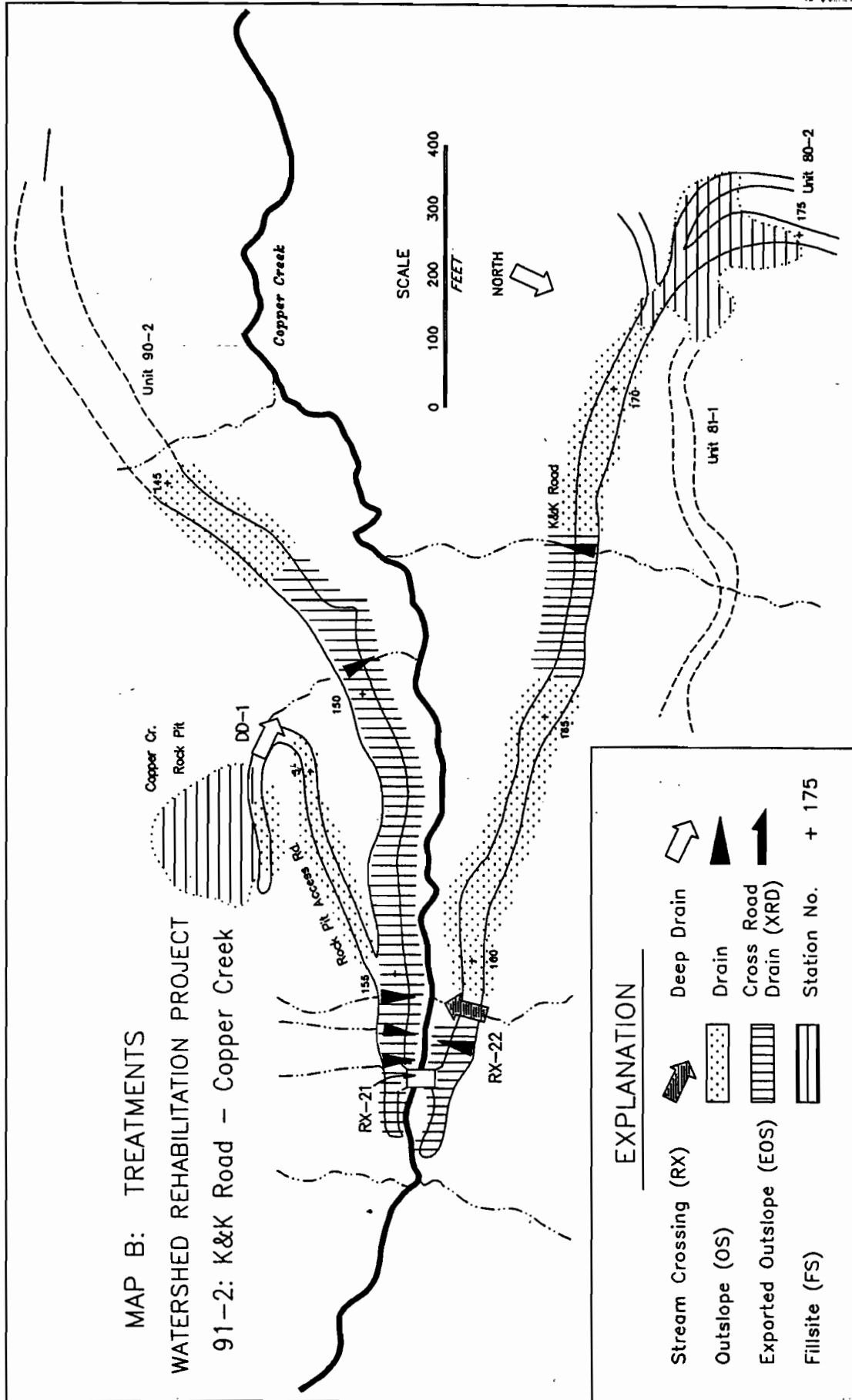
Treatment	Total Quantity	Total Cost	Ave. Unit Cost
TECHNICAL WORK			
<u>Evaluation of Rehabilitation Unit</u>			
Detailed mapping ⁴	40 person-hours	\$742	-.-
Prescribe treatments	35 person-hours	649	-.-
Survey and design	169 person-hours	2172	-.-
Contract prep.	154 person-hours	2847	-.-
<u>Heavy Equipment Supervision</u>			
Project leader	393 person-hours	6207	-.-
Assistant	183 person-hours	1918	-.-
<u>Documentation</u>			
Photo points	29 person-hours	273	-.-
Summary report	80 person-hours	1404	-.-

TOTAL TECHNICAL COSTS = \$16,212

TOTAL PROJECT COSTS = \$166,429

⁴The majority of detailed mapping was performed during previous years.

MAP B: TREATMENTS WATERSHED REHABILITATION PROJECT 91-2: K&K Road - Copper Creek



EXPLANATION

Stream Crossing (RX)	Deep Drain
Outslope (OS)	Drain
Exported Outslope (EOS)	Cross Road Drain (XRD)
Fillsite (FS)	Station No. + 175

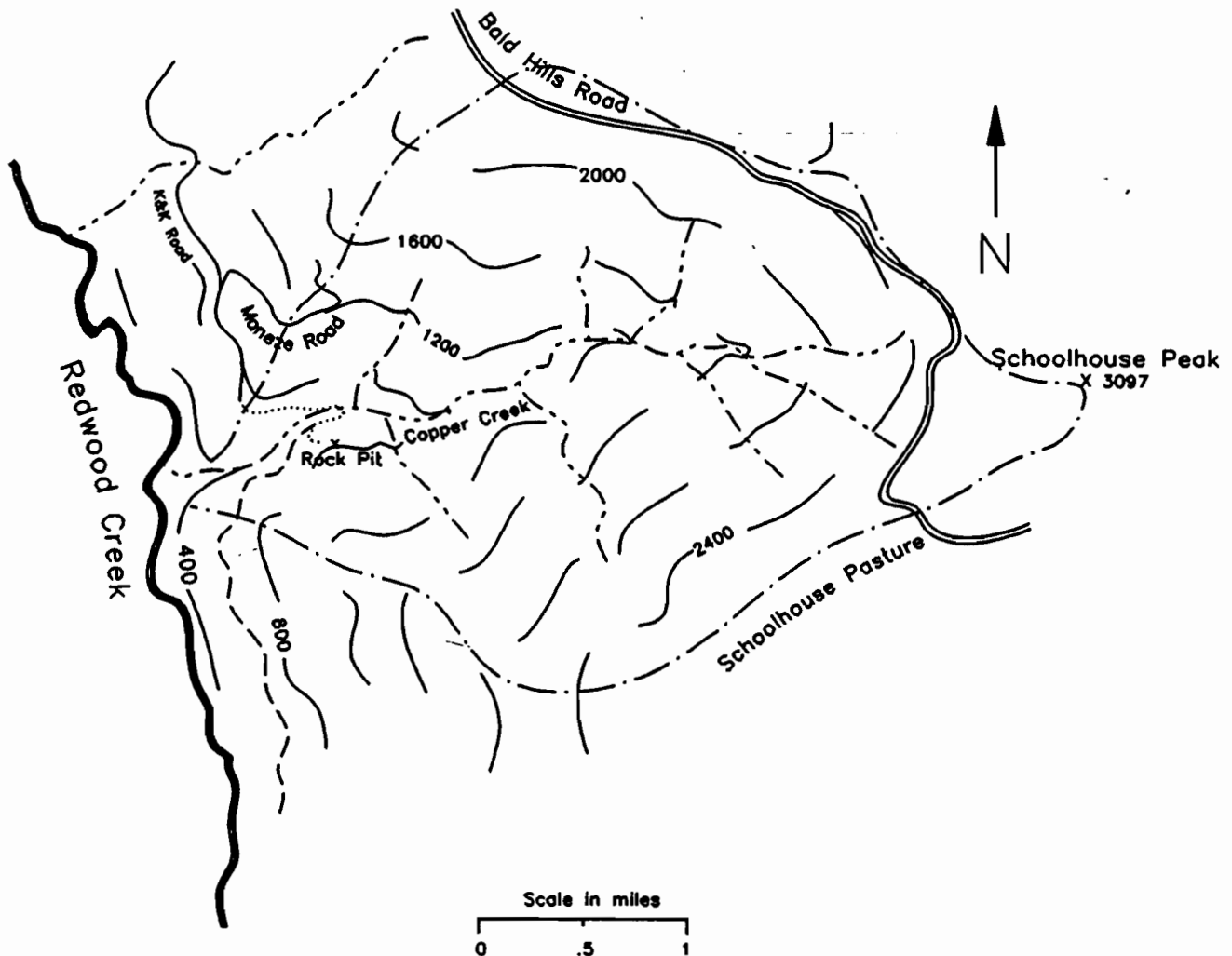
Geology/Geomorphology

The entire rehabilitation unit is underlain by the Incoherent Coyote Creek Unit of the Jurassic-Cretaceous Franciscan Formation. The Coyote Creek Unit is comprised of unmetamorphosed mudstones and sandstones, with a low sandstone/mudstone ratio (Harden *et al.*, 1982). Rocks are typically more brecciated and sheared than other units, especially in the vicinity of the Grogan Fault Zone. Tectonic blocks of chert, greenstone and sandstone are common and are usually in a sheared mudstone matrix. The Incoherent Coyote Creek Unit is not considered "melange", a term often used to describe Franciscan rocks elsewhere in the California Coast Range that exhibit a greater degree of shearing and that contain more exotic blocks.

The boundaries of the work area were almost entirely within the inner gorge region of Copper Creek and are characterized by steep ($\geq 75\%$) slopes that are, for the most part, wet on the left valley-side (north facing) and relatively dry on the right valley-side (south facing). The wet/dry relationship is probably more dependent upon contributing watershed area above the inner gorge than aspect. The drainage area of Copper Creek at the former bridge site is 1,590 acres (6.4 km^2) and the estimated Q_{25} is 600 cfs (17 cms) (after Campbell and Sidle, 1984). Copper Creek has a steep gradient (0.01) and a cobble-boulder bed. Large organics contribute to channel structure. Several large plunge pools and lateral scour pools exist in the stream reach below the K&K segment that was rehabilitated. It is not known precisely how the existing channel compares with the pre-disturbed channel but abundant evidence suggests the stream bed remains elevated relative to pre-road conditions. Tributary streams to Copper Creek generally occupy poorly to moderately incised valleys and often amount to nothing more than large gullies when they flow through inner-gorge terrain. The unit exhibits moderate relief from about 480 feet to about 790 feet in elevation above sea level (Map C).

Much of the previous work along the K&K (1988-1990) was adjacent to the Grogan Fault Zone. The Grogan Fault is defined along a zone of slightly metamorphosed and pervasively sheared rocks (Harden *et al.*, 1982). The shear zone is of varying width and separates the Redwood Creek Schist from the unmetamorphosed rocks of the Incoherent Coyote Creek Unit and Coherent Lacks Creek Unit (also Franciscan Fm.). The fault zone is considerably straighter than other NNW trending faults in the region suggesting that it is near-vertical. Unit 91-2 is immediately east of the mapped trace of the Grogan. The influence of the fault may play a significant role in landscape stability within the unit.

Map C: Topography
Unit 92-1; K&K Road



Legend

- K&K removed previous years
- K&K removed 1992
- K&K remaining
- . - - Watershed divide

Soils

Elfcreek Soils are commonly found within the inner gorge region of Copper Creek. Elfcreek soils are described by Popenoe and Sturhan (1988) as youthful, grayish soils formed in deep colluvium. These soils are found on lower hillslopes associated with imperfectly drained conditions. They generally lack mottles and have a 10%-20% clay content with a 35%-60% gravel fraction. Elfcreek soils are usually associated with debris sliding and local slumping of over-steepened fill prisms.

As the K&K climbs away from Copper Creek towards the north end of the unit, Coppercreek Soils become dominant. Coppercreek Soils are brown, deep (> 60 in.), well-drained soils. They contain 15%-35% gravel and cobble-size rock fragments and are quite prone to fluvial erosion. Mass failure generally occurs in areas where fill material has been over-steepened, or in the case of Unit 91-2, where slopes have been undercut by bank erosion in Copper Creek.

Land Use History

Prior to timber harvest the grass prairie and grass-oak woodland areas which dominate the ridge top areas in the Copper Creek basin were grazed by cattle and sheep (upslope from Unit 91-2). Grazing of domestic stock did not stop until the park was expanded in 1978.

The K&K Road was constructed through the Copper Creek basin between 1955 and 1958. A log bridge had been constructed across Copper Creek with the first alignment. This bridge failed during the 1964 storm (Laroy Hake, personal communication, 1993) and was replaced with another log stringer bridge. Following the 1972 storms, a major realignment of the K&K occurred because of slope stability problems and the bridge was replaced with a flatcar bridge which remained in place until the time of rehabilitation.

Timber harvest began soon after the road had been completed and it appears that logging began on the hillslopes above the K&K and was exclusively selective cuts. As time progressed, these cuts were re-entered (seed-tree removal and clearcut) and an increasing number of trees were removed from the downslope region between the K&K and Redwood Creek. Tractor yarding methods were common, but cable methods may have been used in some downslope areas. Very few old growth conifers remain today within the unit and the ones that do are mostly small. One maple tree near station 152+00 has survived all past ground disturbances.

The upslope areas were first harvested (select cut) between 1958 and 1962. Significant erosion or stream channel alteration resulting from the 1964 storm was not obvious in aerial photograph analysis. Little or no logging took place in the

areas immediately adjacent to the rehabilitation unit between 1962 and 1968, although an increasing amount of the upstream watershed area of Copper Creek was harvested, principally from the 1900, 2002, and Manezes Road systems. All of the area downslope of the K&K, and down to Copper Creek, were clearcut between 1968 and 1972. The previously select cut areas above the K&K were re-entered and clearcut during this time period.

With the expansion of Redwood National Park in 1978, Simpson Timber Company was granted a temporary easement to haul logs on the K&K until 1987. Simpson was also required to maintain the road. In 1987, Redwood assumed sole responsibility for maintenance and management of this road.

Erosional Features

The Lower K&K Unit includes some of the most erodible terrain in the Redwood Creek Basin (Coleman, 1973; Janda *et al.*, 1975). Erosion rates are naturally high and have been accelerated by land use practices. Man-influenced sediment sources included stream crossing fills and large quantities of sidecast road materials. Swales and small stream channels above the K&K were invariably undercut by road construction and channel instability migrated several hundred feet upstream. Unstable headcuts and stream bank slides were common and persistent sediment sources. Erosional processes are presently dominated by shallow debris sliding, mostly consisting of road fill or sidecast, cutbank failures and wet cutslope debris sliding. Eroded materials enter Copper Creek directly and are rapidly transported to Redwood Creek. Disturbance to this area has been great enough to obliterate all but a few small areas of "original ground".

The north facing slope has considerably more surface and emergent flow along the road than the south facing slope. Fed by gully systems that diminish rapidly in size, cutslopes apparently failed by debris sliding, creating large scars adjacent to the road. These scars probably developed quickly and subsequently little erosion has occurred in them in recent times. The vegetation is well established and is relatively advanced in age. The south facing slope is dominated by shallow debris slides that appear to be more related to the slow retreat of cutbanks rather than concentrated runoff.

Fill materials sidecast during the construction of the K&K have significantly impinged upon the channel of Copper Creek. Fillslopes on the left bank toe-out in the active channel of Copper Creek for nearly 700 feet downstream from the bridge site. Field observations of fluvially deposited sand and gravel in the fill, with subsequent burial by additional fill, indicate that reconstruction of the road occurred at least once during its existence. It is likely that fill material exists below the current channel elevation, having been buried by aggradation

within Copper Creek which has not downcut to the original channel elevation. Numerous cut logs protruding from channel deposits and in-place, but partially buried, stumps suggests the channel remains elevated.

It is likely that significant amounts of road fill eroded during the 1972 storm. Aerial photo analysis shows that the channel was significantly aggraded and much of the stream-side vegetation had been lost as a result of that storm. Field observation of fill terraces and log jams at several locations adjacent to Copper Creek show as much 10-15 feet of aggradation occurred as a result of major storms.

The project site also included "Leon's Slide", a relatively small complex earthflow feature named after an elk that inhabited the area. For the most part, the project site was dominated by debris sliding rather than deep seated failures which is in contrast to past work on the K&K. Most recently, even in mild winters, several small debris slides have been active, especially along the left bank of Copper Creek immediately downstream of the former bridge.

Aquatic Habitat

Concern over the diversity of stream habitat brought up the question of whether or not a fishery existed at the time of rehabilitation. This section of stream has at least four, perhaps six, downstream barriers to anadromous fish.

Surveys had been conducted in 1981 for the lower reaches of Copper Creek (Anderson, 1988; Brown, 1988) and no salmonids were found above the first barrier upstream from the mouth. Stream reaches within and adjacent to the project area were surveyed by electrofishing in late spring, 1991, prior to project work. No fish were found.

REHABILITATION WORK - PRIMARY TREATMENTS

Project Implementation

Field mapping, site evaluations, and prescriptions were accomplished in January, 1991 by D. Steensen. Mapping utilized enlarged aerial photography at a scale of 1:1200. The majority of ground surveys had been completed during previous years, but additional surveys were performed by D. Steensen, M. Napolitano, T. Hardt, D. Short, K. Griffin, G. Bundros, J. Wood, and T. Abel. Photo-documentation of the site was by T. Abel, K. Helstrom, and D. Steensen. Rehabilitation work was supervised D. Steensen, G. Bundros (project leaders and contracting officer's representatives), T. Abel, and K. Helstrom (assistants). Table 1 summarizes all costs for this rehabilitation unit. Table 2 compares contract bid costs with rental equivalent costs based

upon actual hours worked. Earthmoving utilized two Bucyrus-Erie hydraulic excavators (300H and 350H), an International TD-20E bulldozer, a Case 850B bulldozer, and three 10 yd³ dump trucks.

Primary rehabilitation treatments included the removal of the Copper Creek Bridge, excavation of one haul road stream crossing and one deep drain, 0.3 mile of exported outsloping which also included six "drains" (see EOS below), and 0.4 mile of outsloping. Refer to Map B for the locations of individual worksites.

Detailed definitions and explanations of treatments are discussed in numerous past reports (for example, Weaver et al., 1987; Spreiter, 1990; among others).

Exported Outsloping

Exported outslope treatments (EOS) can either remove the entire road bench or just the outboard portion of the road, but in both cases the fill must be exported (endhauled) some distance to a stable fillsite. A considerable portion of the effort to treat Unit 91-2 was spent excavating the entire road prism of the K&K and truck-endhauling the fill material to stable fillsites (Map B). The inherent instability of the materials on this site warranted removing as much material as was practical to lessen driving forces causing road-related fill failures and discourage the propagation of failure through the larger slope failures (e.g. earthflows).

The segment of the K&K downstream of the bridge and on the left bank of Copper Creek passed through increasingly wet slopes as the road approached the bridge. Numerous recent debris slides, a slumping road bench near the bridge, and flood deposits cut into existing fill were all indicators of the erosion potential that existed there. Several portions of "intact" road prisms were being supported by rotting organic debris which was exposed along the stream banks.

Treatments were designed to remove as much of the potential sediment source as practical, while still leaving as much of the stream-side vegetation as possible. When stream bank scour occurs during large future runoff events, the potential for undercut fillslopes and failing road benches will be reduced.

Table 2.
A COMPARISON OF CONTRACT
VS. H.E.R.E. HEAVY EQUIPMENT COSTS
Unit 91-2; K&K Road

Treatment	Number of Worksites	Total Quantity	Total Costs		Government Savings (+) or Losses (-)	Average Unit Costs	
			Contract	H.E.R.E. ¹		Contract	HERE
Road Crossings (T) ²	1	1450 yds ³	\$6003	\$4906	-\$1097	\$4.14/yd ³	\$3.38/yd ³
Dismantle Bridge	1	1 job	6600	2365	-4235	-.-	-.-
Exported Outslope	5	23,520 yds ³	92,669	77,399	-15,270	3.94/yd ³	3.29/yd ³
Outslope	5	6360 yds ³	12,656	10,825	-1831	1.99/yd ³	1.70/yd ³
Deep Drain (T)	1	965 yds ³	2738	1600	-1138	2.84/yd ³	2.30/yd ³
Cross-Road Drains	2	107 feet	156	260	+104	1.46/ft	2.43/ft
Improve Ditches	2	253 feet	369	260	-109	1.46/ft	1.03/ft
Rip Roads ³	-.-	0.6 mile	570	2100	+1530	950/mi	3500/mi
Straw Distribution ⁴	-.-	276 bales	1656	394	-1262	6.00/bale	1.43/bale
Miscellaneous Jobs ⁵	-.-	-.-	12,280	6260	-6020	-.-	-.-
Miscellaneous Cbsts ⁵	-.-	-.-	0	16,412	+16,412	-.-	-.-
Move In/Out	-.-	-.-	5000	4000	-1000	-.-	-.-

TOTALS = \$140,697 \$126,781 -\$13,916

GOVERNMENT "LOSSES" REPRESENTS A 10% PROFIT MARGIN FOR CONTRACTOR.

MISCELLANEOUS COSTS REPRESENT A 10% OVERHEAD COVERED BY CONTRACT.

¹Heavy Equipment Rental Equivalent (HERE) is the cost to perform each task based upon the actual hours worked and following, prevailing equipment rental rates: Bucyrus Erie 300H @ \$130/hr; Bucyrus Erie 350H @ \$160/hr; International TD-20 @ \$120/hr; Case 850 @ \$95/hr; dump truck @ \$50/hr.

²(T) fill is truck endhaunched; (P) fill is push endhaunched.

³A ripping implement with a single ripper tooth, towed behind the TD-20 was used to rip roads instead of hydraulically activated, rear mounted rippers that are most common. Although this operation worked, it is not the most cost-effective way to rip roads and explains the unusually high cost.

⁴Includes transport of flatcars to Z-Deck, log placement at RX21, rock salvage and placement and record keeping.

⁵Includes improving roads for dump truck endhaunching (\$665), idle time (\$56,860), down time (\$2465) and paid breaks (\$7282). This particular contractor is perhaps the only contractor who can afford leaving machinery idle as they did. Normal idle time would rarely exceed \$3000. Assuming a normal idle time, the total amount of miscellaneous cost of \$13,412 represents a 10% overhead for this contract.

The majority of work performed on this rehabilitation unit occurred on road sections immediately above Copper Creek. Road excavations included some of the largest volume-per-foot (up to 36 yd³/ft) excavations ever performed in Redwood National Park. Roughly 23,500 cubic yards was excavated and truck endhauled to stable fillsites. The fillsites utilized were the Copper Creek Rock Pit (avg. hauling distance of 1000 ft.), a ridge-top area near station 172+00 (avg. distance of 1100 ft.), and a major through-cut near station 186+00 (avg. distance of 900 ft.).

Drain treatments were specified for six locations within EOS treatments. Drains are channels constructed across the finished EOS to convey storm gully flow and spring flow into appropriate locations below the excavations. The drain across Leon's Slide was also armored with rock. Exported outslope costs are summarized in Table 3.

Outsloping

Outsloping (OS) removes fill material from the outer edge of a road and stores this material against the cutbank and shapes the finished surface to blend with surrounding topography. Outsloping is an appropriate rehabilitation measure in areas where treatments solely for erosion control do not encourage vigorous natural revegetation.

Roughly 0.4 mile of road was outsloped primarily in areas away from Copper Creek where Coppercreek soils exist. Outsloping costs are summarized in Table 4.

Haul Road Stream Crossings

Haul road-stream crossing excavations (RX) remove road fill materials from buried stream valleys and channels. RX excavations eliminate potential stream diversions at crossings and remove sediment sources. RX excavations in Unit 91-2 deviate from typical examples of RX treatments in Redwood, in that all stream channels had been so greatly disturbed that the original channel elements were missing. Virtually no original channel elements were found during any of the stream excavations.

With the completion of four rehabilitation projects on the K&K with more than 27 stream crossing excavations (RX, SX, and DD) finished, only one stream crossing has shown any appreciable amounts of original elements: RX-5 (Unit 89-2; see Steensen, 1992a). There are three principal causes for this: 1) undercutting of the original grade by road construction, with the channel elements simply bulldozed away (especially true for small steep drainages), 2) large-scale failures at stream crossings combined with mass movement that destroyed the original morphology, and 3) pre-disturbance channels were often poorly developed in the youthful, inner gorge terrain. With no natural channel armoring expected, rock armor was placed in certain streams to inhibit excessive downcutting (described below in the Secondary Treatments section).

TABLE 3
EXPORTED OUTSLOPE (EOS) TRUCK ENDHAUL COSTS
UNIT 91-2; K&K ROAD

Worksite ¹	Actual Equipment Hours				H.E.R.E.		Volume (yds ³)	Unit Cost (\$/yd ³)	Excavation Rate (yd ³ /hr)	Average Distance to Fillsite	Vol./ft of Road (yd ³ /ft)
	300	350	TD20	DT	Total Cost ²						
EOS 147+32	6.7	39.5	13.0	16.2	88	\$8581	4790	1.79	121	.25 mi	10.3
EOS 151+90	5.0	40.2	41.2	26.5	121	20,607	6485	3.17	161	.20 mi	15.1
EOS 155+15	11.7	53.7	46.2	17.7	139	24,351	6580	3.70	122	.32 mi	18.6
EOS 156+45	6.0	43.5	42.0	6.5	85	17,660	2795	6.32	64	.55 mi	11.4
EOS 165+40	7.5	22.0	--	6.5	22	6200	2870	2.16	130	.19 mi	10.1
TOTALS	37.0	199	142.5	73.5	456	\$77,399	23,520 yd ³	--	--	--	--

The average unit cost for truck endhaunched EOS = \$3.29/yd³.

The total contract bids for truck endhaunched EOS = \$92,699 (\$3.94/yd³).

The average excavation rate for truck endhaunched EOS was 118 yd³/hr.

¹There were no unusual site conditions (materials, moisture, etc.) at any worksite. EOS 156+45 was unusually slow because this excavation occurred around the Copper Creek bridge removal. Logistics were atypical and additional clean up was required.

²H.E.R.E. rates are: Bucyrus Erie 300H @ \$130/hr; Bucyrus Erie 350H @ \$160/hr; International TD-20 @ \$120/hr; Case 850 @ \$95/hr; Dump Trucks @ \$50/hr.

TABLE 4
OUTSLOPE (OS) COSTS
UNIT 91-2; K&K ROAD

Worksite ¹	Actual Equipment Hours				H.E.R.E Total Cost ²	Volume (yds ³)	Unit Cost (\$/yd ³)	Excavation Rate (yd ³ /hr)	Vol./ft of Road (yd ³ /ft)
	300	350	TD20	850					
OS 144+91	--	6.50	5.00	--	\$1640	1180	1.39	181	5.3
OS 1+48 ³	--	5.50	3.50	--	1300	260	5.00	47	2.0
OS 4+54	3.50	2.25	--	--	815	740	1.10	211	2.3
OS 159+44 ⁴	5.75	15.50	--	9.50	4130	2600	1.59	168	4.5
OS 167+83 ⁴	6.50	12.50	--	1.00	2940	1580	1.86	126	3.6
TOTALS:	15.75	42.25	8.50	10.50	\$10,825	6360 yds³	--	--	--

H.E.R.E average unit cost for outslopes = \$1.70/yd³

Total contract bids for outslopes = \$12,656 (\$1.99/yd³)

Average excavation rate for outslopes = 147 yd³/hr.

¹There were no unusual site conditions (materials, moisture, etc.) at any worksite. EOS 156+45 was unusually slow because this excavation revolved around the Copper Creek bridge removal. Logistics were atypical and additional clean up was required.

²H.E.R.E. rates are: Bucyrus Erie 300H @ \$130/hr; Bucyrus Erie 350H @ \$160/hr; International TD-20 @ \$120/hr; Case 850 @ \$95/hr; Dump Trucks @ \$50/hr.

³Unit Cost and excavation rate are a result of data errors.

⁴Inexperienced operator on 300 hydraulic excavator

Perhaps the most spectacular work accomplished within Unit 91-2 was the dismantling of the Copper Creek Bridge. The bridge was the largest structure removed in Redwood as of 1991. The bridge consisted of two side-by-side railroad flatcars creating a 35-foot span that was 25 feet above the channel elevation. More than 40 redwood logs, 2-4 feet in diameter, were used to construct the abutments.

Dismantling the bridge was a relatively easy task. The flatcars were winched off of the abutments with a bulldozer (TD20E) while an excavator (BE350H) held the end of the flatcar down with the bucket (the end attached to the winch line). This prevented the far end of the flatcar from crashing into the creek when it was pulled away from its abutment. Then the excavator, which was equipped with a hydraulic thumb, reached across the channel and plucked the logs from the far abutment.

Most of the materials in the bridge were salvaged. The bridge decking (4"x12"x20' fir), which had been replaced in 1988, was removed prior to bridge dismantling and will be reused. The flatcars were hauled to the Z-Deck near the top of the Upper K&K to be used for bridges elsewhere. About half of the logs were also hauled to Z-Deck to be made into split redwood products for park use. The remainder of the logs were placed on-site, some as channel elements.

The one "real" RX excavation (RX-22) eliminated an active stream diversion and created a stable channel. One Deep Drain at Station 167+60 was excavated, which is similar to an RX, but is a smaller excavation. These costs are summarized in Table 5.

Other

Other rehabilitation treatments employed on Unit 91-2 include cross-road drain (XRD) and deep drain (DD) treatments. Cross-road drains are deeply cut waterbars constructed across the road to disperse runoff. They were employed in areas where winterization was necessary (for example, at the end of Unit 91-2). Deep drain treatments are small versions of RX treatments. See Map B for drain locations.

REHABILITATION WORK - SECONDARY TREATMENTS

Rock Armor

Because unstable materials are common along the Lower K&K and finding original stream channel elements in stream crossing excavations was unlikely, rock armor was prescribe for channel excavations where stream gradients and estimated peak flows could cause significant erosion. Rock armor is appropriate where excessive erosion in unprotected channels allows headcuts to move upstream where much larger slope failures can occur.

TABLE 5
MISCELLANEOUS JOBS, TREATMENTS AND COSTS
UNIT 91-2; K&K ROAD

Item	Actual Equipment Hours						H.E.R.E			
	300	350	TD20	850	DT	Crane	Lowboy	Total Cost ¹	Quantity	Unit Cost
Dismantle bridge (RX21) ²	1.00	8.50	6.50	1.00	--	--	--	\$2365	1 job	--
Flat-cars/logs (RX21) ²	--	1.50	4.00	6.00	7.00	6.00	8.00	2840	1 job	--
Place logs (RX21)	4.50	2.75	--	--	--	--	--	1025	1 job	--
Excavate RX22	2.50	14.00	4.75	5.75	24.50	--	--	4906	1450 yds ³	\$3.38/yd ³
Rock salvage/place ⁴	6.75	8.00	--	--	4.75	--	--	2395	180 yds ³	\$13.31/yd ³
Deep drains	4.00	4.50	3.00	--	--	--	--	1600	965 yds ³	\$1.66/yd ³
Rip roads	--	--	17.50	--	--	--	--	2100	0.6 mile	\$3500/mi.
Cross-road drains	2.00	--	--	--	--	--	--	260	107 feet	\$2.43/ft.
Improve ditches	2.00	--	--	--	--	--	--	260	253 feet	\$1.03/ft.
Distribute straw	--	--	--	1.25	5.50	--	--	394	276 bales	\$1.43/bale
Improve roads	--	--	--	7.00	--	--	--	--	--	--
Idle time ⁶	218.0	9.0	87.0	162.0	25.00	--	--	--	--	--
Down time ⁷	1.0	3.0	3.0	1.0	28.00	--	--	--	--	--
Paid breaks ⁸	7.50	15.75	10.75	10.50	30.00	--	--	--	--	--
Totals:	249.3	67.0	136.5	194.5	124.8	6.0	8.0	\$18,1454	--	--

Total Contract Bid for Same Bid Items = \$29,372

Total for Non-Bid Items (Overhead) Listed Above = \$67,272

¹H.E.R.E. rates are: Bucyrus Erie 300H @ \$130/hr; Bucyrus Erie 350H @ \$160/hr; International TD-20 @ \$120/hr; Case 850 @ \$95/hr; Dump Trucks @ \$50/hr.

²Loading and transportation costs to Z-deck on K&K.

³Six logs salvaged from the bridge were trenched into the stream channel and banks.

⁴Rock was salvaged from the road and placed at RX21, RX22 and DD @ Sta. 167+60.

⁵Upgrading roads to accommodate dump trucks and endhauling. This was not a bid item.

⁶Equipment on site, capable of work but not utilized. This was not a bid item.

⁷Equipment down for maintenance/repair. This was not a bid item.

⁸Two 15-minute breaks each day for all pieces. This was not a bid item.

Rock was placed in the channels in a "blanket" form. At the bottom of both rock channels, rock was keyed-into the stream channel and banks by trenching below finished grades and backfilling with rock, creating a foundation from which to lay additional rock. Rock sizes varied from 1 ft. (1/4 ton) to 4 ft. (1+ ton). Quarter- to half-ton rock was the most common size.

Rock was salvaged from the K&K road surface and from fill material. It was correctly predicted that the fill directly below the Copper Creek Rock Pit would contain appreciable rock. Rock was also discovered at a number of other locations during road excavation. It was not cost-effective to haul rock from the M-Line Deck, which at 50 miles one-way was the nearest developed stockpile in the park (Johnson, 1990).

Straw Mulch

All excavated surfaces along the K&K Road were treated with straw mulch to inhibit sheetwash and provide cover for a seedbed. This site has a southerly to southwesterly aspect and summer conditions are usually hot and dry. The application rate was 5,000 pounds per acre (approximately 63 bales/ac) for the main portion of the K&K up through the former bridge site. From RX-22 to the end of the unit, and for the Copper Creek Rock Pit, the application rate was 4,000 pounds per acre (roughly 50 bales/ac). See Table 1 for straw mulch costs.

DISCUSSION

Unit 91-2 was the fourth phase of a several year project to rehabilitate the K&K Road. The size of the K&K Road, its proximity to Copper Creek and Redwood Creek, and the inherent instability of the terrain, required one of the most effort-intensive sites yet to be completed in Redwood National Park. Examples of other sites in Redwood where extensive truck-endhauling was necessary are the G-Line, Unit 85-3 (Kenning and Wosika, 1986), the M-7, Unit 86-1 (Kenning, 1987), and the earlier Lower K&K units: Unit 88-2 and Unit 89-2 (Steensen, 1989; 1992a; 1992b). It is likely that the next segment of the K&K, the "Middle" section, will be less effort intensive.

Unit 91-2 differed from Unit 89-2 and Unit 90-2 in that there were less frequent "stable" areas along the road. Several small fillsites were utilized as well as several larger areas where fill was placed from several source areas. Because of this, a shorter segment of the road was treated in 1991 relative to 1989 and 1990. Unit 91-2 was more like Unit 88-2 in this regard.

The Lower K&K Rehabilitation Project addressed erosion problems associated with road construction and timber harvest on naturally erosion-prone hillslopes and stream channels. Large stream crossing fills and large, unstable quantities of sidecast road

materials adjacent to Copper Creek were significant, potential sediment sources eliminated by the completion of this project. Haul road-stream crossing excavations removed road fill from stream valleys and channels, and eliminated stream diversions.

Reducing some of the driving forces causing road-related fill failures was accomplished by removing as much material as was practical (i.e., within limits of equipment capability, cost, etc.) and landscapes now conform with other treated areas outside the unit. Restoration of drainage systems was likely the greatest cost-effective contribution toward future stability. Where applied, rock armor will play a key role in stabilizing channel excavations.

As with numerous past accounts of work experiences with heavy equipment operators, heavy equipment work on Unit 91-2 went smoothly due to the experience and capabilities of the contractor. Kjer and Sons has considerable watershed rehabilitation experience in Redwood National Park. Familiarity with Redwood's watershed rehabilitation program goals and heavy equipment methods enabled them to perform this work without complications. Working with this contractor has validated the principle that experienced operators are indispensable in implementing successful rehabilitation work.

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January

1. SOLICITATION NUMBER IFB 8480-91-01		2. DATE ISSUED May 14, 1991	3. DATE OPENED June 18, 1991	4. ISSUING OFFICE NATIONAL PARK SERVICE Redwood National Park 1111 Second Street Crescent City, Ca. 95531	5. PROJECT TITLE Watershed Rehabilitation/Erosion Control of the K & K Road, Redwood National Park	6. NUMBER OF ADDENDA ISSUED	7. DATE SIGNED June 20, 1991	8. DATE SIGNED
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I CERTIFY that I have opened, read, and recorded on this abstract all offers received in response to this solicitation.

SIGNATURE *Debra Seidel*

8. GOVERNMENT ESTIMATE (Check A, B or C and complete D, E and F.)			9. OFFERS		10. OFFERS	
			NO. 1	NO. 2	NO. 1	NO. 2
A. HIRED LABOR			A. OFFEROR MANNING CONSTRUCTION		A. OFFEROR J.W. BRASHEAR CONSTRUCTION	
B. REASONABLE CONTRACT (Without Profit)			B. BID SECURITY (Type and amount) Bond 20%		B. BID SECURITY (Type and Amount) Redding, Ca. 96002	
C. REASONABLE CONTRACT (Including Profit)			C. ADDENDA ACKNOWLEDGED 2		C. ADDENDA ACKNOWLEDGED 20%	
7A. ITEM NO.	7B. DESCRIPTION OF OFFERED ITEM	7C. EST. QUANTITY	D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE	E. ESTIMATED AMOUNT
1.	Move In		LS	\$ 1,850.00		\$ 6,250.00
2.	Move Out		LS	1,850.00		6,250.00
3.	Ripping (0.6 miles)		LS	525.00		3,450.00
4.	Distribution of 276 Straw Bales		LS	1,520.00		1,745.00
5.	Log Placement at RX-21		LS	1,760.00		2,960.00
6.	Bridge Flatcar and Log Transport		LS	3,135.00		4,305.00
7.	Record Keeping		LS	495.00		1,695.00
8.	Rock Salvage	MAX 100	CY	\$ 14.00 1,400.00	\$ 25.00 2,500.00	\$ 21.00 2,100.00
	K & K ROAD					
9.	144+91 - 147+32		LS	1,888.00	4,720.00	2,450.00
10.	147+32 - 151+90		LS	23,711.00	35,925.00	18,500.00
11.	151+90 - 155+15	4910	CY	4.95 24,304.50	7.50 36,285.00	3.80 18,658.00
	ROCK PIT ACCESS ROAD					
12.	01+48 - 03+21		LS	416.00	1,040.00	985.00

9. OFFERS (Continued)

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PAGES

SIGNATURE	DATE SIGNED
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9. OFFERS

4-00-	158 821 25
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9. OFFERS (Continued)

NO. 3			NO. 4			NO. 5			NO. 6			NO. 7		
A. OFFEROR			A. OFFEROR			A. OFFEROR			A. OFFEROR			A. OFFEROR		
ANDERSON DRAGLINE			BEN'S TRUCK & EQUIPMENT			HAYES & SONS			CARL M. KJER & SONS			TWIN PARKS LUMBER CO.		
Arcata, Ca. 95948			Red Bluff, Ca. 96080			Yreka, Ca. 96097			Arcata, Ca. 95521			Arcata, Ca. 95521		
B. BID SECURITY (Type and Amount)			B. BID SECURITY (Type and Amount)			B. BID SECURITY (Type and Amount)			B. BID SECURITY (Type and Amount)			B. BID SECURITY (Type and Amount)		
Bond \$60,000			Bond \$50,000			Bond 20%			Bond 20%			Cashier's Check \$30,000		
C. ADDENDA ACKNOWLEDGED			C. ADDENDA ACKNOWLEDGED			C. ADDENDA ACKNOWLEDGED			C. ADDENDA ACKNOWLEDGED			C. ADDENDA ACKNOWLEDGED		
2			2			2			2			2		
D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE	E. ESTIMATED AMOUNT	D. UNIT PRICE
\$ 5.00	\$ 4,825.00	\$ 4.00	\$ 3,860.00	\$ 3.00	\$ 2,895.00	\$ 3.94	\$ 3,802.10	-----	\$ 1,930.00					
	2,960.00		2,960.00		2,200.00		1,472.60		2,960.00					
5.00	31,450.00	4.00	25,160.00	4.80	30,192.00	3.94	24,782.60	2.00	12,580.00					
	10,000.00		5,000.00		5,000.00		6,600.00		19,000.00					
	13,975.00		11,180.00		13,416.00		11,012.30		16,770.00					
5.00	7,050.00	5.00	7,050.00	8.00	11,280.00	4.14	5,837.40	3.00	4,230.00					
	10,400.00		10,400.00		10,400.00		5,174.00		5,200.00					
	14,350.00		11,480.00		14,350.00		11,307.80		11,480.00					
	6,320.00		6,320.00		4,740.00		3,144.20		3,200.00					
	200.00		1,000.00		200.00		73.00		200.00					
	500.00		2,740.00		150.00		200.00		300.00					
	250.00		1,140.00		200.00		83.00		150.00					
	450.00		2,320.00		120.00		169.00		300.00					
TOTAL	\$ 191,040.00		\$ 207,930.00		\$ 149,243.00		\$ 132,717.84		\$ 144,250.00					



91-2 PP5b Pre H.E. 7/31/91 From: TOC 154 +00 View: upsta -> E.O.S. 35mm DLS



91-2 PP5b Post H.E. 10/3/91 From: TOC 154 +00 View: upsta -> E.O.S. 35mm TCA



91-2 PP6B Pre H.E. 7/31/91 K=K View from rock pit 50mm DLS



91-2 PP6B Post H.E. 10/3/91 From: STA 1+45 Rock Pit Rd. View: k+k O.S. 50mm TCA



91-2 PP11b Pre H.E. 7/31/91 STA 157 + 00 Upsta -> CC Bridge 35mm DLS



91-2 PP11B Post H.E. 10/3/91 From: STA 157+00 Above LB Bridge View: upsta -> CU Crk
Bridge 35mm KSH



91-2 PP14b Pre H.E. 7/3/91 Upsta E.O.S. Toward RX22 35mm DLS



91-2 PP14b Pre H.E. 10/3/91 From: Up CB of R.B side of CU crk Bridge site. View: upsta -
>EOS 35mm KSH



91-2 PP20 Pre H.E. 7/3/91 From: Top Drain 167 + Down Channel 35mm DLS



91-2 PP20 Post H.E. 10/17/91 From: Top Drain 167+61 View: Down Channel to bottom 35mm
KSH