

*Terry Sprater*

Rehabilitation Unit 87-6

C-9, North G-6 Roads

Tom McDonald Creek Basin

written and compiled by

Michael Sandeck

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## INTRODUCTION

Rehabilitation unit 87-6 is located in Tom McDonald Creek basin, one of several westside tributaries to Redwood Creek located within the 1978 Redwood National Park expansion area. Tom McDonald Creek enters Redwood Creek at the Tall Trees Grove, about seven miles southeast of Orick, CA, and drains some 4,500 acres into the Redwood Creek system. The basin is underlain by quartzofeldspathic mica schist of greenschist to lower blueschist facies of the Redwood Creek outlier (Blake and Jones, 1981). The bedrock is generally coherent but zones of pulverized or strongly weathered schist (blue-goo) is found locally. Soils are generally deep, with brown or red clay Bt horizons with 40-60% clay (Popenoe, 1987). Development is correlated with slope position. In the immediate vicinity of stream channels, areas of underdeveloped soils often exist. These soils are grey to brown in color, imperfectly drained, and contrast with the well drained, red soils found over most of the unit.

Prior to timber harvesting, vegetation was dominated by redwood, with Douglas fir, western hemlock, grand fir, and tanoak in the overstory and rhododendron-huckleberry and Baccharis-Whipplea seral types with a low to moderate density of red alder. The majority of precipitation, about 80 inches annually, occurs between October and April. Coastal fog is characteristic during the summer months.

The Tom McDonald Creek basin ranges in elevation from 2,760 feet (MSL) at Rodgers Peak to 120 feet at the confluence with Redwood Creek (see topographic map). Unit boundaries include elevations ranging from 1,200 feet to 400 feet. The lower slopes found within the project area average 40-50% but locally steepen to 90% or greater. These contrast with ridgetop areas in Tom McDonald basin, which are gentle, generally 20 to 25%. Project boundaries incorporate 368 acres in the lowermost portion of the basin. Hillslopes included within the project boundaries generally fall within the inner gorge of major streams, where slope processes are most active and contributing hydraulic areas are large. Major flood producing storms occurred in 1953, 1955, 1964, 1972, and 1975. Timber harvest activities, beginning in Tom McDonald Creek basin in 1952, ended at the time of park expansion in 1978.

Geotechnical work in the project area focused on mitigation of erosional problems associated with 2.86 miles of major logging haul road. Excavation of more than 5,366 cubic yards of fill from seven major haul road stream crossings, removal of greater than 11,465 cubic yards of unstable material from 3,864 linear feet of road, installation of 51 crossroad drains, disaggregation of compacted road surfaces and log deck areas, and application of some 26 tons of straw mulch was accomplished at a cost of \$48,372. Unit costs were improved over those seen in similar heavy equipment projects through use of a large hydraulic excavator (Case 220 with 2.75 cubic yard bucket) and blade-endhauling using large (Caterpillar D8H) U-blade bulldozers (table 1).

## TIMBER HARVEST

Within the 368 acres included in the unit boundaries, 153 acres were harvested by 1954 (see land use map). This acreage was clearcut by cable method from the C-line road, which skirts the upper boundary of the project area. Originating at the Louisiana Pacific lumber mill at Big Lagoon, the C-line entered the westside of the basin through a topographic divide. A 21 mile loop was created that accessed harvest units in Tom McDonald, 44 Creek, and Bridge Creek basins, and linked the C-line road system to the M-line road system, which originated in Crannel.

Streambed skimming in the vicinity of the Tall Trees Grove provided surfacing for the road network, and was a major source of gravel until Redwood National Park was created in 1968. After 1968, road surfacing materials were quarried in bedrock in upper hillslope locations.

Land above the C-line was progressively harvested from 1954 to 1975. Tractor logging was used in this relatively gentle terrane, and generally the areas were clearcut in one or two entries. Skid trails often buried channel reaches above C-line stream crossing fills, which were used as log decks, and discrete skid trail slope crossing fills were emplaced throughout the harvested areas.

By 1974, virtually all land above the C-line had been clearcut, and the only remaining timber in Tom McDonald basin was located in the lowermost elevations, beyond the lower boundaries of the 1950's cable units. In 1974 the C-9 road was built through the project area to access the remaining old growth. By 1975 the G-6 road was complete, passing through the project area and crossing Tom McDonald Creek via a log bridge, providing direct access to the G-line deck. Rock was quarried at the intersection of C-line and G-line and used to surface the route connecting G-line deck to C-line.

These roads allowed clearcutting of about 85 acres, and recutting of 18 acres of seed trees left on the lower portions of the 1950's cable yarded units. All of this acreage falls within unit 87-6 boundaries. The largest cutblock, at 40 acres, was tractor logged. The other three areas logged range in size from 14 to 18 acres. Two of these were cable logged from the G-6 road. The third was tractor logged from the C-9 road. A portion of the latter acreage was roaded but left unharvested. Forest Practice Act regulations in 1974 required a buffer of unharvested land left between logged units, and limited the size of cut areas. The strips that were left largely coincide with major stream channels.

By 1978, both 1975 cable units had been salvage logged by tractor method. Areas adjacent to these units were entered locally, selectively removing timber.

By the time of park expansion in 1978, only about 30 acres remained in old growth within the project boundaries. All of this land is adjacent to major perennial stream channels. Much of the remaining forest is difficult to access, with unharvested trees showing prominent bowing due to soil creep, and contained the least commercially viable timber in the basin.

## GEOMORPHOLOGY AND SEDIMENT SOURCES

Most of the 368 acres within the rehabilitation unit boundaries fall within the inner gorge of mainstem reaches of Tom McDonald Creek. Landsliding dominates hillslope processes, and sediment is effectively routed through major tributaries within the project boundaries into mainstem Redwood Creek. Due to the young age of roads found within the unit, and the lack of major storm events since their construction, geotechnical work was focused on incipient erosion. The effects of a long history of logging in the basin, however, can be seen superimposed on the natural erosion processes at work in the area. An understanding of the unique landforms in the project area and interaction of background erosion and land use must be understood in order to implement watershed rehabilitation.

### Geomorphic characteristics

Pitlick, 1984, maintains that tributary stream channels quickly transfer sediment into Redwood Creek, but emphasizes the importance of long term storage behind log jams within these channels. Geomorphic mapping completed in 1987 by Sandeck and Horns shows aggradation or fill terraces along many channel segments, and formerly choked reaches of channels which had markedly degraded, recovering from post-logging sediment input.

At stream crossing C-30+00, gravels were found on the freshly excavated channel banks. These had been buried by fill emplacement during road construction in 1974. The most extensive remnants of channel aggradation were present at the confluences of stream channels. Here, remnant aggradational deposits are generally one to three feet above the present thalweg height. The alluvial material is composed of angular clastic fragments and coarse sand and gravel. Most of the terrace surfaces have brush or small trees growing on them. Dead old growth trees are sometimes present, presumably killed by burial by coarse sediment and elevated ground water levels, while some terraces support live old growth trees. Some of the more stable terraces (those with some vegetative cover) display high water flow patterns (rills). These are located in the extremely low gradient reaches and often behind large debris dams.

Aerial photographs record land-use related aggradation of stream reaches within the project boundaries had occurred prior to 1954, during initial logging in the upper Tom McDonald Creek watershed. Most of this sediment was generated by debris torrents originating at or above project boundaries at the C-line road, or transported into the area as bedload when skid trail stream crossings and buried channel reaches eroded on tractor logged units above the C-line. Debris torrents on the C-line were probably initiated by flow diversions at undersized or plugged culverts at road stream crossings. One small (approximately 450 cubic yard) debris torrent occurred within the unit boundaries on a cable unit above station C-30+00 and was not associated with roads.

Growth of log jams on perennial streams within project boundaries is most evident in aerial photographs taken after the 1964 storm. Aggradation behind one pre-existing log jam accelerated blocksliding on the hillslope below the C-9 project road (station C-10+00). Logs were conveyed to the channel on landslides accelerated by undercutting that was initiated by deflection of

streamflow during high flows. This occurred throughout storm events during the 1970's and continued into the 1980's. Aggregation of stream channels probably increased bank cutting and encouraged channel widening on channel reaches behind major log dams on mainstem channel reaches throughout the project area.

Numerous failures occurred on the C-line above the C-9 project road (station C-44+00) and was a major contributor of sediment to channels within the project boundaries. Progressive failure of this section of road culminated in 1974. The road reach crosses an ancient landslide feature that heads at the ridgeline and toes at the stream channel. Emergent flow and failed cutbanks are visible on aerial photographs beginning soon after C-line construction. After the slope above C-line was logged in 1972, which intercepted ground water and concentrated surface flow on a skid trail network, the area experienced a major storm event. By 1974, much of the road segment had failed directly into the channel below in a number of discrete debris torrents. One large torrent deposited on the ancient landslide toe which provided a bench above the existing channel. The deposit was subsequently eroded by gullying.

Sonneval, 1986, describes blocksliding as a major slope forming process in schist terrane. The blockslide is a discrete, episodic slope failure, the scale of which generally overrides the effects of redistribution of hillslope mass due to road building. High pore pressures, experienced during major storm events, trigger movement of the features. Geomorphic mapping and aerial photo investigation show scalloped, tread and riser morphology exists throughout the project area. Ridgelines above the unit boundaries are offset in a number of localities. Entire slopes exhibit blockslide features which become more numerous and more active downslope. Where blockslides intersect major perennial streams deep within the unit, slopes fail in streamside landslides in glacier-like fashion.

Fluvial hillslope erosion is intimately related to blockslide activity. Collection of groundwater into zones of pulverized rock or along landslide scarps, and capture of surface flow by hollows created by slope displacement affect the development of small stream channels. Drainages often initiate as emergent flow on water collecting slopes at mid basin elevations. Generally, emergence occurs within a spoon shaped hollow (debris torrent track) on a planar or concave slope. Gullies generated in this area coalesce downslope, and may exist only intermittently as surface flow. The amount of surface flow is controlled by slope steepness and thickness of colluvial deposits, and relative abundance of rainfall. Gully flow frequently occurs as near-surface flow following pipe networks, buried organics, roots, animal burrows, or weakened bedrock.

#### Geotechnical Description

Stream channels crossed by haul roads within the project boundaries include three sites with large drainage areas, at 3,270 acres, 850 acres, and 158 acres, and several smaller channels ranging from 20 to 40 acres. Stream power, a relative measure of erosive force, is based on drainage area and elevation (25 year return interval peak discharge), and channel gradient, and is measured in kilograms per second. The large channels had values of 2,339, 1,104, and 266, respectively. The smaller channels had values ranging from 157 to 75.

Apparently, the most erosive forces are found in channels which have middle range values. Excavation of the buried channel bottom during road removal, and restoration of the original energy dissipators and knickpoints (large and small organics, rock) is most important in these high gradient, relatively young streams.

The largest stream crossed by project area roads, at 3,270 acres, is located at station G-1+00 on the G-6 project road. This stream crossing was a redwood log bridge consisting of four horizontal abutment logs and 12, 40-foot spanning logs creating a deck and supporting several hundred yards of fill. The abutment logs were placed on boulders in the stream channel. These had been arranged to accommodate the spanning log length. This constricted the channel somewhat. Boulders in the reach had been repositioned to armor erosive fill material along the channel sidebanks at the left bank where the road prism entered the stream channel.

A flood terrace, about 18 inches in height above the present thalweg, is present on the right bank for several tens of feet downstream and apparently continued beneath the bridge location prior to road construction. The terrace is about 15 to 20 feet wide and pinches out upstream, at the bridge location. The slope above the terrace is a toe feature of a large landslide. Soils are moderately deep, poorly drained Entisols (Popenoe, 1984) and bedrock is sheared schist, dark grey in color. A veneer of sidecast fill from the G-6 road alignment covers the slope nearly to its base at the terrace. The slide mass is quite mobile above the road, having been undercut by the road bench. Also, emergent groundwater is intercepted by the inboard ditch off the cutbank failure/slide mass, in effect dewatering the toe of the slide. This road segment was treated separately by the adjacent rehabilitation unit: 87-2, South G-6.

The left bank of Tom McDonald Creek at the bridge location differs markedly in character from the right bank. Bedrock is relatively coherent schist, and soils are well developed utisols. A narrow ridge is truncated by the stream, forming a steep, high left bank prior to road building. This bank was cut extensively to construct the road bench and bridge ramp.

A resistant bedrock knob is found on the left bank of Tom McDonald Creek, about 200 feet upstream from the bridge location, and a major tributary stream enters the mainstem from the right bank at this location. The knob protects the base of the slope, diverting streamflow around a 40 foot wide terrace(?), 15 or more feet above the present stream height. The terrace was used to store approximately 2600 cubic yards of fill material generated during construction of the road.

The second largest channel crossed by roads within the project area had a 48 inch diameter corrugated metal culvert set to grade, and the upstream side of the fill prism was armored with imported rock. The road alignment on both sides of the crossing were undercut by the road during construction. Both slopes exhibit blockslide terrane with underdeveloped soils, and numerous, high discharge springs. Cutbanks are unstable, and continuously wet.

The third large channel, at 158 acres, was built at a natural knickpoint in the channel, downstream from the large ancient landslide feature discussed earlier. The area had numerous outcrops of quartz-rich schist bedrock, which may have controlled the channel morphology. However, old growth, pre-logging windfalls also provided base levels in this channel reach.

The smaller channels crossed by project roads all displayed vertical, vegetated sidebanks and steep gradients. These channels, even in old growth settings and undisturbed by logging activities, displayed gully-like morphology, and often changed in size, gradient, or amount of surface flow they contained notwithstanding relative apparent size of contributing hydraulic area.

#### EROSION CONTROL TREATMENTS

Within the project area, incipient erosional problems created by timber harvest and road building activities included: diversion of streamflow at road crossings and subsequent gullying of native ground; erosion of haul road stream crossing fill prisms due to culvert failure; introduction of sediment to stream channels from unstable road alignments by fill failure, debris torrent or surface erosion; undercutting of hillslopes by roadcuts and consequent landsliding; interception by roadcuts and concentration of ground water and overland flow in inboard ditches; and cumulative impacts due to accelerated erosion.

Geotechnical work utilized a heavy equipment format to: remove haul road stream crossing fill prisms and the log bridge at Tom McDonald Creek, thereby correcting possible diversion of flow and preventing erosion of crossing fills and native channel banks; remove unstable road reaches, especially where failure could provide sediment to the fluvial network, and placement of spoil in stable roadcuts and log decks, thereby recontouring road alignment scars; deconcentrate flow and provide drainage by installing crossroad drains and excavating deep dishes across the road prism, and decompaction of road and log deck areas through ripping, thereby increasing infiltration and encouraging revegetation. Labor intensive work on the unit consisted of application of straw mulch to treatment areas in order to reduce surface erosion and also to enhance revegetation.

Seven stream crossings are located on the unit. Four had potential to divert streamflow out of the drainage. Most stream crossings were excavated as closely as possible to their pre-roadbuilding configurations. Wide channels were constructed in order to accommodate the anticipated large peak flows on the crossings at station C-30+00 and station C-47+00, and at the log bridge site at station G-1+00. Anticipated 25-year return interval peak discharges at these sites are 307 c.f.s. (cubic feet per second), 59 c.f.s., and 1,197 c.f.s., respectively.

The top and bottom limits of excavation along the filled channel reach was easily distinguished at station C-30+00, as the culvert was set at grade, and at station G-1+00, since the log span left the channel floor open. At station C-47+00, however, the lower limit of excavation was determined only after unearthing the log knickpoint and realizing the road was built after the knickpoint was established.

Smaller channels, at stations C-25+00, G-48+00, and G-52+00, were carefully exhumed to trace small channel-floor features. Steep or vertical native sidebanks were excavated flatter than the original ground to allow for adjustments of the channel floor. Road rock was scavenged to armor headcuts created by road construction, which buried the downstream but removed the upstream portions of the small, steep gradient channels they crossed. Also at station G-52+00, a side channel was created to capture dispersed surface flow on the slope above the road, and channelize it into the flow course. This excavation did not encounter the original channel, which was probably mostly removed during road construction, or poorly developed through this reach. After excavation, the blue goo that was encountered was somewhat protected with rock, which was scraped off the road surface adjacent to the excavation.

One small channel at station C-48+00 was underexcavated, although the diversion potential was removed. Discharge anticipated at this location after dewatering a gully system originating at a culvert on the C-line is minimal, about 7 c.f.s. in a 25-year event. Also, the fillsite for additional spoil beyond that which was removed was 700 feet distant, making further fill removal less cost effective. Rock was scavenged by hand and added to the completed excavation.

Deep dish excavations were completed in nine locations where small drainages became non-surface flow courses above the road, except during intense storm events. These areas were often shaped by blockslides, and the potential for ground movement, which could interrupt ditch gradients or plug crossroad drains, warranted excavations of this type.

More than 3,312 feet of roads and landings were outsloped with the spoil placed directly against the cutbank, removing the road alignment completely. This work was done in areas where potential fill failures would have contributed sediment directly to stream channels, but was also prescribed in areas where residual old growth forest may have been impacted.

552 linear feet of roads and landings were outsloped with the spoil exported. This treatment was prescribed where the hillslope or cutbank above the road or landing required drainage, and removal of fill was required to eliminate debris torrent potential or gully-erosion potential. In all cases drainage was provided with the largest gradient or downslope configuration possible. Two reaches on the C-9 project road (stations C-22+70 and C-27+15) were built at a steep grade across blockslides. Inboard ditches captured surface flow and effectively dewatered the downslope portion of the slide masses. However, exported outsloping of the road prism, including some native ground (blue goo) was prescribed because it was felt that the ditch would eventually be filled by the active slope above the road alignment.

Fill from excavations was push-endhauled to the closest stable area. As much as was possible, in terms of allocation of fill generated, the prelogging slopes were rebuilt; roadcuts were filled, and landings and deck areas were recontoured. All available fillspace was used to maximum capacity. No trucks were used and all that was required was a blade width, space to allow filling, since no turn around area was needed. Areas were ripped prior to spoil placement in order to facilitate normal ground water circulation, thereby increasing stability of massive and steep fills. Blade-endhauling permitted maximum compaction of fill, which, along with the high clay content of these materials, inhibits saturation and slope failure (blurps). Compaction of the excavated fill was 1:1 or greater, depending on moisture content. Incorporation of copious quantities of brush into fills was avoided, which reduces later compaction and eliminates piping along former ditch lines and compacted road surfaces where buried brush stockpiles have decomposed.

Of the total 2.86 miles of haul road addressed in unit 87-6, almost half (1.26 miles) was ripped and crossroad drained. This was done in drier areas, higher on the hillside, and around ridge areas to break up overland flow intercepted by the road alignment during major storm events. In areas where emergent flow from relatively stable cutbanks required drainage, and no other treatment was warranted, crossroad drains were installed.

#### HEAVY EQUIPMENT APPLICATION

Unit 87-6 utilized a 1985 Case 220 hydraulic excavator equipped with a oversized 2.75 cubic yard (struck) capacity bucket. Except for the A-9-7-3 (horsetrail) project, unit 87-8, which was completed immediately prior to unit 87-6, this was the first slope stability and erosion control project to employ a large excavator. Previous rehabilitation units have used Case 980 or John Deere 690 excavators. These are equipped with 1.5 cubic yard or smaller sized buckets.

Surveys on the A-9-7-3 road show that the machine is capable of bailing up to 600 cubic yards per hour in ideal situations (flat swing, <180 degree turn, dry, relatively clean fill). This capability tends to bury backup equipment. For this reason, and because the fillsites for about half the worksites averaged a 278 foot push, two D8H Caterpillar bulldozers equipped with U-blades were employed on the site.

The Case 220 is an air cooled machine, and the cab is shorter than most excavators in this size class. However, larger machines require more room to swing, and have more ground pressure. This may limit their use in cramped or muddy worksites. The increased weight of the machine makes it difficult for it to be winched out of trouble spots with a D-8 cat, so less risks are taken. (There is, however, some advantage in having an excavator capable of pulling a D-8 out of the mud!).

The main advantage in using the larger machine is the improved reach of the boom (27 feet below the level of the tracks) and the increased production rate at this digging depth. The machine is capable of completing a deeper outsloping cut on a wider road, compared to smaller equipment. Since all the work on unit 87-6 involved major haul roads, worksites were large enough to accommodate the large machine, and access to the sites was not limiting.

The most efficient operation of the Case 220 involved worksites where the excavator completed, or very nearly completed the task. In situ outsloping, for example, averaged out at 100 cubic yards per hour (\$0.73 per cubic yard) using backup equipment. This rate increased to 150 cubic yards per hour (\$0.50 per cubic yard) when no final grading by bulldozer was required.

The high production rate of bulldozers for many earthmoving rehabilitation tasks, and the ability of the bulldozer to both excavate and endhaul to the fillsite on its own, limits the amount of work on rehabilitation units that may be more cost effectively completed by excavators. However, given the appropriate worksites, theoretical production rates and low unit costs can be achieved with a large hydraulic excavator.

#### HEAVY EQUIPMENT COSTS

The tables in this report present unit costs as well as production rates so that they can be used as a reference for future projects where the same operators and equipment are not available, or the rental rates have changed (tables 1 thru 7).

One cost incurred in rehabilitation work that has been included in unit costs in past projects is the amount of time necessary to acquaint an operator with types of excavations unique to rehabilitation work. Road removal techniques are oftentimes just opposite to road building procedures, and can take some getting used to for the average operator. Discussion time also may vary with the complexity of the worksite as it progresses. On this unit, discussion time increases the cost of the average worksite by seven percent. Only one of the three operators who worked on the unit had significant previous experience in restoration techniques. "Discussion" has been broken into a miscellaneous category because operators already familiar with rehabilitation techniques may be available for future work, and because it makes comparisons of equipment production rates more realistic.

\*\*\*The best combination seems to be the "dig-ologist". This is where a rehabilitation geologist is able to operate the equipment.\*\*\*

Essential to low unit costs are low rental agreement rates on well maintained equipment. The hourly rental rate on the Case 220 (with operator Chris Hake) was \$95 per hour, which was the lowest bid submitted to the park contracting office for this particular size class excavator. This price was comparable to low bids for much smaller excavators. The identical machine, also a Hogue Equipment rental, was bid this year at \$135 per hour by another contractor.

Total cost of unit 87-6 was \$48,369 (table 2). \$41,672 was spent on heavy equipment, and the remainder, \$6,697, was spent on labor. These costs do not include salaries of geologists and technicians who prepared the unit for heavy equipment work, for administrative overhead costs, or the expense of park-owned equipment used in distribution of straw mulch.

Unit costs for excavation of haul road stream crossing fills averaged \$1.56 per cubic yard (table 4). Discussion time and break time increase this cost to \$1.75 per cubic yard. Volume-weighted mean endhaul distance for these excavations was 292 feet.

Deep dish, swale (interfluvial) excavations were installed by bulldozer. These were not surveyed and excavation rates for this work are not available (table 5). In the past, rates for these excavations approached 100 cubic yards per hour, or about \$0.90 per cubic yard.

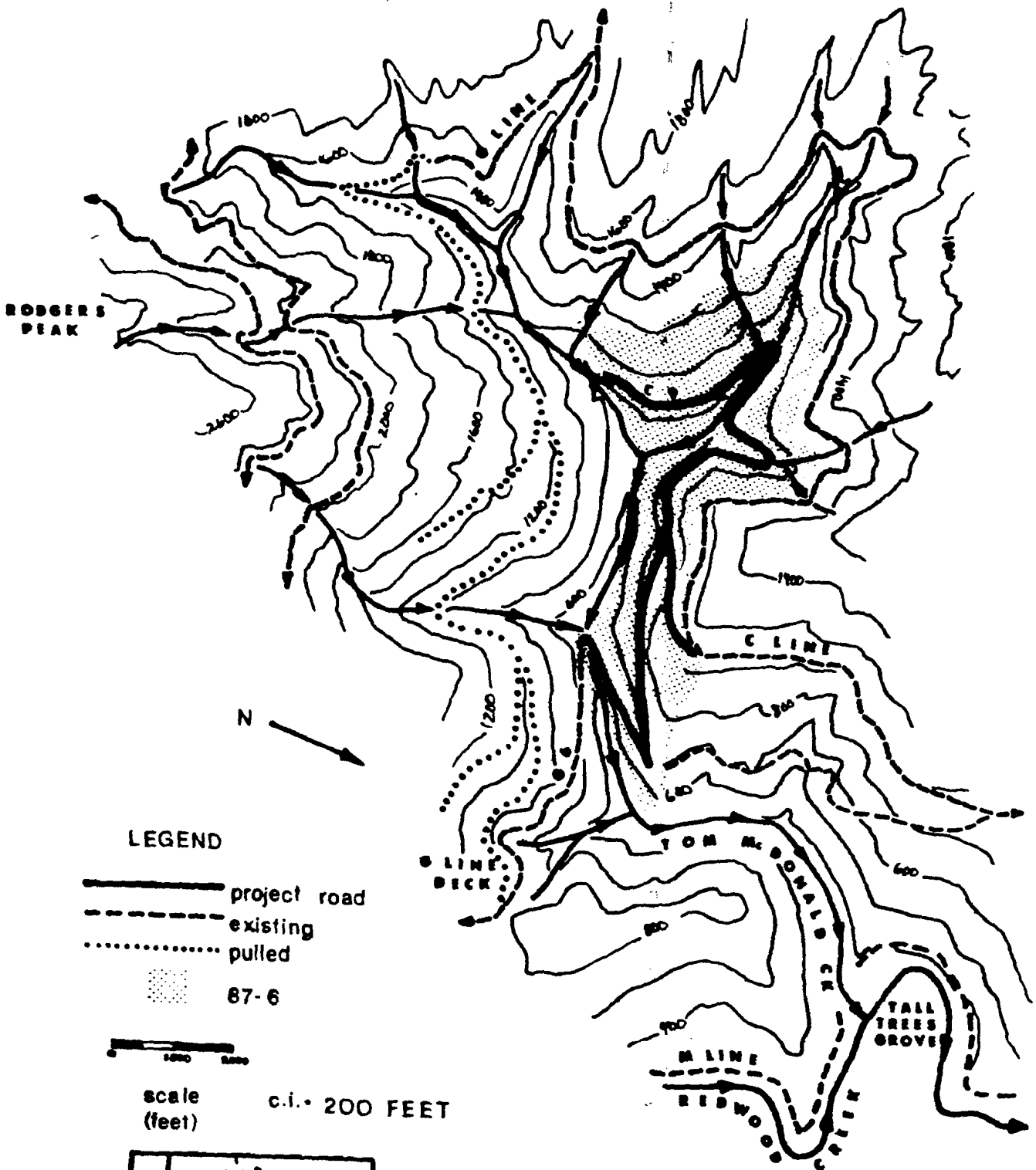
Exported outslowing averaged \$1.38 per cubic yard, with a mean push of 253 feet (table 6). Including discussion and break time, the unit cost increases to \$1.55. These are lower than stream crossing excavation costs for two reasons. The primary reason is the shorter endhaul distance. The second reason is that the dozers could both excavate and endhaul the fill in one continuous sweep at one worksite. This increased per piece production from about 40 cubic yards per hour to about 90 yards per hour and raised the average rate.

Regular outslowing, where fill is placed against the cutbank locally, cost \$0.73 per cubic yard (\$0.82 with breaks and discussion) (table 7). The excavator did most of the excavation, and left some final grading for the bulldozer. Generally the excavator was used to do as much of the lifting as possible (vertical handling of the material) and the dozers were used to prep the area by ripping, and contour the final slope.

Total cost of crossroad drains and ripping was \$1,854 (\$2,084 with breaks and discussion). Each crossroad drain cost an average of \$36.37 (\$40.88) per drain. All drains are of the "rolling dip" variety and were installed by bulldozer.

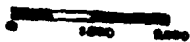
#### LABOR INTENSIVE WORK

Labor intensive application of straw mulch cost \$6,697 (\$9.05 per bale) (table 8). Mulch was applied to all areas disturbed by heavy equipment during rehabilitation activities, except in crossroad drain reaches. 26 tons (740 bales) of straw was applied at 4,000 to 6,000 pounds per acre. The higher application rate was used at excavated flow courses. The straw was distributed by National Park labor crews before heavy equipment work began. The park's boom truck was used to place bales above the worksites on native ground, generally, or on unstable cutbanks where no fill placement was prescribed. Later, straw was hand-applied by National Park, Redwoods United, and Youth Conservation Corps crews.



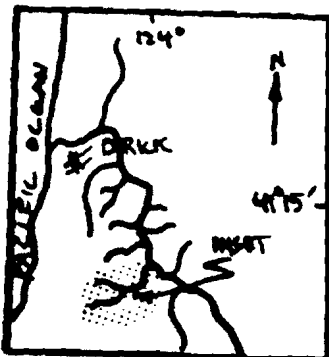
# LEGEND

- project road
- - - existing
- ... pulled
- 87-6



scale  
(feet)

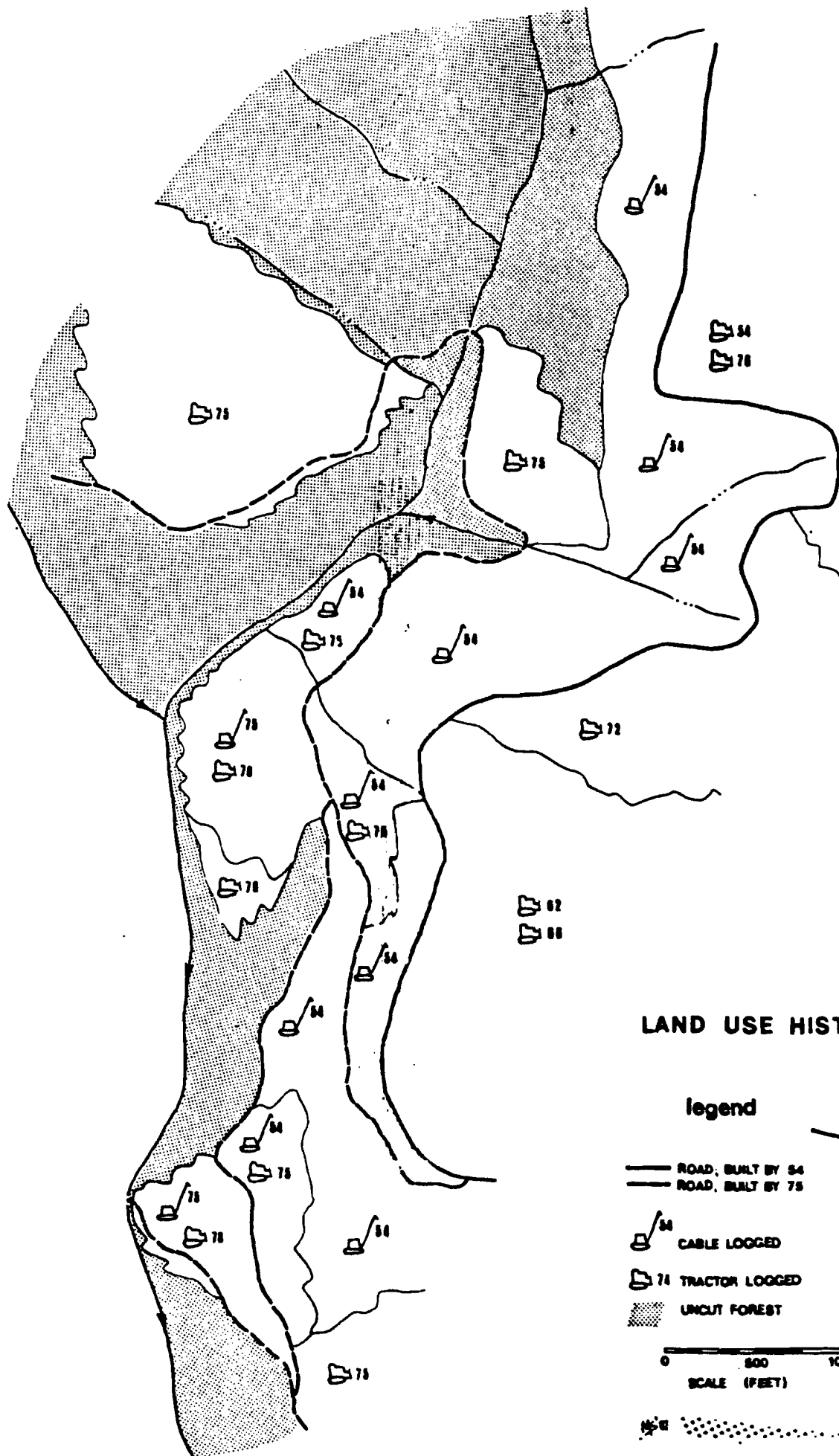
c.i. 200 FEET



Redwood CK. 0 2 4  
Miles, CA.

## LOCATION AND TOPOGRAPHY

.....



## LAND USE HISTORY

### legend



— ROAD, BUILT BY 84  
- - ROAD, BUILT BY 75

 84 CABLE LOGGED

 75 TRACTOR LOGGED

 UNCUT FOREST

0 500 1000  
SCALE (FEET)



Table 1

Volume Weighted Mean Statistics for Unit 87-6

| Volume<br>-Weighted<br>Statistic | Blade-<br>Endhauling<br>Fill | In-Place<br>Fill           |
|----------------------------------|------------------------------|----------------------------|
| Cost/Volume                      | \$1.50                       | \$0.73                     |
| Endhaul Distance                 | 278 feet                     | appx. 50 feet              |
| Volume/Equipment<br>Hours        | 77 yd <sup>3</sup> /pc-hr.   | 128 yd <sup>3</sup> /pc-hr |
| Yardage Basis                    | 8381 yd <sup>3</sup>         | 8449 yd <sup>3</sup>       |

Synopsis

Operators: J. Franke, C. Hake, J. Wiggins

Equipment: 2, V. strong, well maintained D-8's with U-blades, winch, ripper, xlt rental rate (\$95.00) on 1985 2.75 yd<sup>3</sup> capacity (Case 220) hydraulic excavator.

Endhauling: Varied up and downgrade push, 70% flat. 2 dozers required to match output of excavator.

Excavation: Relatively clean dry fill at 85% of worksites. Large worksites, major haul road.

Other: Miscellaneous heavy equipment costs increase these figures by 7 to 23.8%.

Table 2

## Rehabilitation Work Costs, Unit 87-6

Heavy Equipment Work:Primary Treatments

| Treatment             | Worksite Distribution | Total Quantity        | Total Cost \$ | Worksite Cost Average \$ | Unit Cost \$         | Unit Cost Range \$        |
|-----------------------|-----------------------|-----------------------|---------------|--------------------------|----------------------|---------------------------|
| Haul Road Crossings   | 7 sites               | >5366 yd <sup>3</sup> | 14,400.29     | 2,057.18/site            | 1.56/yd <sup>3</sup> | 0.72-2.46/yd              |
| Deep Dish Excavations | 9 sites               | ?                     | 1,359.52      | 151.06/site              | ?                    | ?                         |
| Exported Outslope     | 552 linear ft.        | 3015 yd <sup>3</sup>  | 4,167.45      | 7.55/linear ft.          | 1.38/yd <sup>3</sup> | 0.79-2.97/yd <sup>3</sup> |
| Outslope              | >3312 linear ft.      | >8449 yd <sup>3</sup> | 7,693.88      | 1.93/linear ft.          | 0.73/yd <sup>3</sup> | 0.54-1.00/yd <sup>3</sup> |
| Crossroad Drains      | 1.26 road miles       | 51 drains             | 1,854.62      | 1,472.54/road mile       | 36.37/drain          | -                         |

Secondary Treatments

Mulch 43.98

Other Work

(See Table 3) 9,152.61

Total Heavy Equipment Cost 41,672.35 Totals add up to \$38,672.35

Labor Intensive Work:Primary Treatments

None 0

Secondary Treatments

Mulch 6.7 acres 740 bales 6,697.10 999.57 acre 8.93 bales

Other

None 0

Total Labor Intensive Cost 6,697.10

GRAND TOTAL COST 48,369.45

Table 3

Miscellaneous Rehabilitation Costs for Heavy Equipment

| Task                      | Task Cost<br>\$ | Equipment Hours<br>hr |       |       | % of Total Heavy<br>Equipment Cost |
|---------------------------|-----------------|-----------------------|-------|-------|------------------------------------|
|                           |                 | W                     | R     | X     |                                    |
| Mobilization              | 701.00          | -                     | -     | -     | 1.8                                |
| Access                    | 2,246.76        | 6.83                  | 10.42 | 6.92  | 5.8                                |
| Standby w/o<br>Operator   | 399.50          | -                     | 10.00 | -     | 1.0                                |
| Breaks                    | 2,095.78        | 8.08                  | 6.00  | 8.58  | 5.4                                |
| Discussion                | 2,701.34        | 9.75                  | 7.83  | 11.58 | 7.0                                |
| Handling Used<br>Culverts | 524.45          | 3.08                  | 0.67  | 2.00  | 1.4                                |
| Log Salvage               | 351.84          | 4.00                  | -     | -     | 0.9                                |
| Relocate flatcar bridge   | 131.94          | 1.50                  | -     | -     | 0.3                                |
| TOTALS                    | 9,152.61        | 33.25                 | 24.92 | 29.08 | 23.8                               |

W: \$87.94 per hour: Caterpillar D8H bulldozer with winch and U-blade.

R: \$94.89 per hour: Caterpillar D8H bulldozer with rippers and U-blade.

X: \$95.00 per hour: Case 220 Hydraulic Excavator with 2.75 yd<sup>3</sup> bucket.

Table 4

## Haulroad Stream Crossing Excavation Summary

| Station   | Excavated<br>Volume<br>Yd <sup>3</sup> | Total<br>Cost<br>\$ | Unit<br>Cost<br>\$/yd <sup>3</sup> | Equipment Hours<br>Hr. |       |       | Mean Blade-<br>Endhaul<br>Distance<br>ft. | Excavation<br>Rate<br>yd <sup>3</sup> /pc-hr |
|-----------|----------------------------------------|---------------------|------------------------------------|------------------------|-------|-------|-------------------------------------------|----------------------------------------------|
|           |                                        |                     |                                    | W                      | R     | X     |                                           |                                              |
| C 25+00 ✓ | 935                                    | 1,215.90            | 1.30                               | 2.67                   | 2.00  | 8.33  | 105                                       | 71                                           |
| C 30+00 ✓ | 1442                                   | 3,552.55            | 2.46                               | 17.00                  | 11.25 | 10.42 | 517                                       | 37                                           |
| C 44+00 ✓ | 1231                                   | 2,144.62            | 1.74                               | 9.00                   | 8.17  | 6.08  | 327                                       | 53                                           |
| C 47+00   | 560                                    | 576.19              | 1.03                               | 1.33                   | 2.67  | 2.17  | 403                                       | 91                                           |
| G 1+00 ✓  | ?                                      | 3,841.96            | ?                                  | 16.33                  | 14.75 | 10.58 | 600                                       | ?                                            |
| G 52+00 ✓ | 1198                                   | 861.45              | .72                                | 2.42                   | 2.58  | 4.25  | 80                                        | 130                                          |
| G 67+00 ✓ | ?                                      | 2,207.62            | ?                                  | 11.33                  | 4.33  | 8.42  | 200                                       | ?                                            |
| TOTALS    | >5366                                  | 14,400.29           | 1.56                               | 60.08                  | 45.75 | 50.25 | 292                                       | 73                                           |

W: \$87.94 per hour: Caterpillar D8H bulldozer with winch and U-blade.

R: \$94.89 per hour: Caterpillar D8H bulldozer with rippers and U-blade.

X: \$95.00 per hour: Case 220 Hydraulic Excavator with 2.75 yd<sup>3</sup> bucket.

Averages are volume weighted.

Excavation rate is volume excavated divided by the total combined number of equipment hours.

Table 5

Deep Dish<sup>1</sup> Excavation Summary

| Station   | Total <sup>2</sup><br>Cost<br>\$ | Equipment Hours<br>hr |      |      |
|-----------|----------------------------------|-----------------------|------|------|
|           |                                  | W                     | R    | X    |
| C 16+19 ✓ | 87.96                            | 1.00                  | -    | -    |
| C 29+00 ✓ | 87.07                            | -                     | -    | 0.92 |
| G 7+60    | 109.58                           | -                     | 1.15 | -    |
| G 9+00 ✓  | 180.08                           | -                     | 1.90 | -    |
| G 12+00   | 212.23                           | 1.17                  | 1.15 | -    |
| G 22+50   | 95.32                            | 0.92                  | 0.15 | -    |
| G 26+50   | 184.07                           | 0.67                  | 1.32 | -    |
| G 30+00 ✓ | 161.92                           | 1.67                  | 0.15 | -    |
| G 48+00 ✓ | 241.92                           | 2.58                  | 0.15 | -    |
| TOTALS    | 1,359.52                         | 8.01                  | 5.97 | 0.92 |
| Average   | 151.06                           |                       |      |      |

W: \$87.94 per hour: Caterpillar D8H bulldozer with winch and U-blade.

R: \$94.89 per hour: Caterpillar D8H bulldozer with rippers and U-blade.

X: \$95.00 per hour: Case 220 Hydraulic Excavator with 2.75 yd<sup>3</sup> bucket.

<sup>1</sup>Deep dishes are generally <150 yd<sup>3</sup> excavations designed to remove fill from zero order basin areas or headwater swales, and to improve drainage.

<sup>2</sup>Includes ripping 1600 feet of road.

Table 6

## Exported (Blade Endhauled) Outslowing Summary

| Station | Excavated<br>Volume<br>yd/ <sup>3</sup> | Total<br>Cost<br>\$ | Unit<br>Cost<br>\$/yd <sup>3</sup> | Equipment Hours |       |       | Linear<br>Feet of<br>Road<br>ft. | Volume<br>Per<br>Linear<br>Foot of<br>Road<br>yd <sup>3</sup> /ft. | Mean Blade<br>Endhaul<br>Distance<br>ft. | Excav.<br>Rate<br>yd <sup>3</sup> /<br>pc-hr |
|---------|-----------------------------------------|---------------------|------------------------------------|-----------------|-------|-------|----------------------------------|--------------------------------------------------------------------|------------------------------------------|----------------------------------------------|
|         |                                         |                     |                                    | W               | R     | X     |                                  |                                                                    |                                          |                                              |
| C 3+70  | 1351                                    | 1,071.06            | .79                                | 5.25            | 3.17  | 3.25  | 100                              | 13.5                                                               | 200                                      | 116                                          |
| C 22+70 | 573                                     | 1,136.76            | 1.98                               | 1.50            | 6.42  | 4.17  | 162                              | 3.5                                                                | 400                                      | 47                                           |
| C 27+15 | 634                                     | 602.82              | .95                                | 6.58            |       | 0.25  | 135                              | 4.7                                                                | 200                                      | 93                                           |
| C 44+82 | 457                                     | 1,356.81            | 2.97                               | 6.25            | 4.50  | 4.00  | 155                              | 2.9                                                                | 300                                      | 31                                           |
| TOTALS  | 3015                                    | 4,167.45            | 1.38                               | 19.58           | 14.08 | 11.67 | 552                              | 8.1                                                                | 253                                      | 85                                           |

W: \$87.94 per hour: Caterpillar D8H bulldozer with winch and U-blade.

R: \$94.89 per hour: Caterpillar D8H bulldozer with rippers and U-blade.

X: \$95.00 per hour: Case 220 Hydraulic Excavator with 2.75 yd<sup>3</sup> bucket.

Averages are volume weighted

Excavation rate is volume excavated divided by the total combined number of equipment hours.

Table 8

Straw Mulch Application Summary

|              | Bales<br># of/<br>Total Cost | RNP<br>person hrs/<br>Cost | RUI<br>person hrs/<br>Cost | YCC<br>person hrs/<br>Cost | COST<br>TOTALS<br>\$ |
|--------------|------------------------------|----------------------------|----------------------------|----------------------------|----------------------|
| Materials    | 740/2,286.60                 | -                          | -                          | -                          | 2,286.60             |
| Distribution | -                            | 190/1,879.00               | -                          | -                          | 1,879.00             |
| Application  | -                            | 90/892.80                  | 170/1,437.70               | 60/2,531.50                | 4,862.00             |
| TOTALS       | 740/2,286.60                 | 280/2,771.80               | 170/1,437.70               | 60/2,531.50                | 6,697.10             |

RNP: Redwood National Park, Resource Management labor crew

RUI: Redwood United Incorporated labor crew

YCC: Youth Conservation Corps