

SUMMARY OF EROSION CONTROL WORK  
UNIT 82-1  
C-30 ROAD AND SLOPE, EMERALD CREEK BASIN

Redwood National Park  
Orick, California

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## TABLE OF CONTENTS

|                                                            | <u>Page</u> |
|------------------------------------------------------------|-------------|
| INTRODUCTION . . . . .                                     | 1           |
| Road Network . . . . .                                     | 1           |
| Land Use History . . . . .                                 | 3           |
| Details of Timber Harvest Activities . . . . .             | 5           |
| EROSION FEATURES . . . . .                                 | 8           |
| History of Erosion Features . . . . .                      | 8           |
| Sediment Sources . . . . .                                 | 14          |
| EROSION-CONTROL REHABILITATION WORK . . . . .              | 15          |
| Introduction . . . . .                                     | 15          |
| Procedures . . . . .                                       | 15          |
| Objectives . . . . .                                       | 15          |
| Cost Summary . . . . .                                     | 16          |
| Heavy Equipment Phase . . . . .                            | 16          |
| Heavy Equipment Application . . . . .                      | 16          |
| Heavy Equipment Sequencing . . . . .                       | 22          |
| Heavy Equipment Costs . . . . .                            | 24          |
| Haul Road & Skid Trail Crossing Excavation Costs . . . . . | 26          |
| Outsloped Roads . . . . .                                  | 36          |
| Landings . . . . .                                         | 39          |
| Landslides . . . . .                                       | 41          |
| Rock Pits . . . . .                                        | 41          |
| Overall Heavy Equipment Evaluation . . . . .               | 41          |
| Labor Intensive Phase . . . . .                            | 44          |
| Labor Intensive Application . . . . .                      | 44          |
| Labor Intensive Costs . . . . .                            | 44          |
| Evaluation of the Labor Intensive Application . . . . .    | 47          |

## MAPS & TABLES

|                                                                                                  | <u>Page</u> |
|--------------------------------------------------------------------------------------------------|-------------|
| Map A - Site 82-1 W-Line/C-30 = Emerald Creek . . . . .                                          | 2           |
| Map B - Logging History . . . . .                                                                | 4           |
| Map C - Erosion Features . . . . .                                                               | Pocket      |
| Map D - Worksite Locations . . . . .                                                             | 19          |
| <br>Table 1. Summarized Inventory of Skid Trail Crossings in Emerald<br>Creek Drainage . . . . . | <br>6       |
| Table 2. Inventory of Erosion Features and Probable Causes . . . . .                             | 10          |
| Table 3. Summary Cost of Erosion-Control Rehabilitation Work . . . . .                           | 17          |
| Table 4. Rehabilitation Work Summary . . . . .                                                   | 18          |
| Table 5. Heavy Equipment Used . . . . .                                                          | 20          |
| Table 6. Heavy Equipment Sequencing . . . . .                                                    | 23          |
| Table 7. Summary of Average Costs of Heavy Equipment Treatments . . . . .                        | 25          |
| Table 8. Average Haul Road & Skid Trail Excavation Costs . . . . .                               | 27          |
| Table 9. Comparison of Crossing Excavation Costs on Sites 81-2 & 82-1 . . . . .                  | 28          |
| Table 10. Haul Road Crossing Excavation Costs . . . . .                                          | 29          |
| Table 11. Skid Trail Crossing Excavation Costs . . . . .                                         | 33          |
| Table 12. Stream Crossing Rock Costs . . . . .                                                   | 35          |
| Table 13. Outsloping Costs . . . . .                                                             | 37          |
| Table 14. Landing Treatment Costs . . . . .                                                      | 40          |
| Table 15. Landslide Treatment Costs . . . . .                                                    | 42          |
| Table 16. Rock Pit Treatment Costs . . . . .                                                     | 42          |
| Table 17. Labor Intensive Costs . . . . .                                                        | 45          |
| Table 18. Straw Mulch Costs . . . . .                                                            | 46          |

## CONTENTS OF APPENDIX

|                                                                                               |
|-----------------------------------------------------------------------------------------------|
| Table 1. Complete Inventory of Skid Trail Crossings in Mapped Area of Emerald<br>Creek Basin. |
| Table 2. C-30 and W-Line Culvert Capacities                                                   |
| Table 3. Miscellaneous Heavy Equipment Costs                                                  |
| Table 4. Straw Distribution: Road Reaches                                                     |

Revised Site Numbers for Rehabilitation Unit: 82-1

The following new site numbers will appear in our report and on the final erosion (blue lines) and report maps. All numbers for the erosion potentials have remained the same as on the site review map (1:6000). Only the Rehabilitated site areas have changed.

SITE NUMBERS:

NEW: corresponding OLD:

|             |                                                      |
|-------------|------------------------------------------------------|
| R-1         | R-1, Rx-1, R-2, Rx-2, R-3                            |
| Rx-1, Sx-1A | Rx-3, Sx-3A                                          |
| R-2         | R-4                                                  |
| Rx-2        | Rx-4                                                 |
| R-3         | R-5                                                  |
| Rx-3, Sx-3A | Rx-5, Sx-5A                                          |
| R-4         | W-Line: C-30<br>R-6, Rx-6, R-7, R-1, Rx-1, R-2, Rx-2 |
| Rx-4        | Rx-7                                                 |
| R-5         | R-8                                                  |
| Rx-5, Sx-5A | Rx-3, Sx-3A                                          |
| R-6         | R-3                                                  |
| Rx-6        | Rx-4                                                 |
| Rx-7, Sx-7A | Rx-5, Sx-5A                                          |
| R-7         | R-4                                                  |
| Rx-8        | Rx-6                                                 |
| R-8         | R-5                                                  |
| Rx-9        | Rx-7                                                 |
| R-9         | R-6                                                  |
| Rx-10       | Rx-8                                                 |
| R-10        | R-7                                                  |
| Rx-11       | Rx-9                                                 |
| R-11        | R-8, Rx-10, R-9                                      |
| R-12        | R-10, Rx-10, R-11                                    |
| R-13        | Rx-11, R-9, R-11                                     |
| Rx-12       | Rx-12                                                |
| R-12        | R-12                                                 |
| Rx-13       | Rx-13                                                |
| R-15        | R-13                                                 |

## INTRODUCTION

The C-30 Unit, 82-1, is located on the east side of Redwood Creek about 13 miles upstream from Orick (Map A). The unit includes the upper portion of the Emerald Creek drainage. The boundaries are the Dolason-Emerald Creek divide on the south, the Miller-Emerald Creek divide on the north, the Bald Hills Road and ridgeline on the east, and a line approximately 500 feet below the C-30 Road on the west. The boundaries encompass 834 acres; mapping was concentrated in the 555 acre logged area between the Bald Hills Road and the C-30 and on the 156 acres of prairie (Elk Camp, 148 acres; and Dolason, 8 acres), with a total of 711 acres mapped in detail.

Relief in the Emerald Creek drainage ranges from 125 feet on Redwood Creek to 2,682 on the Bald Hills ridge. Within the 82-1 unit, the lowest elevation is 1,200 feet, near the Emerald Creek crossing on the C-30 Road. Slopes are moderate, averaging between 25 and 65 percent.

The entire drainage area of Emerald Creek is 2.96 mi<sup>2</sup> (1894 acres). At the mouth of Emerald Creek, the calculated 25-year discharge is 1,326 cfs (using the Rational Formula and these factors: acres=1,894, I=2 in./hr, k=35). Highest flows recorded at the mouth have been 278 cfs on November 8, 1973, and 113 cfs on February 13, 1975 (Twatsubo, USGS Data Release No1, 2). These were not peak storm runoff events. At the Emerald Creek crossing on the C-30, the calculated 25-year discharge is 122 cfs.

### Road Network

The Bald Hills Road runs along the upper boundary of the unit (elevation 2,100-2,400 feet) for two miles, with an average gradient of four percent. The major haul roads that cross the unit are W-Line, the C-30, and the K & K Road (Map A).

W-Line traverses the unit for 2.4 miles through prairie for the upper mile and through 10-year-old clear-cut units for the lower 1.4 miles. The overall gradient is three percent, and the elevation ranges between 1,440-2,100 feet. The road was heavily rocked with an inboard ditch, culverts with trash racks, and numerous wide pull-outs and landings along its entire length. The road was drivable in 1982, though one large scale slump at the north boundary of the clear-cut units was reactivated during the winter storms with a vertical movement of 6-12 inches for 150 feet. This is the crown region of a large active mass movement feature. All but one culvert was sufficiently sized for a 25-year storm event, and no failures have occurred in the past. The entire road and slope was mapped in detail during the winter of 1982, and the lower .8 mile was rehabilitated during the summer of 1982.

The lower road, C-30, crosses the slope for 1.9 miles from an elevation of 1,415 feet on the north boundary ridge to 1,600 feet at W-Line intersection, dipping down to 1,200 feet at the Emerald Creek gorge crossing. Slopes above the road have been clear-cut tractor yarded; below the road are three cable yarded units, and a small clear-cut and tractor yarded unit. Below the road right-of-way for approximately one-third of its length, there remains old growth redwood and Douglas fir forest. There is also a small patch of old growth remaining above the road at Emerald Creek. The average gradient north of Emerald Creek is 5-7 percent, and south of Emerald Creek is 11 percent. The road was heavily rocked with an inboard ditch, culverts and trash racks, and

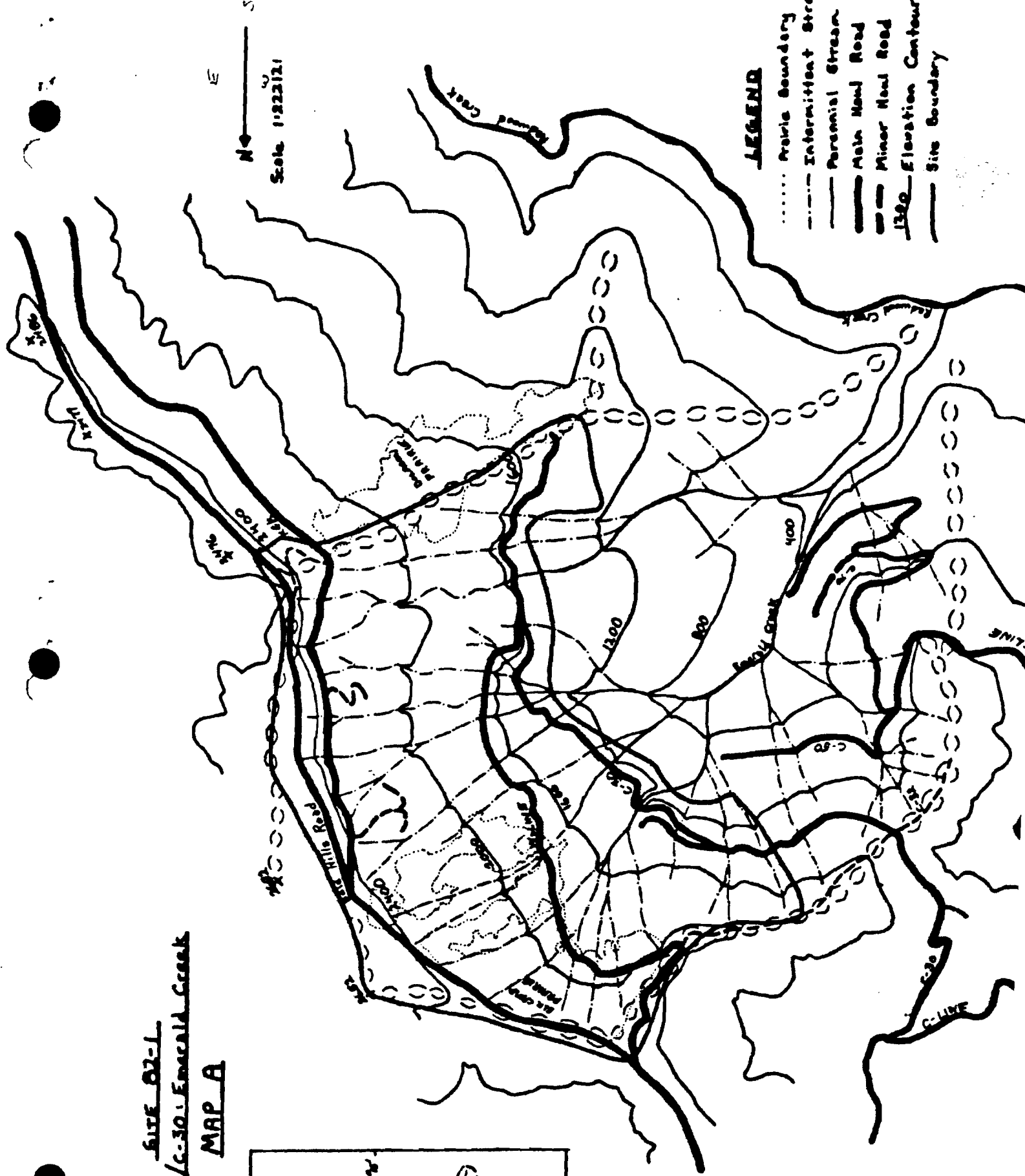
SITE 82-1  
McLURE/C-301 Emerald Creek  
MAP A



North Arrow  
 Scale 1:22,212

LEGEND

- ..... Prairie Boundary
- Intermittent Stream
- Perennial Stream
- Main Mail Road
- ==== Minor Mail Road
- 1200 — Elevation Contour
- Site Boundary



had wide pull-outs or landings between most stream crossings. The road was drivable until January 1982, when a 160-foot section (R-13) of C-30 slumped (2-6 foot vertical displacement); another 100-foot section (R-11) failed on February 25, 1982 (4-8 foot vertical displacement). Both these failures were north of Emerald Creek where the natural slopes average 65-75 percent. South of Emerald Creek along the steepest section of the C-30 (17 percent grade), repeated failure at a culvert (RX-9) diverted stream and inboard ditch flow down the inboard ditch to the next culvert, enlarging the ditch to a gully ranging from 5/2 feet up to 12/8 feet. This occurred each winter for the last two to four years. The park's backhoe has replaced the culvert and attempted to plug the ditch at least twice, but the area has remained an unsolvable road maintenance problem. The southern 1.5 miles of C-30 was mapped in detail and rehabilitated in 1982.

The K & K crosses the upper portion of the unit, just below Bald Hills Road. It traverses the unit for one mile, ranging in elevation from 2,474 feet to 2,314 feet, with an average gradient of three percent. This portion of the K & K crosses the drainage headwaters and has adequate culverts and inboard ditches with no erosional problems.

The Bald Hills Road is paved across Elk Camp Prairie with no culverts. Inboard ditch flow is drained towards the Klamath River. The road beyond the K & K intersection is intermittently paved and has culverts draining inboard ditch flow towards Redwood Creek and the K & K. There are no erosional problems.

#### Land Use History

Ranching was the predominant land use within the Emerald Creek drainage until the 1960's. The activity was limited to Elk Camp and other nearby prairies. A ranch was established on Elk Camp Prairie in , and was in use until the summer of 1982. A handsplit redwood barn and outhouse from the original homestead still stand. Other buildings are more recent. Both sheep and cattle were grazed along the Bald Hills Ridge at various times.

Road associated with ranching activity are minimal. One road runs along the Miller-Emerald Creek divide then traverses the lower prairie slopes. Stream crossings are small; cutbanks are generally less than 18 inches high. Another road with several spurs was used to access a pond, and to bring timber to the ranch from a very old, selectively logged area directly below the ranch. This timber may have been used in ranch construction. Erosion resulting from these roads is minimal.

Construction of the Klamath-Korbel (K & K) Road in the late 1950's initiated commercial logging in the Emerald Creek basin, and on much of the east side of Redwood Creek.

During the 1960's, only three small areas in Emerald Creek were cut, each less than 46 acres. Yarding was done by tractors. These cutblocks are high on the slope, drainages are small and few crossings were constructed. Little erosion potential exists in these areas.

Scale 1: 12212

## LEGEND

- Mapping Boundary
- ..... Prairie Boundary
- Cut Stock Boundary
- 71 Year of Cut
- U Uncut
- \* Select Cut
- /// Cable Yarded (all others truster yards)

Air Photo years used to determine logging history: 62, 66, 68, 70 (partial), 71, 72 (partial), 73, 74, 75, 77, 78.

Timber harvest activity was greatly accelerated in the early 1970's. The C-Line and spur roads (such as C-30 and C-50) were constructed and large clear cuts were common. Between 1970 and 1973, 367 acres were logged within the 82-1 mapping area. The largest single cutblock was 191 acres, or four times the size of any of the 1960's cuts. Tractors were used to yard timber on 90 percent of this land. An additional 50 acres (within the mapping area) was logged shortly before park expansion in 1978. Additional areas (acres undetermined) within the Emerald Creek basin have been logged but were not looked at in detail for this project.

The majority of the logging in Emerald Creek basin occurred after the 1972 storms. Thus the area has experienced only one major (20-year) storm. This was in 1975, when 10.4 inches of rain fell in three days, measured at the Tall Trees Grove. The only other storm of note occurred in December 1981, when 9.9 inches of rain fell in four and a half days, measured at the Harry Weir landslide. This was estimated to be a 2-5 year storm. One cannot really compare these two storms because of different antecedent conditions, different rain gage locations, different time periods, and undoubtedly different intensities of rainfall. However, let it suffice to say that the area has not experienced many major storms since timber harvest.

#### Details of Timber Harvest Activities

Areas cut, and roads and crossings constructed are summarized by year of first appearance in air photos. Photo years available and used are 62, 66, 68, 70 (partial coverage), 71, 72 (partial coverage), 73, 74, 75, 77, and 78. For further details on specific crossings, erosion and diversion potential, and stability, please refer to accompanying Table 1 and Erosion Features section. A complete inventory of all skid trail crossings and culvert capacities is in the appendix.

Air photos taken in 1962 show the K & K and adjacent logging activities. Timber harvest had occurred on 73.3 acres, which included the strip of land between the Bald Hills and K & K roads, and a block below the K & K adjacent to Dolson Prairie. All logging was high on the slopes where drainages are small; only four crossings were constructed. A few trees were left; timber was yarded by tractors.

By 1966, another 46.2 acres below the K & K and adjacent to Elk Camp Prairie had been cut. Three crossings were constructed. This was a select-cut, yarded by tractor. Skid trail patterns were random, leading to the "Anchor Decks", a spur road off the K & K.

After establishment of the original Redwood National Park (and possibly when it became evident that the park was to be expanded), logging accelerated. Between 1970 and 1973, 367.8 acres of the mapped area was harvested. This is the period when the majority of the sediment sources with erosion potential were created.

By 1970, 84.6 acres below the K & K were clear cut (the "Z Deck" area). Logs were removed by long-line tractor yarding methods. Because of this there are fewer skid trails here than in other tractor yarded cutblocks. However, 15 large stream crossings were constructed on well-incised channels. The fill volume present in streams is estimated to be 3651 cy with 1255 cy likely to be eroded before they stabilize.

TABLE 1. SUMMARIZED INVENTORY OF SKID TRAIL CROSSINGS IN EMERALD CREEK DRAINAGE

| Year Constructed | Number of Crossings | Excavatable Volume <sup>1</sup><br>(cy) | Eroded Volume <sup>2</sup><br>(cy) | Future Fill Erosion <sup>3</sup><br>(cy) | Future Diversion Erosion <sup>4</sup> | Total Erosion Expected <sup>5</sup> | Volume Removed by Rehab <sup>6</sup> | Remaining Erosion Expected <sup>7</sup> |
|------------------|---------------------|-----------------------------------------|------------------------------------|------------------------------------------|---------------------------------------|-------------------------------------|--------------------------------------|-----------------------------------------|
| Pre-1962         | 3                   | 300                                     | 39                                 | 5                                        | 0                                     | 5                                   | 0                                    | 5                                       |
| 1966             | 3                   | 170                                     | 20                                 | 50                                       | 0                                     | 50                                  | 0                                    | 50                                      |
| 1970             | 15                  | 3,651                                   | 1,255                              | 925                                      | 330                                   | 1,255                               | 0                                    | 1,255                                   |
| 1972             | 8                   | 927                                     | 39                                 | 275                                      | 26                                    | 301                                 | 250                                  | 51                                      |
| 1973             | 17                  | 4,125                                   | 443                                | 920                                      | 430                                   | 1,350                               | 910                                  | 440                                     |
| 1976-7           | 5                   | 250                                     | 25                                 | 50                                       | 0                                     | 50                                  | 0                                    | 50                                      |

<sup>1</sup> Volume estimated in field, often not measured. In general, these estimates are lower than what is actually removed by rehabilitation.

<sup>2</sup> Volume estimated in field, often not measured.

<sup>3</sup> Estimated volume of fill that will erode before crossing stabilizes.

<sup>4</sup> Estimated fill of original ground that will erode if stream diverts.

<sup>5</sup> Future fill erosion and future diversion erosion.

<sup>6</sup> Volume removed by rehabilitation is the estimated excavatable volume from this table, rather than actual surveyed volume for the excavations.

<sup>7</sup> Remaining erosion expected = (total erosion expected) - (volume removed by rehabilitation).

By 1971, the first haul road into the Emerald Creek basin, the C-30, was constructed from the C-Line to the rockpit above Emerald Creek. There are six stream crossings on the C-30 in the Emerald Creek drainage, three of which are within Rehabilitation Unit 82-1. The culverts on these three crossings were undersized for a 25-year storm. In the mapping area, 47.7 acres were clearcut and 7.8 acres were select-cut along the Emerald-Miller divide and hauled out along the C-30. Note that the 1971 cutblock extends far beyond the boundary of our mapping area. Skid trail patterns are random. Streams in this area are small; eight crossings were constructed and head-water bowls are disrupted by a dense network of skid trails. The total excavatable volume remaining in the streams is 400 cy. Thirty-five cy have eroded to date, the majority probably during the 1972 storms immediately following timber harvest. The potential future erosion from unrehabbed skid trail crossings is estimated to be 25 cy.

The first one-third mile of the W-Line along the Emerald-Miller divide had also been constructed by 1971. About eight acres on "Archie Ridge" had been clearcut and tractor yarded. Skid trails run along contour and there are no stream crossings. Erosion has been minimal.

By June 1973, the C-30 had been re-routed from RX-12 to the present Emerald Creek crossing location and extended across the basin to near Dolason Prairie. Thirteen additional streams were crossed. Culverts used were generally adequate for 25-year storms. Wide landings (decks, pull-outs) were constructed along the road between most streams.

The slope above the C-30, south of Emerald Creek, was clear-cut and tractor yarded down to the C-30. Skid trail patterns are random; 14 skid trail stream crossings were constructed. There was an estimated original fill volume of 4125 cy. 443 cy had already eroded; future erosion was predicted to be 1350 cy. Four of the most unstable crossings were removed preventing 910 cy of the estimated potential erosion.

On the slopes below the C-30, 36.2 acres were clear-cut and cable yarded. Ground disturbance was minimal: no skid trails, no crossings. A reach of channel six was obliterated for several hundred feet below the road, probably during road construction. The flow that previously used the channel was diverted down the inboard ditch to the next culvert.

Beyond our mapping area in the Emerald Creek drainage, construction of the C-50 was underway in 1973 but no logging had occurred here yet. Lower on the slope the C-Line entered the basin and a large area between C-Line and the C-32 was clear-cut and tractor yarded.

By 1974, the C-50 was completed and the slope above was harvested. This was the only activity in the basin aside from some erosion (detailed in Erosion Features section).

There was no new timber harvest activity in Emerald Creek visible in 1975, although additional erosion is visible.

By 1977, the W-Line was constructed across Elk Camp Prairie, through the 1973 clear-cut slopes, and into the Dolason Creek drainage. Twelve streams were crossed. All culverts are correctly sized for a 25-year storm. A large sandstone knob above the W-Line had been blasted; broken rock filled the adjacent swale. The road alignment crossed an area (at the north boundary of the clear-cuts) shown in earlier photos as very springy and possibly gullied. This section of road has dropped approximately 18 to 24 inches since construction. Although the slope was riddled with skid trails, the new road alignment did not follow existing skid trails nor use their crossings, thus many of the W-Line crossings have an old skid trail crossing directly above or below.

Two new clear cutblocks were associated with the W-Line: a 33.5 acre cable yarded unit below "Archie Ridge", and a 16.5 acre tractor yarded unit below W-Line adjacent to Dolason Prairie. Within the tractor yarded unit are five small crossings on small headwater drainages. The crossings were dished out and the road waterbarred following timber harvest and erosion has been minimal.

By 1978 (probably in late 1977), the 46.2 acre selective cut below the K & K, adjacent to Elk Camp Prairie, was re-entered and clear-cut. Yarding was done by tractors; but no new crossings were built. Following timber harvest all skid trails were waterbarred. These are the biggest, deepest waterbars on the site. Virtually all soil was removed from the skid trails during water bar construction. Little regrowth has occurred on these skid trails.

In 1980 and 1981, the W-Line rockpit was quarried for rock used in rehabilitation work. This is apparently the only time rock from this pit was used (Dwain Cossairt, pers. comm. 1982). It was too hard for use as road rock during construction of the W-Line. A total of       cy has been removed for rehabilitation purposes.

## EROSION FEATURES

### History of Erosion Features

Erosion features existing in Emerald Creek drainage in 1982 consisted of mass movements (fill and slope failures), washed out skid trail crossings and small gullies on skid trails. A much larger volume of material resulting from logging exists on the unit as potentially erodible, rather than sediment that has already moved into the fluvial system as a result of logging. The main reasons for this are the timing of timber harvest in relation to major storm events and the methods used to yard timber. Map C (in pocket) shows erosion features.

The basin was virtually untouched in 1964. At the time of the 1972 storms, the C-30 had been constructed from the C-Line to the Emerald Creek rock pit, but had not crossed Emerald Creek yet. Stream crossings along this stretch of road are small, draining areas less than 25 acres. The three culverts within unit 82-1 were undersized for a 25-year storm, but no washouts are visible in air photos. Logging was concentrated above the road along the ridge. Logging that had occurred off the K & K was also high on the slope. Haul roads for this area (spur roads off the K & K) did not cross any streams; the largest stream crossed by a skid trail drains 28 acres.

The 1975 storm had the potential to do the greatest damage. Much of the site had been logged within the preceding two years, and the C-30 crossed the entire basin mid-slope. Drainages along the newly constructed section of the C-30 range from 7 to 171 acres, with 5 crossings draining areas over 50 acres. The culverts (except RX-2) along this stretch of road were capable of handling a 25-year storm, and no washouts occurred in 1975 (or since). The main erosion feature caused by this storm was the failure of a portion of a deck with numerous logs directly into channel 7. This deck was constructed on a steep wet, blue-goo-Atwell slope and skid-trail concentrated runoff had been directed by waterbars towards the failure area.

The only other storm of note occurred in December 1981. This was estimated to be a 2 to 5 year storm, much milder than the 1972 or 1975 storms. It occurred at the time of minimal root strength, 8 to 12 years after timber harvest. Culverts survived the storm with no problems (except regular cleaning of trash racks), however, five mass movements occurred on the slopes and roads.

Two of the mass movements occurred in a broad benchy bowl with no well-incised drainages (above RX-9). One of these slides initiated in 1974 and greatly increased in size in 1981-2. The cutbanks along the C-30 below here are made of a colluvial/landslide deposits, indicating the area has experienced mass movement activity in the past. Concentration of water by skid trails, lack of root strength, and saturated ground conditions were contributing factors to reactivating portions of the older, pre-logging feature.

Two other failures (on R-11 and R-13) were caused by road building across areas of groundwater discharge, underlain by "blue-goo"-Atwell soil and sheared bed-rock. Some road-concentrated runoff was also directed onto these slopes.

The remaining failure (near RX-3) was probably caused by a combination of ground saturation and removal of slope support by road construction.

In addition to the fortunate timing of major storms in relation to logging and road building, the methods of yarding timber helped keep the erosion potential low. Most areas were logged only once. In the mid-slope area, all timber was tractor yarded down to the C-30, and stream crossings were minimized. On the upper slopes, skid trails crossed streams more frequently. The crossings are large, but drainages are fairly small, so erosion has been limited. In addition, timber was long-lined to skid trails, resulting in a lower density skid trail network. The steepest slopes in the drainage basin were cable yarded.

Details of major erosion features and their probable causes follow. Included in addition to the features mentioned above, there are numerous ones which formed during other smaller storms. The reader may also wish to refer to tables 1 and 2 (Complete Inventory of Skid Trail Crossings and Culvert Capacities in the appendix).

TABLE 2: INVENTORY OF EROSION FEATURES AND PROBABLE CAUSES

## SEDIMENT SOURCE: SKID TRAIL CROSSINGS

| <u>Location</u>             | <u>Year</u> | <u>Volume Eroded</u> | <u>Description</u>                                                                                                                                       |
|-----------------------------|-------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| SX-1A(N)                    | 1974        | 14 + cy              | Diverted 50' down skid trail, then gullied CB of W-Line and flowed down IBD to a cross road culvert. Slope below culvert gullied to 2'/2' max. for 700'. |
| ● SX-10E(W)                 | 1973-4      | 41 cy                | Diverted 50' down skid trail. Gullied slope for 100', 5'/2' av.                                                                                          |
| SX-13C(C)                   | 1972        | rills                | Diverted 200' down skid trail, to left fork of channel.                                                                                                  |
| SX-3A(N)                    | 1975        | 60                   | Eroded a 6'/4' gully through crossing.                                                                                                                   |
| ● SX-5C(W)                  |             | 65                   | Eroded surface flow route across crossing.                                                                                                               |
| ● SX-5F(W)                  |             | 14                   | Eroded surface flow route across crossing.                                                                                                               |
| SX-7A(N)                    |             | 56                   | Collapsing and being undermined by subsurface flow.                                                                                                      |
| SX-7A(C)                    |             | 22                   | Eroded surface flow route.                                                                                                                               |
| SX-8A(C)                    |             | 75                   | Collapsing and eroded high flow surface route.                                                                                                           |
| SX-8B(C)                    |             | 100                  | Totally washed out.                                                                                                                                      |
| ● SX-8B to C (W)            | 1972?       | 150                  | Skid trail up channel eroded to 6'/3' av. gully.                                                                                                         |
| ● SX-9A(W)                  |             | 10                   | Eroded surface flow route.                                                                                                                               |
| ● SX-9B(W)                  |             | 50                   | Eroded surface flow route.                                                                                                                               |
| ● SX-10 A/B(W)              |             | 15                   | Eroded surface flow route.                                                                                                                               |
| ● SX-10C(W)                 | 1975        | 37                   | Eroded surface flow route.                                                                                                                               |
| ● SX-10D(W)                 | 1975        | 10                   | Eroded surface flow route.                                                                                                                               |
| ● SX-10F(W)                 |             | 76                   | Collapsing and being undermined by subsurface flow.                                                                                                      |
| ● SX-10H(W)                 |             | 42                   | Collapsing and eroded high flow surface route.                                                                                                           |
| ● SX-10I(W)                 |             | 37                   | Collapsing.                                                                                                                                              |
| ● SX-11A(W)                 |             | 20                   | Collapsing.                                                                                                                                              |
| ● SX-11B(W)                 |             | 17                   | Eroded surface flow route.                                                                                                                               |
| SX-13A 1/2 (C)              | 1972        | 10                   | Collapsing and eroded surface flow route.                                                                                                                |
| SX below RX-13's(N) log jam |             | 10                   | Collapsing and eroded surface flow route.                                                                                                                |

NOTE: "(N)" denotes new number ... was rehabbed.

"(W)" denotes old erosion potential number, above W-Line.

"(C)" denotes old erosion potential number, above C-30.

## SEDIMENT SOURCE: SKID TRAIL SURFACES

| <u>Location</u>                                  | <u>Year</u> | <u>Description and Probable Cause</u>                                                                             |
|--------------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------|
| Virtually all sloping skid trails.               | numerous    | Rills to 2/2 gullies have formed shortly after logging (few waterbars were built).                                |
| Between channels 7 & 8 above C-30.               | 1973-5      | Gully ranging from 4'/6' to 25'/10' formed on a skid trail (30% gradient) where flow from 3-5 skid trails joined. |
| W-Line Rock Pit                                  | 1973        | Numerous seeps and springs on skid trails in wet bowl.                                                            |
| Around large knocker in headwaters of channel 9. | 1973        | Flow concentrates on skid trails causing rills to mass movements.                                                 |

## SEDIMENT SOURCE: CHANNELS IMPACTED BY HAUL ROAD CONSTRUCTION

| <u>Location</u> | <u>Year</u>  | <u>Description</u>                                                                                                                                                                                                                   |
|-----------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RX-5            | 1973-5       | Gullying of fill sidecast into channel during construction of C-30.                                                                                                                                                                  |
| RX-7            | 1973-5       |                                                                                                                                                                                                                                      |
| RX-11           | 1974-present | Gullying of fill sidecast into channel during construction of C-30, but numerous logs and stumps were pushed into the channel as well. Log jams formed, causing bank erosion. Jams are beginning to rot <u>and</u> release sediment. |

## SEDIMENT SOURCE: HAUL ROADS

| <u>Location</u>          | <u>Year</u> | <u>Description and Probable Cause</u>                                                                                                 |
|--------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Below RX-4               | 1976 on     | Discontinuous gully 5'/5' (max) formed by W-Line culvert concentrated runoff in headwater bowl.                                       |
| IBD between RX-6 & RX-7  | 1973 on     | Channel 6 had no culvert. Flow was diverted down IBD to RX-7, causing minor gullying of the ditch.                                    |
| IBD between RX-8 & RX-9  | 1973-4      | Gullied IBD (4/2 max) caused by road interception of slope runoff. Cross-road culvert installed midway between RX-8 and RX-9 in 1974. |
| IBD between RX-9 & RX-10 | 1973 or ?   | Gullied IBD, 5'/2' to 8'/4', caused by repeated failure of culvert at RX-9.                                                           |

## SEDIMENT SOURCE: FILL FAILURE MASS MOVEMENTS

| <u>Location</u>            | <u>Year</u>            | <u>Description and Probable Cause</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R-7 & Channel 7            | 1974 on                | Failure of a portion of a deck with numerous logs directly into Channel 7. Cause: in 1973 landing edge loaded with slash and stacked logs. Logs also stacked near the IBD (carries flow from wet skid trails and gully above to RX-8). XRD's run diagonally from ditch to edge of landing. Landing was built on a steep wet blue-goo slope. Failure knocked over several old-growth trees and caused formation of a 20-30' high log jam in channel. Log jam is causing bank failures and channel gullying. |
| R-12                       | 1972                   | Fill failure of @100' of road caused by lack or failure of culvert (present culvert undersized).                                                                                                                                                                                                                                                                                                                                                                                                           |
| R-11 (directly below R-12) | 1982<br>&<br>previous? | Fill failure of 100' of road caused by lack of culvert below RX-10, and CB interception of groundwater. Has toppled several old-growth redwoods.                                                                                                                                                                                                                                                                                                                                                           |
| R-13                       | 1981                   | Fill failure of 165' of road and sidecast slash and fill caused by road construction through springy headwaters. Directly above and contributing to Channel 12. Has toppled several old-growth trees.                                                                                                                                                                                                                                                                                                      |

## SEDIMENT SOURCE: SLOPE FAILURE MASS MOVEMENTS

| <u>Location</u>                                                                                                                                                                                                                                                                  | <u>Year</u> | <u>Description and Probable Cause</u>                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RB of RX-3 &<br>SX-3A                                                                                                                                                                                                                                                            | 1982        | Area 250' x 250' dropped >5 feet. Caused by wet ground conditions and removal of slope support by W-Line cutbank.                                                                                               |
| Between C-30 &<br>W-Line, above<br>RX-9                                                                                                                                                                                                                                          | 1974        | Large slide occurred to west of a large knocker in ancient slide area. Caused by skid trail concentrated spring and rill flow, and a dense network of skid trails leading to and crossing the steep slide area. |
|                                                                                                                                                                                                                                                                                  | 1975        | Slide area increased in size.                                                                                                                                                                                   |
|                                                                                                                                                                                                                                                                                  | 1976        | Crown area begins to receive flow concentrated by a cross-road culvert on W-Line.                                                                                                                               |
|                                                                                                                                                                                                                                                                                  | 1982        | Crown scarp migrated upslope about 100' and the entire slide zone destabilized with large blocks and root wads sliding downslope.                                                                               |
|                                                                                                                                                                                                                                                                                  | 1982        | Another slide occurred just east of the knocker. Probably caused by concentrated spring and rill flow on skid trails.                                                                                           |
| NOTE: This area is visible as being springy and rilled in the first photos after logging. These slides are occurring on a steep slope @9 years after logging when root strength is nearing minimum. The cutbanks on C-30 below here are made up of colluvial/landslide deposits. |             |                                                                                                                                                                                                                 |
| Slope above and<br>to east of RX-12.                                                                                                                                                                                                                                             | 1981 or 2   | Shallow failures on an ancient landslide feature caused by numerous skid trails crossing and undercutting the slope, and minimal root strength.                                                                 |

### Sediment Sources

The sediment sources with the greatest potential for introducing material to the fluvial system were judged to be the haul road crossings on the C-30. These were mid-slope and on an unmaintained road. Although culverts were of adequate size for a 25-year storm, the likelihood of trash racks plugging from organic or large bedload material is still high. Most culverts, if plugged, would be diverted due to the slope of the road, potentially causing much more erosion than just the loss of the crossing fill. Being located fairly low on the slope, it is likely that any sediment introduced would be transported at least to the lower reaches of Emerald Creek and probably Redwood Creek. Emerald Creek is one of the three creeks in the park which supports anadromous fish.

Skid trail crossings low on the slope, on large streams, with high erosion and/or diversion potential were also considered high priority for excavation. There are numerous other skid trail (and haul road) crossings on the site which warrant treatment, but due to their location higher on the slope, and the desire by some to leave the W-Line in, they were not treated in 1982. Part of the reason was that these crossings would be unprotected due to lack of rock access by dump trucks, and it was felt that sediment released in the first winters adjustment period could cause major problems with culverts on the W-Line below. (This problem occurred in winter 1981-82 with the unprotected crossings above the K & K yielding large amounts of sediment which plugged trash racks, nearly causing the K & K to washout.) It was thought to be better to leave the crossings "as is" for another year (hopefully a mild one) and remove them in conjunction with the W-Line.

Mass movements, particularly those contributing material directly to a stream, were considered high priority for treatment. These included active fill failures and perched, potentially unstable fill. It was noted on the review how far from the stream the deck failure on R-7 was, yet it effectively plugged the channel 300 feet below with logs and debris. Based on this observation, we felt it was important to pull back many fill edges which might otherwise have been left.

The slope failures between W-Line and C-30 were not considered high priority for treatment. Presently they are contributing mostly fine sediment, making this (channel 9) the most turbid creek on the site. Perhaps the most effective treatment will be to remove the culvert on the W-Line which is collecting slope and road runoff and discharging onto the headscarp of this very active, large mass movement. This is discussed in more detail under Erosion Control Rehabilitation work objectives.

There remains 37 skid trail crossings within the mapped area which should not be forgotten (excluding those constructed pre-1962 which are quite stable). From erosion potential estimates there are a total of 6503 cy of fill which could be excavated. These are all humboldt crossings, in various stages of decay. Of this, 1410 cy was estimated likely to erode before the crossing stabilize. An additional 386 cy could erode if diversions occur at those crossings with diversion potential. The W-Line haul road crossings contain another 6081 cy of excavatable fill. Potential erosion has not been calculated for these.

It should be kept in mind that the W-Line has not yet experienced a major storm. In the event of an extreme storm, nothing can be done to prevent erosion of the Humboldt crossings above the road, but trash rack maintenance will be extremely important to prevent erosion of the W-Line itself.

## EROSION-CONTROL REHABILITATION WORK

### Introduction

#### Procedures

There are four phases of rehabilitation work: evaluation, heavy equipment, labor intensive, and documentation. Evaluation of the site consists of inventorying erosional problems and sediment sources through aerial photo reconnaissance and detailed field mapping, estimating the erosional potential of the sediment sources, and prescribing treatment where necessary. In the latter part of the phase, costs are estimated and heavy equipment procured. Just prior to equipment work, photo points are established and worksites surveyed. On the C-30 unit, this phase occurred in the winter and spring of 1982.

The heavy equipment and labor intensive phases occur simultaneously during the summer months. This is when the bulk of the erosion control work is performed. The labor intensive work generally closely follows the heavy equipment sequence (detailed in Table 6).

#### Objectives

Logging has greatly accelerated erosion on the slopes of the Redwood Creek basin. The objectives of the project are to minimize erosion on the unit, particularly that occurring in or adjacent to stream channels, and to restore the area as much as possible to its pre-logging condition. This is achieved by removing active and potential sediment sources from the streamside environment, returning drainage networks to their original configuration, and removing roads and their scars. All haul road crossings and skid trail crossings with high erosion potential were removed. In the prairie a short road section crossing the Emerald-Dolason drainage divide was completely recontoured. One gully caused by road concentration of slope runoff was filled and blended into surrounding topography. Roads and landings were ripped, then slightly to completely outsloped to restore runoff patterns and minimize the possibility of future fill failures. Where road stability was questionable, the road fill material was either end-hauled or pushed by bulldozers to stable locations.

The W-Line and C-30 unit encompassed an evaluated (mapped) area of 834 acres (555 acres cutover, 156 acres prairie, and 123 acres old growth). The estimated cost of prescribed primary heavy equipment treatments for the entire site was over \$160,000.00. This would include ripping and draining or outsloping 4.3 miles of haul roads and 1.3 miles of minor prairie roads, and excavating 38 haul road crossings and 43 skid trail crossings. The entire unit could not be rehabilitated in one season, due to lack of estimated site cost and lack of time to complete the unit during the summer months (100 day estimate to complete the unit).

The most critical area in terms of erosion potential and sediment yield to Redwood Creek was chosen to be rehabilitated. This consisted of 1.5 miles of the C-30, the lower .8 mile of W-Line, and the adjacent skid trail crossings. This is the lowest road traversing the entire drainage basin. The upper slopes and remainder of the W-Line were considered lower priority due to their position higher on the slope, where streams are smaller and less likely to transport sediment directly to Redwood Creek.

### Cost Summary

Table 3 shows the overall cost summary of erosion control work on the C-30 unit. The grand total of the project was \$129,343.46. Of this, 5 percent was spent on the evaluation and documentation phases and 91 percent on the actual implementation of erosion control work (83 percent on the heavy equipment, and 8 percent on labor-intensive work). Table 4 summarizes the erosion-control work completed. Map D shows all worksite locations.

### Heavy Equipment Phase

#### Heavy Equipment Application

The primary heavy equipment phase on the C-30 unit was completed by an excavator and two bulldozers (Table 5). The excavator was a CASE 980B with a 1 1/4 yard bucket (owned by H.O. "Whitey" Brown and operated by Ellis Campbell). One bulldozer was a CASE 1450 with a winch and an 8-way hydraulic blade (owned by H.O. "Whitey" Brown and operated by Gary Netherby). The other bulldozer was a Caterpillar D-8H with rippers, which by week four was replaced with a Caterpillar D-8H with a winch (both were owned and operated by Jay Franke). Also four 10-yard dump trucks were used to end-haul fill from Rx-11.

Two different excavators were used during the course of the summer. During the first week of heavy equipment work, a CASE 980B excavator, owned and operated by Stephen LaRaut, was on the site. It was immediately obvious that the operator had never operated an excavator prior to this job. Not only was he unfamiliar with the machine's controls and its capabilities and limitations, but he was unable to maneuver, let alone work, on sloping ground. All the operators' inabilities and inefficiencies were documented by the frustrated site geologist and technician, and by the end of the first week the operator decided to back out of the project. The replacement, also a CASE 980B, was operated by Ellis Campbell, a highly skilled and efficient operator, who has worked for the park for three seasons.

Due to the inexperience of the first excavator operator, many of our site costs during the first week were well above average. Towards the end of the week we were already several days behind schedule, so we pulled the D-8 from road ripping to help out on site work with the 1450 bulldozer. Rx-1 and Rx-2, and R-3 and R-4 were done almost entirely by the two bulldozers, while the inexperienced excavator operator was used primarily on flat terrain pulling landings back. The D-8 proved such an efficient dirt mover that his original 40 hours were extended to nearly 200 hours.

TAB 3:  
SUMMARY COSTS OF EROSION-CONTROL REHABILITATION WORK SITE 82-1

|                          | Task                     | RNP Employees             |            | Heavy<br>Equipment<br>Rentals | Redwoods<br>United | Total<br>Task<br>Costs            | %<br>Total<br>Cost | Phase<br>Totals | Phase<br>% |
|--------------------------|--------------------------|---------------------------|------------|-------------------------------|--------------------|-----------------------------------|--------------------|-----------------|------------|
|                          |                          | Geologist &<br>Technician | Laborers   |                               |                    |                                   |                    |                 |            |
| EVAL-<br>UATION<br>PHASE | Mapping                  | \$3,990.00                |            |                               |                    | \$3,990.00                        | 3                  | \$6,030.00      | 5          |
|                          | Prescription             | 2,040.00                  |            |                               |                    | 2,040.00                          | 1.5                |                 |            |
| HEAVY EQUIPMENT<br>PHASE | Primary Treatment        | 7,050.00                  |            | \$95,231.81                   |                    | 102,281.81                        | 79                 | \$107,522.95    | 83         |
|                          | Secondary Treatment      |                           |            | 4,857.50                      |                    | 4,857.50                          | 3.7                |                 |            |
|                          | Miscellaneous            |                           |            | 383.64                        |                    | 383.64                            | .3                 |                 |            |
| LABOR INTENSIVE<br>PHASE | Travel                   |                           | \$1,176.35 |                               |                    | 1,176.35                          | .9                 | \$10,969.83     | 8          |
|                          | Secondary Treatments     |                           | 3,885.77   |                               | \$5,120.66         | 9,006.43                          | 7                  |                 |            |
|                          | Miscellaneous            |                           | 787.05     |                               |                    | 787.05                            | .6                 |                 |            |
| DOCUMENTATION<br>PHASE   | Cost Analysis and Report | 4,820.68                  |            |                               |                    | 4,820.68                          | 4                  | \$ 4,820.68     | 4          |
| TOTALS:                  |                          | \$17,900.68               | \$5,849.17 | \$100,472.95                  | \$5,120.66         | GRAND TOTAL: <u>\$ 129,343.46</u> |                    |                 |            |
| % OF TOTAL:              |                          | 14%                       | 4%         | 78%                           | 4%                 |                                   |                    |                 |            |

ACQUISITION OF STP&W: \$4400

Rehabilitation Work Summary, 82-1

|                                                                  |                                |
|------------------------------------------------------------------|--------------------------------|
| Total site cost <sup>1</sup> . . . . .                           | \$111,442.78                   |
| Heavy equipment cost                                             | \$100,472.95                   |
| Labor cost <sup>2</sup>                                          | \$10,969.83                    |
| Total length of haul roads treated . . . . .                     | 2.3 miles                      |
| Through logged areas                                             | 2.25 miles                     |
| Through prairie                                                  | .05 mile                       |
| Haul road crossings excavated . . . . .                          | 13 crossings<br>(11,444 cy)    |
| Unprotected crossings                                            | 6                              |
| Rocked crossings (670 cy used)                                   | 7                              |
| Skid trail crossings excavated . . . . .                         | 4 crossings<br>(1759 cy)       |
| Unprotected crossings                                            | 3                              |
| Rocked crossings (80 cy used)                                    | 1                              |
| Gullies shaped                                                   | 1 -- 150 linear feet (prairie) |
| Landings outsloped                                               | 5                              |
| Outsloped roads - total length                                   | 2.3 miles                      |
| Cross road drains - total number<br>(skid trail crossing access) | 6                              |
| Ripped - total miles                                             | 2.3 miles                      |
| Stabilized slide areas                                           | 2 slides                       |
| Recontoured rock pits                                            | 2                              |

<sup>1</sup>Excludes supervision cost (geologist and technician).

<sup>2</sup>Cost does not include wages for CETA or YCC, see Table 17 in the Labor Intensive section of this report.

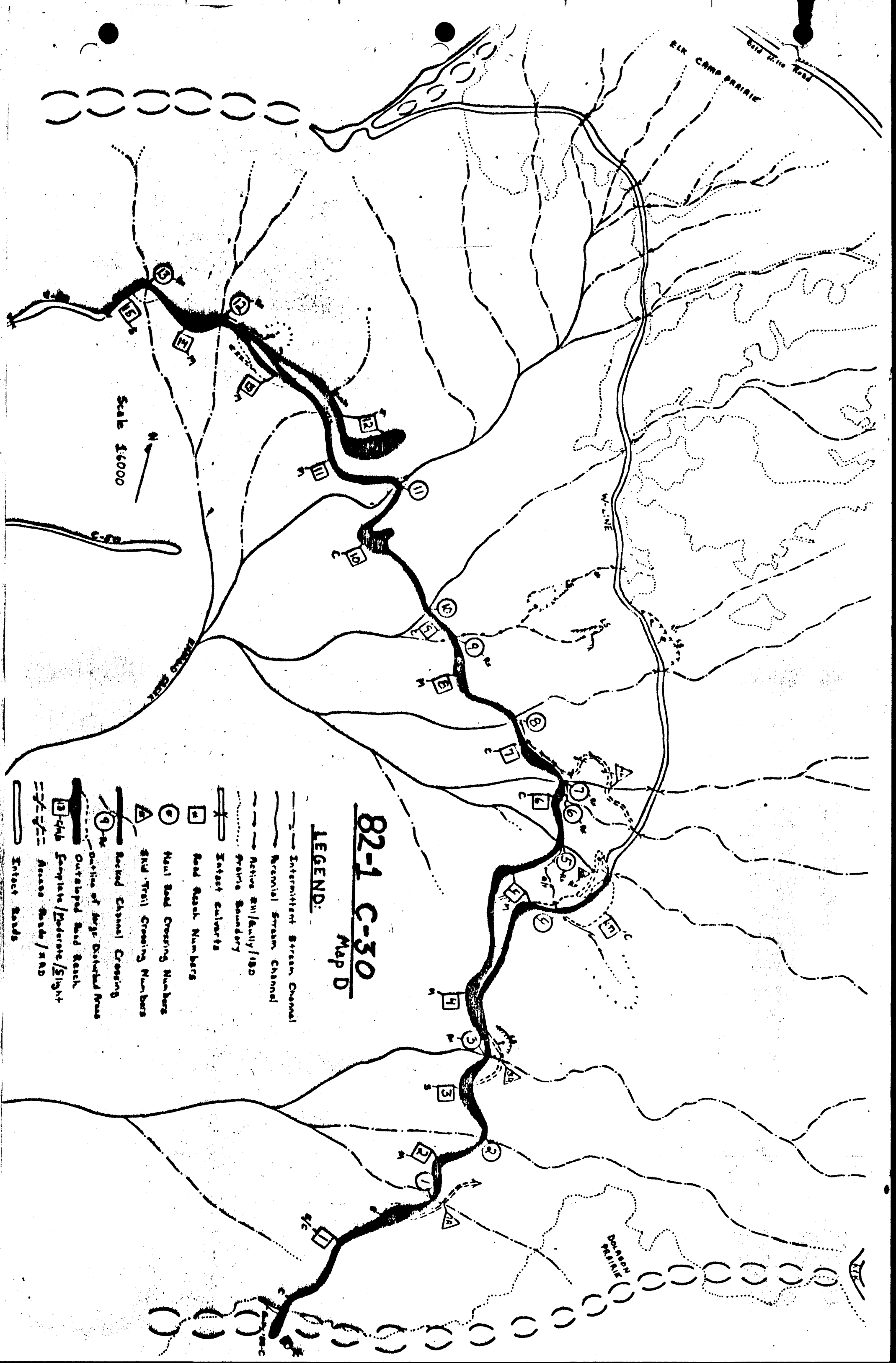


TABLE 5  
Site 82-1  
HEAVY EQUIPMENT USED

| TYPE       | DESCRIPTION                                       | OWNER and<br>OPERATOR                      | COST/<br>HOUR | DATES IN USE<br>(WEEK NUMBER) |
|------------|---------------------------------------------------|--------------------------------------------|---------------|-------------------------------|
| Excavator  | Case 980B<br>1 1/4 yd. bucket                     | Stephen LaRaut                             | \$70.00       | 1                             |
| Excavator  | Case 980B<br>1 1/4 yd. bucket                     | H.O. Whitey Brown<br>Ellis Campbell        | 85.00         | 2-10                          |
| Bulldozer  | Case 1450, winch,<br>8-way blade                  | H.O. Whitey Brown<br>Gary Netherby         | 75.00         | 1-10                          |
| Bulldozer  | Caterpillar D-8,<br>H46A, rippers,<br>4-way blade | Twin Parks Lumber<br>Company<br>Jay Franke | 99.00         | 1-3                           |
| Bulldozer  | Caterpillar D-8,<br>winch, 4-way<br>blade         | Twin Parks Lumber<br>Company<br>Jay Franke | 85.00         | 4-9                           |
| Dump Truck | 10-yard                                           | Neil Chaffee                               | 34.00         | 7-8                           |
| Dump Truck | 10-yard                                           | Duane Cossairt                             | 35.00         | 6-8                           |
| Dump Truck | 10-yard                                           | Keith Parker                               | 34.32         | 6-7                           |
| Dump Truck | 10-yard                                           | Frank Vyskocil                             | 35.00         | 6-7                           |

Two different D-8 Caterpillars were used on the site due to the fact the D-8 ripper cat was scheduled to go over to site 82-3 after we completed our road ripping and it was replaced by a less expensive D-8 winch cat for the remainder of the work on our unit. The owner, Jay Franke, was willing to leave the D-8 on site and work when needed, eliminating the expense of standby time, and allowing us to use the D-8 whenever needed during the summer.

The D-8 bulldozer (ripper and winch) was used primarily for ripping roads, shaping both the W-Line and C-30 rock pits, and shaping some of the landings. During the course of heavy equipment work the D-8 also dished out several crossings to culvert level and was used with the excavator on some of the large stream crossings or when the 1450 was down, and worked on outsloping some road reaches, both solo and with the other equipment. In the future we hope to use D-8s for dising out all stream crossings and removing culverts prior to the excavator beginning work and for outsloping road reaches where terrain and minor sidecasting will not be a problem.

Generally, the excavator and the 1450 bulldozer worked on all stream crossings together. The excavator sat on the outboard edge of the road prism digging the culvert out and laying back the sides of the channel as it moved back and up the channel. The excavator placed the fill on the inboard side of the road, and the cat pushed it out of the crossings, simultaneously working the channel banks with each pass. The channel fill was used to partially or completely outslope the road reach on either side. Once the excavator removed the culvert and reached the desired depth at the outboard edge, the channel bank slope on the far side was finished. The excavator then completed the desired channel width, gradient, and sideslope at the lower end. If the channel was to be rocked, the excavator started rocking before the near sideslope and the upper channel were completed. Then the excavator finished the upper channel reach while the bulldozer worked on the near side bank pushing fill down the road, and if needed pushing rock over to the excavator. Once the channel was completely rocked the excavator finished sloping the near channel bank.

If the channel was to be rocked with natural rock, hopefully found during excavation, the approach was a little different. While the excavator was still in the channel, each boulder or rock that was excavated was stockpiled along a bank, allowing the channel to be dug to the desired width and depth, then the rocks were placed back in the channel. If the boulders were too large to move, then the excavator worked around the rock, incorporating it into the channel design. Thus with natural rock, placement takes place in channel length segments, not all at once as with quarry rock. The rest of the excavation is the same as above.

On Rx-11, Emerald Creek crossing, the entire fill volume was end-hauled using the excavator and two dump trucks. Four different dump trucks were actually used, due to breakdowns and work schedule conflicts. The 1450 bulldozer was also used in the excavation work and at the fill site. The excavator loaded the dump trucks directly throughout the excavation. First the road prism was removed down to within five to eight feet of the desired channel bottom. Then the side banks were shaped by the bulldozer which pushed fill down the slope and then over to the excavator, which by this time had established a stationary loading location. All this time a road was left

intact so the dump trucks could drive in and out of the crossing each day. Once the side banks were completed the lower end of the channel bottom was excavated using both the bulldozer and excavator. Then at the last, the upper sediment pond was excavated and the dump truck access road was removed, still by end-hauling. The final 25 cubic yards which was pushed out of the crossing by the bulldozer. The entire excavation of Rx-11 was filmed using a 5-frame/second time-lapse setting on a movie camera.

All road reaches, inboard ditches, and rock pits were decompacted using the Caterpillar D-8 H ripper cat. Effective ripping depth was 30-36 inches, deeper than previous years. In conjunction with ripping, the bulldozer also shaped some of the landings and dished about half of the haul road crossings down to culvert depth. The D-8 was very effective on landings, pushing large quantities of fill towards the inboard ditch and cutbank. Sidecasting was avoided by leaving a berm (4-8 feet high) around the edge. At the end, the berm was either back-bladed or pulled in using the D-8's rippers or pulled back by the excavator. This same technique was used at the two rock pits on the unit. At the W-Line rock pit the berm was pushed down and blended with the road.

The entire C-30 unit was outsloped to varying degrees of completeness. Several methods were employed this year in terms of equipment used. The majority of the unit was outsloped by the excavator and 1450 bulldozer team. The excavator leads doing the majority of the fill moving and the bulldozer follows and shapes the fill into the natural slopes and contours. Three road reaches (R-2, R-3, and R-12) were outsloped entirely by bulldozer. When the bulldozers worked as a team, the D-8 leads doing the majority of the fill moving while the 1450 follows shaping the fill and bringing in the straw. In the future, outsloping will probably be done entirely by the large bulldozer. Also a portion of R-10 was end-hauled using the excavator to directly load the two dump trucks. Approximately half the road fill along this 300-foot long section was removed, then the rest was outsloped using only the excavator (the terrain was too steep and the fill too loose for the bulldozer to work on).

One gully located on Dolason Prairie ridge (R-1), was shaped by the 1450 bulldozer. The near vertical walls were knocked down, filling the gully and the surrounding area was shaped into a gentle swale.

#### Heavy Equipment Sequencing

The first work performed on the unit was the delivery of quarried rock to specific haul road crossings. This was completed the week before the actual rehabilitation heavy equipment started. The rock was quarried during the winter and spring of 1981 and was stockpiled for use in following rehabilitation years. The entire stockpile was used this year and the W-Line rock pit closed.

Sequencing of the work sites was very simple this year (Table 6). The equipment started at the bottom of the W-Line and worked towards the C-30 intersection. Upon reaching this location, the equipment "jumped" over the W-Line rockpit and Sx-5A and worked back towards the C-30 intersection. Then the equipment progressed down C-30 towards C-Line. All three pieces of heavy equipment (D-8, 1450, and excavator) started work on the first day. The D-8

Table 6  
Site 82-1  
HEAVY EQUIPMENT SEQUENCING

| WEEK<br>NUMBER | DATES(WEEKLY)   | WORK LOCATIONS                                                            | TYPE OF EQUIPMENT                              |
|----------------|-----------------|---------------------------------------------------------------------------|------------------------------------------------|
| 1              | July 12-16      | --Ripping roads; W-Line<br>and C-30.<br>--W-Line (R-1,2,3 and<br>Rx-1,2). | D-8 Ripper Cat.<br>Excavator, 1450 and<br>D-8. |
| 2              | July 19-23      | --W-Line (R-2,3,4,5 and<br>Rx-2,3 and Sx-3A,5A).                          | Excavator, 1450 and<br>D-8.                    |
| 3              | July 26-30      | --W-Line ( Rx-4 and Sx-3A,<br>and R-4).<br>--C-30 (R-4,6,7 and Rx-5).     | Excavator, 1450 and<br>D-8.                    |
| 4              | August 2-6      | --C-30 (Rx-5,6,7,8 and<br>Sx-7A and R-6,7,8).<br>--C-30; ripping.         | Excavator, 1450 and<br>D-8.<br>D-8 Ripper Cat. |
| 5              | August 9-13     | --C-30 (Rx-8,9,10 and<br>R-8,9,10).                                       | Excavator, 1450 and<br>D-8.                    |
| 6              | August 16-20    | --C-30 (Rx-10,11 and<br>R-10,12,13).                                      | Excavator, 1450 and<br>D-8, and 3 dump trucks. |
| 7              | August 23-27    | --C-30 (Rx-11 and<br>R-12,13).                                            | Excavator, 1450 and<br>D-8, 4 dump trucks.     |
| 8              | Aug.30-Sept.3   | --C-30 (Rx-11,12 and<br>R-11,12,13,14).                                   | Excavator, 1450 and<br>D-8, and 2 dump trucks. |
| 9              | September 7-10  | --C-30 (Rx-12,13 and<br>R-13,14).                                         | Excavator, 1450 and<br>D-8.                    |
| 10             | September 13-16 | --C-30 (Rx-13 and<br>R-14,15).                                            | Excavator and 1450.                            |

ripped the roads, shaped some landings, and dished out some crossings ahead of the excavator and 1450 bulldozer, and then later worked with the excavator and/or 1450 bulldozer on specific sites.

Skid trail crossings 1A and 3A were completed prior to the haul road crossings located immediately below. This allowed a continuous stream gradient throughout the excavation.

During Rx-11's excavation, when there were numerous breakdowns by both the excavator and dump trucks, standby was avoided for other equipment (excluding dump trucks) because work could be performed on R-12 and R-13 without shutting off access to Rx-11. Almost all of R-12 and R-13 were completed before Rx-11 was finished.

### Heavy Equipment Costs

Table 7 shows the total and average costs of heavy equipment treatments on Rehabilitation Unit 82-1. Primary treatments involve removal of actual and potential sediment sources from streams, removing fill from active landslides, shaping rock pits and removing roads, restoring drainage patterns to their original configuration as much as possible.

Secondary treatments reduce erosion, aid revegetation, and attempt to stabilize the completed primary worksites. This includes channel armoring in unstable channels and mulch (straw) application on disturbed ground. Rock was used in eight of seventeen crossings, where full excavation were not feasible, or up or downstream channel conditions indicated little rock was likely to be found. Rock costs in Table 7 include placement only. Quarrying and delivery to the worksites was an additional \$6,662.75. Straw distribution includes only the cost of moving bales with the bulldozers from straw stockpiles to their final spreading location. The operating cost of the park's two-ton truck is not included or known; the truck operator's cost is included in the labor-intensive cost summary (Table 17). Cost for moving culverts covers moving them with the bulldozer to where the park's two-ton truck could pick them up; this could be considered a primary treatment cost. Mulch was "walked-in" on the one prairie road treated to prevent wind loss on the ridge.

Miscellaneous costs include several hours of unclassified, miscellaneous heavy equipment work.

This table does not include lowboy move-in/out expenses, which totalled \$1,485.75. Move-in/out and standby expenses for dump trucks (\$693.28 and \$452.59, respectively) were included in the total cost of RX-11 (the only place they were used). Access costs between worksites were minimal and included with each worksites cost.

The costs shown on this table agree and balance with costs billed to 82-1. They do not include prompt payment discounts. They represent the true times and costs of all work done on the site.

TABLE 7.  
SUMMARY OF AVERAGE COSTS OF HEAVY EQUIPMENT TREATMENTS  
82-1

25

| Treatment                    | # of Work-Sites | Total Quantity         | Total Cost    | Average Costs: |                        | Cost/Quantity Range                   |
|------------------------------|-----------------|------------------------|---------------|----------------|------------------------|---------------------------------------|
|                              |                 |                        |               | Work-Site      | Quantity               |                                       |
| Haul Road Crossings          | 13              | 11,444 yd <sup>3</sup> | \$46,590.56   | \$3584         | \$4.07/yd <sup>3</sup> | <u>\$ .99-7.29</u><br>yd <sup>3</sup> |
| Skid Trail Crossings         | 4               | 1,759 yd <sup>3</sup>  | 6,744.25      | 1686           | 3.83/yd <sup>3</sup>   | <u>2.27-4.57</u><br>yd <sup>3</sup>   |
| Outsloping                   | 9               | 5,395 ft.              | 10,418.25     | 1158           | 1.93/LF                | <u>.56-8.36</u><br>linear ft.         |
| Landings                     | 5               | 4,607 ft.              | 15,581.75     | 3116           | 3.38/LF                | <u>2.47-7.04</u><br>linear ft.        |
| Landslides                   | 2               | 635 ft.                | 8,102.50      | 4051           | 12.76/LF               | <u>8.08-13.64</u><br>linear ft.       |
| Rock Pits                    | 2               | 2.6 acres              | 4,321.00      | 2161           | 1661.92/<br>acre       | <u>1497-1735</u><br>acre              |
| Rip Roads                    | 1               | 2.3 miles              | 3,473.50      | same           | .28/LF                 | same                                  |
| TOTAL PRIMARY TREATMENT      |                 |                        | = \$95,231.81 |                |                        |                                       |
| Channel Rocking <sup>1</sup> | 8               | 750 yd <sup>3</sup>    | 3,432.75      | 429            | 4.58/yd <sup>3</sup>   | <u>1.48-11.26</u><br>yd <sup>3</sup>  |
| Straw Distribution           | ---             | ---                    | 768.50        | ---            | ---                    | ---                                   |
| Moving Culverts              | ---             | ---                    | 543.75        | ---            | ---                    | ---                                   |
| Mulch: Walk-in               | 1               | 300 LF/<br>65 bales    | 112.50        | same           | .38/LF<br>1.73/bale    | same                                  |
| TOTAL SECONDARY TREATMENT    |                 |                        | = \$ 4,857.50 |                |                        |                                       |
| Miscellaneous Work           | 2               | N/A                    | 383.64        | 192            | ---                    | ---                                   |

TOTAL HEAVY EQUIPMENT COSTS = \$100,472.95

NOTE: This tables does not include lowboy move in/out expenses (except those for RX-11, included in excav. cos nor rock quarry and transport costs.

<sup>1</sup> Rock placement cost only.

### Haul Road and Skid Trail Crossing Excavation Costs (Table 8)

Haul road and skid trail crossings on Unit 82-1 had an overall average cost of \$4.04 per cubic yard. Most crossings ranged from \$2 to \$5 per cubic yard. Two-thirds of the crossings were completed with unit costs under \$3.50 per cubic yard. If the one most expensive crossing (RX-13 at \$7.29 per cubic yard) is eliminated, the overall average cost drops to \$3.61 per cubic yard. This crossing is discussed in detail at the end of this section.

Medium-sized crossings (400-800 cubic yards) had the cheapest average cost, \$2.59 per cubic yard. This seems to be the most efficient size. The proportion of time spent on giving instructions and coordinating equipment is less than for smaller crossings.

The large and extra-large crossings were the most expensive, at \$4.77 and \$4.91 per cubic yard, respectively. Generally they were the most difficult to excavate, primarily due to their depth and steepness. The one extra-large crossing was end-hauled. It should be noted that the three large crossings were all between 1400 and 1600 cubic yards. Storing that much material usually requires a fairly long push for a dozer. Two cats (or dump trucks) are often necessary, which raises the unit cost somewhat. However, if only one cat is available and two are needed, the unit cost can skyrocket, as at RX-13. The cheapest excavations were those where a large portion of the fill was removed by the D-8 before the excavator got there. Two crossings were done entirely by the cats. The first one they did was \$2.71 per cubic yard (RX-1). The second one was done for only \$1.28 per cubic yard. We would have like to use the D-8 on more of the excavations but due to having a limited number of hours, we tended to "save" the time for upcoming extra-large and extra-difficult crossings. The D-8 only worked 70 hours on excavations, versus 228 hours for the 1450. I believe our overall unit costs would be significantly reduced if we had used the D-8 extensively on all crossings. A D-8, or other large powerful bulldozer, should be able to do the majority of the crossings, with the excavator used only to define the channel, excavate the upper and lower extremes and do any necessary rocking. (However: beware of letting the D-8 dig out the natural channel rock! When you get close to the bottom, the excavator should be called in. It can salvage, stockpile, and re-use natural rock in the excavation.)

Table 9 is a comparison of this years unit excavation costs with last years on Lower Slide Creek. Costs for last year were adjusted upward to reflect increased equipment costs (see footnote 1). Also shown is the percent of bulldozer hours of the total equipment hours for each size category. Small crossings showed the most marked decrease in unit cost (\$1.46 less per cubic yard). Dozer time increased from 44 percent to 61 percent of the total equipment time. Medium crossings had a similar increase in dozer time but showed less of a cost decrease (\$.27 less per cubic yard). Large crossings increased in unit cost; dozer time remained about the same. Comparing only crossings with volumes between 1400 and 1600 cubic yards, actual costs are similar with a slight decrease in adjusted costs (\$.44 per cubic yard). Considering that we still used the basic excavator/dozer approach, the similarity of unit costs this year and last is to be expected. It will be interesting to compare this with Ed's costs, since the D-8's did much of his excavations.

TABLE 8.  
AVERAGE HAUL ROAD AND SKID TRAIL CROSSING EXCAVATION COSTS<sup>1</sup>  
82-1

| Type of Worksite                     | # of Worksites  | Range: vol. fill yd <sup>3</sup> | Equipment                                      | Range: Hours                | Total Sites Cost <sup>1</sup> | Average Cost/ Worksite | Range: Cost      | Total yd <sup>3</sup>  | Average: Cost/ yd <sup>3</sup> | Range: Cost/ yd <sup>3</sup>        |
|--------------------------------------|-----------------|----------------------------------|------------------------------------------------|-----------------------------|-------------------------------|------------------------|------------------|------------------------|--------------------------------|-------------------------------------|
| EXTRA-SMALL<br>0-100 yd <sup>3</sup> | 0               |                                  |                                                |                             |                               |                        |                  |                        |                                |                                     |
| SMALL<br>100-400 yd <sup>3</sup>     | 5               | 131-336                          | Excavator<br>1450<br>D-8                       | 1½-7½<br>½-8½<br>1½-2       | \$3120.25                     | \$ 624                 | \$228-1275       | 1016                   | \$ 3.07                        | \$ .99-<br>4.54                     |
| MEDIUM<br>400-800 yd <sup>3</sup>    | 7               | 407-798                          | Excavator<br>1450<br>D-8                       | 4½-19½<br>3½-16<br>1½-8     | 10,017.00                     | 1431                   | 609-3650         | 3872                   | 2.59                           | 1.28-<br>4.57                       |
| LARGE<br>800-2000 yd <sup>3</sup>    | 3               | 1468-1571                        | Excavator<br>1450<br>D-8                       | 20½-55½<br>5 -74½<br>10 -22 | 21,772.00                     | 7257                   | 4274-11,136      | 4566                   | 4.77                           | 2.72-<br>7.29                       |
| EXTRA-LARGE<br>>2000 yd <sup>3</sup> | 1               | 3749                             | Excavator<br>1450<br>D-8<br>Dump Trucks<br>(4) | 76<br>74½<br>10<br>166½     | 18,425.56                     | ← same                 | ← same           | 3749                   | 4.91                           | 4.91                                |
| TOTALS:                              | 16 <sup>2</sup> | 131-3749<br>yd <sup>3</sup>      | Excavator<br>1450<br>D-8                       | 1½-76<br>½-74½<br>1½-22     | \$53,334.81                   | \$3333                 | \$228-<br>18,425 | 13,203 yd <sup>3</sup> | \$4.04/<br>yd <sup>3</sup>     | \$ .99-<br>7.29/<br>yd <sup>3</sup> |

<sup>1</sup> Does not include rock placement costs.

<sup>2</sup> Actual total of crossings is 17, though Rx-6 is a rocked inboard ditch with minimum excavation work.

NOTE: For details of specific crossings, see Table 10 in Appendix.

**TABLE 9.**  
**COMPARISON OF CROSSING EXCAVATION COSTS ON SITES 81-2 & 82-1**

| Type of Worksite                                          | Rehab Unit | # of Worksites | Total Excavation Cost | Total Yd <sup>3</sup> | Avg. Cost/Yd <sup>3</sup> | Excavator Hours | Dozer Hours | % done by Dozers | Adj. Avg. <sup>1</sup> Cost/Yd <sup>3</sup> |
|-----------------------------------------------------------|------------|----------------|-----------------------|-----------------------|---------------------------|-----------------|-------------|------------------|---------------------------------------------|
| Extra-Small<br>0-100 yd <sup>3</sup>                      | LSC        | 14             | \$4,390.28            | 639                   | 6.87                      | 35.5            | 22.75       | 39%              | \$7.57                                      |
|                                                           | EC         | 0              |                       |                       |                           |                 |             |                  |                                             |
| Small<br>100-400 yd <sup>3</sup>                          | LSC        | 11             | 9,220.15              | 2,256                 | 4.09                      | 69.75           | 53.75       | 44%              | 4.53                                        |
|                                                           | EC         | 5              | 3,120.25              | 1,016                 | 3.07                      | 15.25           | 24.0        | 61%              | 3.07                                        |
| Medium<br>400-800 yd <sup>3</sup>                         | LSC        | 2              | 2,380.75              | 915                   | 2.60                      | 18.5            | 13.0        | 41%              | 2.86                                        |
|                                                           | EC         | 7              | 10,017.00             | 3,872                 | 2.59                      | 48.75           | 73.75       | 60%              | 2.59                                        |
| Large<br>800-2000 yd <sup>3</sup>                         | LSC        | 3              | 12,510.01             | 3,926                 | 3.19                      | 70.0            | 98          | 58%              | 3.51                                        |
|                                                           | EC         | 3              | 21,772.00             | 4,566                 | 4.77                      | 107.75          | 157.25      | 59%              | 4.77                                        |
| Equalized Large <sup>2</sup><br>1400-1600 yd <sup>3</sup> | LSC        | 2              | 10,877.38             | 3,039                 | 3.57                      | 60.25           | 85.75       | 59%              | 3.94                                        |
|                                                           | EC         | 2              | 10,635.75             | 3,039                 | 3.50                      | 52.25           | 73          | 58%              | 3.50                                        |

<sup>1</sup>For Lower Slide Creek, 81-2, the adjusted average cost/yd<sup>3</sup> was calculated using actual equipment hours but at 1982 prices: Excavator = \$85.00/hr; Dozer = \$80.00/hr (dozer rate is average between 1450 and D-8 winch cat). For Emerald Creek, 82-1, average cost/yd<sup>3</sup> is unadjusted.

<sup>2</sup>In an attempt to explain the large average cost increase for large crossings, RX-13 was eliminated from EC's figures (numerous difficulties were encountered: steep wet conditions, needed 2 cats and only had 1, etc.), and RX-34 from LSC (only 887 cy, much smaller than others being compared in this category). Comparing only equal sized excavations, the difference in average cost is minimal.

TABLE 10.  
HAUL ROAD CROSSING EXCAVATION COSTS  
82-1

| Site Number | Equipment                | Hours               | Cost <sup>1</sup>            | Site Cost | Quantity yd <sup>3</sup> | Cost/ yd <sup>3</sup> | Total Site Cost | Remarks:                                                                                 |
|-------------|--------------------------|---------------------|------------------------------|-----------|--------------------------|-----------------------|-----------------|------------------------------------------------------------------------------------------|
| Rx-1        | 1450<br>D-8              | 2 1/2<br>2          | \$ 187.50<br>198.00          | \$ 385.50 | 142                      | \$ 2.71               | \$ 385.50       | No rock. 1450 did touch up work. <sup>2</sup>                                            |
| Rx-2        | 1450<br>D-8              | 3 1/2<br>3 1/2      | 262.50<br>346.50             | 609.00    | 475                      | 1.28                  | 609.00          | No rock. <sup>2</sup>                                                                    |
| Rx-3        | Excavator<br>1450<br>D-8 | 5<br>8 1/2<br>1 1/2 | 425.00<br>637.50<br>148.50   | 1211.00   | 457                      | 2.65                  | 1711.00         | Fill excavation cost. <sup>3</sup><br>Crossing was dished out to near culvert by dozers. |
|             | Rx:<br>Excavator<br>1450 | 5<br>1              | 425.00<br>75.00              | 500.00    | 100-Rx                   | 5.00-Rx               |                 | Rocking cost.                                                                            |
| Rx-4        | Excavator<br>1450        | 1 1/2<br>4          | 127.50<br>300.00             | 427.50    | 131                      | 3.26                  | 427.50          | No rock. <sup>4</sup>                                                                    |
| Rx-5        | Excavator<br>1450<br>D-8 | 20 1/4<br>5<br>22   | 1721.25<br>375.00<br>2178.00 | 4274.25   | 1571                     | 2.72                  | 4702.75         | Fill excavation cost. <sup>5</sup>                                                       |
|             | Rx:<br>Excavator<br>D-8  | 4 3/4<br>1/4        | 403.75<br>24.75              | 428.50    | 60-Rx                    | 7.14-Rx               |                 | Rocking cost. <sup>6</sup>                                                               |
| Rx-6        | Rx:<br>Excavator         | 5                   | 425.00                       | 425.00    | 130-Rx                   | 3.27                  | 425.00          | Rocking inboard ditch only, minimal excavation. <sup>7</sup>                             |
| Rx-7        | Excavator<br>1450        | 6<br>8 1/2          | 510.00<br>637.50             | 1147.50   | 407                      | 2.82                  | 1600.00         | Fill excavation cost. <sup>8</sup>                                                       |
|             | Rx:<br>Excavator<br>1450 | 4<br>1 1/2          | 340.00<br>112.50             | 452.50    | 100-Rx                   | 4.53-Rx               |                 | Rocking cost.                                                                            |

TABLE 10.  
HAUL ROAD CROSSING EXCAVATION COSTS - cont.  
82-1

| Site<br>Number | Equipment                                      | Hours                         | Cost <sup>1</sup>                       | Site<br>Cost | Quantity<br>yd <sup>3</sup> | Cost/<br>yd <sup>3</sup> | Total<br>Site<br>Cost | Remarks:                            |
|----------------|------------------------------------------------|-------------------------------|-----------------------------------------|--------------|-----------------------------|--------------------------|-----------------------|-------------------------------------|
| Rx-8           | Excavator<br>1450                              | 8<br>9                        | \$ 680.00<br>675.00                     | \$1355.00    | 718                         | \$ 1.89                  | \$1355.00             | No rock. <sup>8</sup>               |
| Rx-9           | Excavator<br>1450                              | 2 1/4<br>1/2                  | 191.25<br>37.50                         | 228.75       | 230                         | .99                      | 495.00                | Fill excavation cost.               |
| Rx:            |                                                |                               |                                         |              |                             |                          |                       |                                     |
|                | Excavator<br>1450                              | 2 1/4<br>1                    | 191.25<br>75.00                         | 266.25       | 90-Rx                       | 2.96-Rx                  |                       | Rocking cost.                       |
| Rx-10          | Excavator<br>1450<br>D-8<br>D-8                | 32<br>28 1/4<br>16 3/4<br>1   | 2720.00<br>2118.75<br>1423.75<br>99.00  | 6361.50      | 1468                        | 4.33                     | 6361.50               | No rock. <sup>9</sup>               |
| Rx-11          | Excavator<br>1450<br>D-8<br>Dump Trucks<br>(4) | 76<br>74 1/4<br>10<br>166 1/2 | 6460.00<br>5568.75<br>850.00<br>5546.81 | 18,425.56    | 3749                        | 4.91                     | 18,425.56             | No rock. <sup>10</sup>              |
| Rx-12          | Excavator<br>1450<br>D-8                       | 4 1/4<br>5 1/2<br>3           | 361.25<br>412.50<br>255.00              | 1028.75      | 569                         | 1.81                     | 1132.50               | Fill excavation cost. <sup>11</sup> |
| Rx:            |                                                |                               |                                         |              |                             |                          |                       |                                     |
|                | Excavator<br>1450                              | 1<br>1/4                      | 85.00<br>18.75                          | 103.75       | 70-Rx                       | 1.48-Rx                  |                       | Rocking cost.                       |

TABLE 10.  
HAUL ROAD CROSSING EXCAVATION COSTS - cont.  
82-1

| Site<br>Number | Equipment                                      | Hours                           | Cost <sup>1</sup>              | Site<br>Cost                                                         | Quantity<br>yd <sup>3</sup>                   | Cost/<br>yd <sup>3</sup>                         | Total<br>Site<br>Cost | Remarks:                            |
|----------------|------------------------------------------------|---------------------------------|--------------------------------|----------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------|-----------------------|-------------------------------------|
| Rx-13          | Excavator<br>1450<br>D-8                       | 55 1/2<br>74 1/4<br>10          | \$4717.50<br>5568.75<br>850.00 | \$11,136.25                                                          | 1527                                          | \$ 7.29                                          | \$11,492.50           | Fill excavation cost. <sup>12</sup> |
|                | Rx:                                            |                                 |                                |                                                                      |                                               |                                                  |                       |                                     |
|                | Excavator<br>1450                              | 3 3/4<br>1/2                    | 318.75<br>37.50                | 356.25                                                               | 120 -Rx                                       | 2.97 -Rx                                         |                       | Rocking cost.                       |
| TOTALS:<br>13  | Excavator<br>1450<br>D-8<br>Dump Trucks<br>(4) | 236 1/2<br>228<br>70<br>166 1/2 |                                | Excavation:<br>\$46,590.56<br>Rocking:<br>\$ 2,532.25<br>\$49,122.81 | 11,444 yd <sup>3</sup><br>670 yd <sup>3</sup> | \$4.07/yd <sup>3</sup><br>\$3.78/yd <sup>3</sup> |                       |                                     |

Footnotes - see next page.

Abbreviations: Rx--rocking or rock quantity. Rx-#--haul road crossing number.

TABLE 10 - FOOTNOTES  
HAUL ROAD CROSSING EXCAVATION COSTS, 82-1

- <sup>1</sup> Rock costs include placement only.
- <sup>2</sup> Both crossings were done by the bulldozers alone. Rx-1 was more per cubic yard because it was the first crossing the two dozers had done together. Rx-2 proceeded much more efficiently, as the two dozers became coordinated in their actions.
- <sup>3</sup> Crossing was dished out to near culvert level by the dozers. Lower end was not completely excavated (still has a buried stump) but this seemed acceptable and cost effective because it was to be rocked.
- <sup>4</sup> This is more of a swale, with inboard ditch spring drains, than a crossing. We are not sure why it cost so much, except that the 1450 was having problems losing traction due to worn grousers (they were repaired thereafter).
- <sup>5</sup> The 1450 was down for grouser repair during this excavation, and the more expensive D-8 was used to support the excavator (\$99/hour versus \$75/hour). But then again, the 1450 would have taken much longer, so there may not be much difference. This crossing was dished out by the D-8 to near culvert level.
- <sup>6</sup> Rock placement cost was higher than usual, because of having to move it several times. First it was pushed approximately 100 feet to the crossing by the dozer; during this the excavator had to move out of the way and was unproductive. Then the excavator had to bail the rock to the lower end of the excavation, and then move it again into its final location.
- <sup>7</sup> Due to the trashed and buried condition of the channel below the road, the flow was kept in the inboard ditch (where it had been since construction), and directed down the adjacent stream. The two channels previously joined several hundred feet below the road. The ditch was widened, a berm was built along the road, and the new "channel" was rocked.
- <sup>8</sup> These crossings were not dished out by dozer.
- <sup>9</sup> A big, deep, steep excavation! Required both cats for lower part of the excavation - one cat pushed the excavator's fill up a "rehab trail" alongside the excavation, the other cat then pushed the load out away from the channel.
- <sup>10</sup> All except the last 25 cubic yards were endhailed to a small rock pit, about 200 yards away. Volume survey calculations agreed with dump truck tally (assuming 6 cubic yards per truck load).
- <sup>11</sup> The D-8 moved the majority of the fill here, including the culvert.
- <sup>12</sup> This crossing included removal of a large logging-caused log jam (possibly skid trail crossing) below the road. The whole area was extremely wet and mucky throughout the excavation. The excavator had to bail his own dirt two to three times before the 1450 could get at it. More time with the D-8 would definitely have improved our efficiency here, but no more time was available...further details in body of report.

TABLE 11.  
SKID TRAIL CROSSING EXCAVATION COSTS<sup>1</sup>  
82-1

| Site Number | Equipment | Hours  | Cost <sup>4</sup> | Site Cost          | Quantity yd <sup>3</sup> | Cost/ yd <sup>3</sup>   | Total Site Cost | Remarks:                           |
|-------------|-----------|--------|-------------------|--------------------|--------------------------|-------------------------|-----------------|------------------------------------|
| Sx-1A       | Excavator | 4      | \$ 280.00         | \$ 803.50          | 177                      | \$ 4.54                 | \$ 803.50       | No rock. <sup>2</sup>              |
|             | 1450      | 5      | 375.00            |                    |                          |                         |                 |                                    |
|             | D-8       | 1 1/2  | 148.50            |                    |                          |                         |                 |                                    |
| Sx-3A       | Excavator | 7 1/2  | 637.50            | 1275.00            | 336                      | 3.79                    | 1275.00         | No rock.                           |
|             | 1450      | 8 1/2  | 637.50            |                    |                          |                         |                 |                                    |
| Sx-5A       | Excavator | 19 1/2 | 1657.50           | 3649.50            | 798                      | 4.57                    | 4550.00         | Fill excavation cost. <sup>3</sup> |
|             | 1450      | 16     | 1200.00           |                    |                          |                         |                 |                                    |
|             | D-8       | 8      | 792.00            |                    |                          |                         |                 |                                    |
|             | Rx:       |        |                   |                    |                          |                         |                 |                                    |
|             | Excavator | 6 1/2  | 552.50            | 900.50             | 80-Rx                    | 11.26-Rx                |                 | Rocking cost. <sup>4</sup>         |
|             | 1450      | 2      | 150.00            |                    |                          |                         |                 |                                    |
|             | D-8       | 2      | 198.00            |                    |                          |                         |                 |                                    |
| Sx-7A       | Excavator | 6      | 510.00            | 1016.25            | 448                      | 2.27                    | 1016.25         | No rock.                           |
|             | 1450      | 6 3/4  | 506.25            |                    |                          |                         |                 |                                    |
| <hr/>       |           |        |                   |                    |                          |                         |                 |                                    |
| TOTALS:     | Excavator | 43 1/2 |                   | Excavation:        |                          |                         |                 |                                    |
|             | 1450      | 38 1/4 |                   | \$ 6,744.25        | 1759 yd <sup>3</sup>     | \$3.83/yd <sup>3</sup>  |                 |                                    |
| 4           | D-8       | 11 1/2 |                   | Rocking:           |                          |                         |                 |                                    |
|             |           |        |                   | \$ 900.50          | 80 yd <sup>3</sup>       | \$11.26/yd <sup>3</sup> |                 |                                    |
|             |           |        |                   | <u>\$ 7,644.75</u> |                          |                         |                 |                                    |

Footnotes - see next page.

Abbreviations: Rx--rocking

TABLE 11 - FOOTNOTES  
SKID TRAIL CROSSING EXCAVATION COSTS, 82-1

1 These costs include access to crossing.

2 This small crossing was expensive due to the inexperience and inability of the excavator operator, Steve LaRaut. During the four hours he spent on the crossing, an insignificant amount of fill was moved. It took him 25 minutes just to get up the skid trail to the crossing (approximately 200 feet). The crossing was finished by the dozers. Excavation cost also includes construction of two long waterbars which direct flow into the crossing.

3 Steep, deep excavation. The D-8 helped push fill out of the crossing, but did not dish it down at the beginning.

4 Rock cost (SX-5A only) includes placement and time spent by dozers pushing rock to the crossing from the rock pit above.

TABLE 12.  
STREAM CROSSING ROCK COSTS  
82-1

| Site Number | Quantity yd <sup>3</sup> | Quarry Cost/yd <sup>3</sup>    | Transport Cost/yd <sup>3</sup> | Average Placement Cost/yd <sup>3</sup> | Average Total Cost/yd <sup>3</sup> | Rock Placement Cost/Site | Total Rock Cost | Total Excavation Cost | Total Site Cost |
|-------------|--------------------------|--------------------------------|--------------------------------|----------------------------------------|------------------------------------|--------------------------|-----------------|-----------------------|-----------------|
| Rx-3        | 100                      | \$4.90                         | <sup>1</sup>                   | \$5.00                                 | \$9.90                             | \$500.00                 | \$ 990.00       | \$1211.00             | \$ 1711.00      |
| Rx-5        | 60                       | 4.90                           | \$5.24                         | 7.14 <sup>3</sup>                      | 17.28                              | 428.50                   | 1036.80         | 4274.25               | 4702.75         |
| Rx-6        | 130                      | 4.90                           | 5.24                           | 3.27                                   | 13.41                              | 425.00                   | 1743.30         | ---                   | 425.00          |
| Rx-7        | 100                      | 4.90                           | 5.24                           | 4.53                                   | 14.67                              | 452.50                   | 1467.00         | 1147.50               | 1600.00         |
| Rx-9        | 90                       | 4.90                           | 5.24                           | 2.96                                   | 13.10                              | 266.25                   | 1179.00         | 228.75                | 495.00          |
| Rx-12       | 70                       | 4.90                           | 5.24                           | 1.48                                   | 11.62                              | 103.75                   | 813.40          | 1028.75               | 1132.50         |
| Rx-13       | 120                      | 4.90                           | 5.24                           | 2.97                                   | 13.11                              | 356.25                   | 1573.20         | 11136.25              | 11492.50        |
| Sx-5A       | 80                       | 4.90                           | <sup>2</sup>                   | 11.26 <sup>2</sup>                     | 16.16                              | 900.50                   | 1292.80         | 3649.50               | 4550.00         |
| <hr/>       |                          |                                |                                |                                        |                                    |                          |                 |                       |                 |
| TOTALS:     |                          |                                |                                |                                        |                                    |                          |                 |                       |                 |
| 8           | 750yd <sup>3</sup>       | Average \$4.90/yd <sup>3</sup> | Average \$5.24/yd <sup>3</sup> | Average \$4.58/yd <sup>3</sup>         | Average \$13.46/yd <sup>3</sup>    | \$3432.75                | \$10,095.50     | \$22,676.00           | \$26,108.75     |

<sup>1</sup> Transport to the site was by the loader between dump truck loads, working at the rock pit.

<sup>2</sup> Rock was transported directly to the crossing from the rock pit area using two bulldozers, thus, the Placement cost also includes the transport costs. Also the excavator bailed the rock several times just to get to the lower end of this long excavation.

<sup>3</sup> High placement cost because excavator bailed rock several times just to get it to the lower end of this long excavation.

Saving culverts also raises unit costs. If you do not worry about having a reusable culvert, you can have the D-8 remove it (usually demolishing it) and continue digging out fill. If one attempts to save culverts, the D-8 can only excavate to the top of the culvert. We saved most of our culverts; however in the future, I do not think we will bother.

The most expensive excavation, RX-13, involved removal of a large log jam/skid trail crossing immediately below the culvert in the C-30. This excavation was very muddy with steep slopes, which rendered the 1450 nearly useless for pushing fill away from the excavator. The D-8, which had the power to push the heavy wet fill out of the crossing, ran out of time on his purchase order (however, we were informed on the last day that it had been extended - too late). He was also worried he might get stuck in the muck, and by that time there were no cats left on the east side big enough to pull him out. For the first two days (of six total), the excavator sat approximately 50 percent of the time waiting for the 1450 to remove his fill. We finally decided to punch in a new road lower on the sideslope (total of three roads) and have the excavator bail his own dirt two to three times from one road up to the next, so the dozer would only be pushing along the level, upper road. This kept both pieces of equipment working. In addition, there were several old growth redwood rootwads in the log jam - one would have been impossible to remove without the D-8. As it was, he broke a mainline and choker (both 1 1/8 inch) in getting it out. The one stump cost \$400 in equipment time. If the D-8 had been available to work during the entire excavation, the work could have been done much more efficiently by using the two cats in a relay system. Costs could probably have been reduced by \$2 per cubic yard with a possible total savings of \$3000.

This clearly illustrates the problem of the end of the budget year coinciding with the tail end of the heavy equipment season and an unexpectedly difficult, large crossing. No more additions are allowed on purchase order, and all time remaining on existing purchase orders must be used (even if it costs the government more in the long run).

Rock placement cost for the eight rock channels averaged \$4.58 per cubic yard, ranging from \$1.48 to \$11.26 per cubic yard. A total of 750 cubic yards of rock was used. Quarrying cost was \$4.90 per cubic yard. Transportation of 570 cubic yards by dump trucks to the worksites averages \$5.24 per cubic yard. The loader delivered 100 cubic yards to a crossing adjacent to the rockpile, and the remaining 80 cubic yards was pushed from the W-Line rock pit to a nearby crossing by the bulldozers. Average rock placement cost was \$1.61 less per cubic yard than last year on Lower Slide Creek. This is partly due to Ellis Campbell's excellent rocking ability (he had more patience with rocks than Larry Lambert does), but mostly due to the fact that this years rocked crossings had adequate amounts of rock stockpiled in easily reachable locations. Last year we had to scrounge for it at several crossings.

#### Outsloped Roads (Table 13)

Roads were outsloped rather than drained for several reasons. Outsloping provides a permanent, maintenance-free product which restores runoff patterns across the road to a more natural configuration. Outsloping disperses flow; cross-road drains, while they break up flow, still collect and concentrate

TABLE 13.  
OUTSLOPING COSTS - cont.  
82-1

- <sup>1</sup>Training inexperienced excavator operator. Includes filling and shaping one gully (200' long, and 10' x 6') and rebuilding high visible prairie ridge dividing the Emerald and Dolason drainages. Eliminating this expensive road reach lowers the average outsloping cost of 1.42/LF.
- <sup>2</sup>Includes 300' long deck which was mildly sloped to drain.
- <sup>3</sup>Old growth below the road.
- <sup>4</sup>Mostly outsloped with fill from Rx-5. This does not include time and cost to bring fill to R-6 from Rx-5, only the short time spent shaping the pile. This cannot be compared to "real" outsloping costs.
- <sup>5</sup>Outslope edge of road cracked and settled 2-4 feet. Old growth below the road.
- <sup>6</sup>Filled gullied inboard ditch formed by diversion at Rx-9. Old growth below the road.
- <sup>7</sup>Sections of the road have failed in the past, including 100' in 1982 (listed on landslides table, R-11). Old growth below the road.
- <sup>8</sup>Road failed in two locations; one section was cracked.
- <sup>9</sup>Includes construction of spring drain to Rx-13.
- <sup>10</sup>Experimental outsloping by D-8. Area was later additionally outsloped with fill from Rx-10. Included for comparison purposes alone; not included in this table's totals. Total cost of RX-10 is included in landing table.

TABLE 13.  
OUTSLOPING COSTS  
82-1

| Site Number   | Equipment             | Hours               | Cost                       | Site Cost   | Length | Average Finished Width | Degree of Outslope | Cost/LF | Remarks:                        | Percent done by Bulldozers. |
|---------------|-----------------------|---------------------|----------------------------|-------------|--------|------------------------|--------------------|---------|---------------------------------|-----------------------------|
| R-1 (prairie) | Excavator 1450        | 21 1/2<br>24 1/2    | \$1505.00<br>1837.50       | \$3342.50   | 400'   | 153'                   | complete           | \$8.36  | 1                               |                             |
| R-1 (woods)   | Excavator 1450<br>D-8 | 10<br>7 1/2<br>5    | 700.00<br>562.50<br>495.00 | 1757.50     | 1140'  | 88'                    | slight             | 1.54    | 56% done by bulldozers.         | 2                           |
| R-2           | 1450<br>D-8           | 4 1/2<br>5          | 337.50<br>495.00           | 832.50      | 559'   | 69'                    | moderate           | 1.49    | 100% done by bulldozers.        | 3                           |
| R-6           | 1450<br>D-8           | 2 1/2<br>1/2        | 187.50<br>49.50            | 237.00      | 424'   | 67'                    | complete           | .56     | 100% done by bulldozers.        | 4                           |
| R-8           | Excavator 1450        | 10<br>9 1/2         | 850.00<br>712.50           | 1562.50     | 767'   | 72'                    | moderate           | 2.04    | 49% done by bulldozers.         | 5                           |
| R-9           | Excavator 1450        | 5<br>1              | 425.00<br>75.00            | 500.00      | 240'   | 50'                    | moderate           | 2.08    | 17% done by bulldozers.         | 6                           |
| R-11          | Excavator 1450<br>D-8 | 7 1/2<br>4 1/2<br>1 | 637.50<br>318.75<br>85.00  | 1041.25     | 1000'  | 62'                    | moderate           | 1.04    | 42% done by bulldozers.         | 7                           |
| R-12          | D-8                   | 8                   | 680.00                     | 680.00      | 600'   | 51'                    | slight to moderate | 1.13    | 100% done by bulldozers.        | 8                           |
| R-15          | Excavator 1450        | 1 1/2<br>4 1/2      | 127.50<br>337.50           | 465.00      | 265'   | 45'                    | slight             | 1.75    | 75% done by bulldozers.         | 9                           |
| R-10(part)    | D-8                   | 3 1/2               | 346.50                     | 346.50      | 350'   | 50' slight to moderate |                    | .99     | 10                              |                             |
| TOTALS:       |                       |                     |                            |             |        |                        |                    |         | average:                        |                             |
| 9             |                       |                     |                            | \$10,418.25 | 5395'  |                        |                    |         | \$1.93/Linear Foot <sup>1</sup> | 37                          |

Footnotes on the following page.

runoff onto places where runoff may not have been naturally concentrated. Much of the C-30 has old growth below the road. Several sections of road had failed, causing loss of old growth trees, and adding sediment to the streams. Other areas showed tension cracks or had settled, indicating that they may fail in the future.

A little over a mile of road was moderately outsloped at an average cost of \$1.93 per linear foot. Cost ranged from \$.56 to \$8.36 per linear foot. The most expensive outsloping consisted of completely rebuilding the prairie divide between Dolason and Emerald Creeks, and was done by the inexperienced excavator operator. Eliminating this one road reach gives an average cost of \$1.42 per linear foot for the remainder of the site. Road width averaged between 20 and 5 feet, with a finished outsloping width between 45 and 88 feet (prairie ridge was 153 feet wide).

These costs were similar to last years cost for slight outsloping in the woods. However, last year's overall average for outsloping in the woods was \$1.95. The technique used was similar for the most part. The excavator preceded the cat pulling up the sidecast with the cat shaping the fill. Sidecasting was not allowed except in one or two locations. Some of the cheapest moderate outsloping was done by the D-8 alone, for \$.99 per linear foot (this was a 350 foot long section of R-10). This was an ideal place for D-8 outsloping. He was able to back off the road and push straight up towards the cutbank. No "quartering" was necessary, and there were no stumps to avoid.

In the Emerald Creek rock pit we were able to compare outsloping (pulling back the edge) using the D-8 along with the excavator/1450 combination. Conditions were virtually identical. The D-8 did about 150 feet in approximately two hours, at a cost of \$170 (\$1.14 per linear foot); it took the excavator and 1450, 4 1/2 hours and 3 1/2 hours respectively, to do a similar length at a cost of \$645 (\$4.30 per linear foot).

In areas that are not congested with trees or stumps, and where a slight amount of spillage over the side is not a problem, a large, powerful cat can outslope at least as efficiently as the excavator/1450 combination. However, the excavator is necessary around trees and where sidecasting is not desirable.

#### Landings (Table 14)

Five landings or decks were treated on Unit 82-1, with an average cost of \$3.38 per linear foot. Cost ranged from \$2.47 to \$7.04 per linear foot. Width of the treated area ranged from 80 to 121 feet.

The most expensive deck per linear foot to treat (R-7 at \$7.04 per linear foot) was one which had failed debris torrent style into a large creek (25-year discharge of 75 cfs) causing a 20 to 30 foot high log jam. Severe bank erosion is occurring upstream of the log jam. Other portions of the deck looked as if they could fail imminently. Two days with an excavator and cat were spent here pulling back 475 feet of deck edge. The edge of the deck was lowered by a minimum of 10 feet.

TABLE 14.  
LANDING TREATMENT COSTS

| Site Number | Equipment                                          | Hours                     | Cost                                             | Site Cost            | 82-1<br>Linear Feet | Average Width | Cost/<br>Linear ft. | Remarks                                                                                                                                                                                        |
|-------------|----------------------------------------------------|---------------------------|--------------------------------------------------|----------------------|---------------------|---------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R-7         | Excavator<br>1450<br>D-8                           | 20<br>20½<br>½            | \$1700.00<br>1593.75<br>49.50                    | \$3343.25            | 475                 | 89            | \$7.04              | Part of deck edge had failed into stream ('74). Remainder of deck edge pulled back--many cracks, lots of slash.                                                                                |
| R-10        | Excavator<br>1450<br>D-8<br>D-8<br>Dump Trucks (2) | 15½<br>16½<br>4<br>4<br>8 | 1317.50<br>1218.75<br>396.00<br>340.00<br>276.00 | 3548.25 <sup>1</sup> | 988                 | 88            | 3.59 <sup>1</sup>   | Part of deck edge had slide into Emerald Creek. Road directly above Em.Cr. had numerous cracks. Edge of deck pulled back; 300' of the road was endhailed.                                      |
| R-3         | Excavator<br>Excavator<br>1450<br>D-8              | 10<br>3<br>5<br>6½        | 850.00<br>210.00<br>375.00<br>643.50             | 2078.50              | 580                 | 96            | 3.58                | Edge of deck directly above stream (Rx-3) had been loaded by logging and mobile mill debris thrown over the side. This was pulled back and entire deck mildly outsloped.                       |
| R-4         | Excavator<br>1450<br>D-8                           | 17<br>10½<br>32           | 1445.00<br>787.50<br>3168.00                     | 5400.50              | 2073                | 80            | 2.61                | Includes two decks where rock had been stockpiled. Ground was severely compacted with numerous small ponds. Area was mildly outsloped to improve drainage in headwaters of several tributaries |
| R-14        | Excavator<br>1450<br>D-8                           | 5 ¾<br>8 ½<br>1           | 488.75<br>637.50<br>85.00                        | 1211.25              | 491                 | 121           | 2.47                | Edge of deck perched over stream (Rx-12); portions had dropped 1-2'; numerous cracks.                                                                                                          |

TOTALS:

5

\$15,581.75

4607 ft.

80-121'  
width  
range

\$3.38/LF

<sup>1</sup>Includes 350' of normal width road, slight to moderate outsloped by the D-8 alone for .99/LF (3 1/2 hours). If this is excluded from R-10, site cost becomes \$3,201.75, length 638', cost/LF \$5.02.

Other decks did not show such extreme erosion potential, and treatments were less extensive and cheaper ranging from \$2.47 to \$3.59 per linear foot. Treatment involved pulling back the outside edges of the decks with the excavator, particularly where perched above streams, and leaving the deck mildly outsloped to improve drainage. Portions of two of the decks had failed into streams in the past and showed tension cracks along the remaining edges. One deck had a large amount of organic debris (from the park's mobile mill crew) perched above a stream. The final area involved two decks and had been used to stockpile quarried rock. It was severely compacted and disrupted runoff in the headwaters of several drainages (the outside edge of an untreated portion of this deck has dropped five to seven feet already this winter).

#### Landslides (Table 16)

Two active landslides were treated on Unit 82-1. One slide area was quite small, involving approximately 100 feet of road. It was bowling over old growth trees below the road but not directly impacting a channel. The road prism was completely removed by the excavator and bulldozer for a total cost of \$807.50. The remaining \$7,295 was spent on a large fill failure which was feeding sediment and old growth trees directly into a stream. Approximately 1,300 cubic yards were removed from the slide at a cost of \$5.55 per cubic yard. Original ground is not exposed over much of the area. The majority of work here was done by the bulldozers. The D-8 was responsible for much of the steep uphill pushing; both the D-6 and 1450 pushed to fill to a stable locations. A factor which drove the cost up here was the long push distance (approximately 400 feet) to a stable fill site. However, the alternative of end hauling would probably have yielded a similar, if not more expensive, unit cost. It also would have been difficult to keep a road open for trucks across the narrow headscarp area.

#### Rock Pits (Table 17)

Two highly visible rock pits were shaped to more natural contours. Treatment of the W-Line rock pit (1.8 acres) cost \$3,123.50. The majority of this work was done by the D-8. All of the massive boulders which had been left around the edges and in the middle of the rock pit were pushed up against the rock face. Sidecast dirt was then pushed up and over the rock, outsloping the rock pit and uncovering several buried stumps. Much more dirt was recovered than we thought possible. Someday it will revegetate!

The smaller rock pit (.8 acre) above Emerald Creek was moderately outsloped for \$1,197.50. This rock pit consisted of well-fractured sandstone and shale, so it was easier pushing. However, the steep slopes below prohibited the cat from recovering as much dirt as at the W-Line rock pit. Part of the edge was pulled up by the excavator (see comments under outsloping).

#### Overall Heavy Equipment Evaluation

An experienced, highly skilled operator is one of the most important factors in achieving lower unit costs. On Unit 82-1, this is evident in the extremely high unit costs of tasks attempted by the original excavator operator, Steve LaRaut. In spite of the fact that he had a high quality excavator, he was unable to operate it. He might as well have had a toy backhoe! The same

TABLE 16.  
LANDSLIDE TREATMENT COSTS  
82-1

| Location/<br>Site<br>Number | Equipment | Hours  | Cost      | Total<br>Cost | Size               | Volume<br>Removed    | Unit<br>Cost |
|-----------------------------|-----------|--------|-----------|---------------|--------------------|----------------------|--------------|
| R-13<br>(all)               | Excavator | 17 3/4 | \$1508.75 | \$7295.00     | length             | 1314 yd <sup>3</sup> | \$13.64/LF   |
|                             | 1450      | 31 1/4 | 2343.75   |               | 535'               |                      |              |
|                             | D-8       | 40 1/2 | 3442.50   |               | 1.8 acres          |                      |              |
| R-11<br>(part)              | Excavator | 4 1/2  | 382.50    | 807.50        | length             | *                    | 8.08/LF      |
|                             | D-8       | 5      | 425.00    |               | 100'               |                      |              |
| TOTALS:                     |           |        |           | \$8,102.50    | 635 linear<br>feet | ---                  | \$12.76/LF   |
| 2                           |           |        |           |               |                    |                      |              |

\*complete outslope, pushing road prism off slump area.

TABLE 17.  
ROCK PIT TREATMENT COSTS  
82-1

| Site<br>Number | Equipment | Hours  | Cost      | Total<br>Cost | Area      | Cost/<br>Acre | Remarks                  |
|----------------|-----------|--------|-----------|---------------|-----------|---------------|--------------------------|
| R-5<br>(all)   | Excavator | 2      | \$ 170.00 | \$3123.50     | 1.8 acres | \$1735        | W-Line<br>Rock Pit       |
|                | 1450      | 11     | 825.00    |               |           |               |                          |
|                | D-8       | 21 1/2 | 2128.50   |               |           |               |                          |
| R-12<br>(pit)  | Excavator | 4 1/2  | 382.50    | 1197.50       | .8 acres  | 1497          | Emerald Ck.<br>shale pit |
|                | 1450      | 3 1/2  | 262.50    |               |           |               |                          |
|                | D-8       | 14 1/2 | 552.50    |               |           |               |                          |
| TOTALS:        |           |        |           | \$4,321.00    | 2.6 Acres | \$1662/acre   |                          |
| 2              |           |        |           |               |           |               |                          |

excavator with a skilled operator, Ellis Campbell, performed excellently. An experienced operator knows how to efficiently perform the necessary work, and will know the capabilities of his equipment. Those experienced in rehabilitation work are even more efficient. They have a much better idea of the desired end product, and a significant amount of time can be saved because of their knowledge of what worked well on previous excavations.

I am not sure if there is a significant difference between a John Deere 690B (used on 81-2 and 80-5) and a Case 980 excavator. Both can do the job. The Case 980, having a larger bucket requires a larger, more powerful dozer to keep up with the dirt. Hourly rental rates are higher but more dirt is moved per hour as well.

The Case 1450 dozer seems best paired with the John Deere 690B excavator. With the Case 980 excavator the 1450 was commonly working full blast to keep up. The 1450 is the smallest dozer that should work with the 980 excavator. A larger, more powerful cat would have been good in many instances; it might have had time to do more actual excavating instead of just keeping up with the excavator. However, the Case 1450 also had advantages over the D-8. It could work effectively in much wetter conditions than the D-8. In many places the D-8 was unable to work without getting stuck in the muck, whereas the 1450 just breezed through. In other places the 1450 did not have the power necessary to push up a steep hill with heavy wet fill, and the D-8 was the only thing (on site) that could get the muck out of the hole. The two made a good combination, however, more time should have been allotted for the D-8 and less time for the 1450.

The choice of a dozer definitely depends on the site conditions. If a lot of wet ground is anticipated, a lightweight dozer such as the Case 1450 is very useful. If large quantities of dirt have to be pushed a long ways, a D-8 (or two) is necessary (if you do not want the excavator sleeping half the day). The 1450 works well with the Case excavator on the smaller (<1000 cubic yards) crossings, probably because the push distance will be relatively short, and they can keep up with each other.

The choice of the relative proportion of excavator and bulldozer time on a rehabilitation unit will be the result of a careful weighing of the crossing sizes and expected amount of outsloping. However, I think that overall, more time should be spent with large, powerful cat on each crossing with it doing the majority of the excavation. Large, powerful dozers definitely move more dirt quicker than anything else. The only limiting factor for cats would be if the natural sideslopes are steeper than they can push up. Steep, narrow crossings are still excavator/dozer combination work.

If the fill site is a considerable distance from the crossings or if the crossing is deep and steep with the excavator working on the actual channel bottom, a two-dozers relay systems works well. One dozer pushes dirt up out of the hole, the other pushes it to the fill site. Dirt can be most effectively pushed a long distance if a thru-cut or push path is constructed with the fill as the excavation proceeds. This prevents dirt from spilling out around the blade. Care must be taken not to cut into original ground if it appears unstable.

A factor which can raise unit costs is attempting to save young vegetation or stumps. Often work can proceed much more efficiently if more bare ground is allowed. In the long run, it seems that the small amount of vegetation we have worked around in the past (which often dies anyway) does not contribute significantly to the revegetation of the site (the Vegies may wish to comment on this). Stumps should be avoided and left in place if they are adding stability to an area; i.e., their roots are forming base levels in a stream. I wonder, however, if some of the stumps we have left on streambanks will rot and fall into the channel causing problems in the future.

Our excavation costs were high in several cases because our crossings were consistently bigger and deeper than we expected. In two of the crossings we kept finding more and more logs the deeper we went. Our total costs at some crossings were higher than expected because in the pre-excavation volume estimates we neglected to include the finished channel width in the calculations. If we had brushed a much larger area at each crossing, we would have had a much better idea of the actual extent of the fill (but we were trying to preserve vegetation at that point). If we had better known the extent of excavation, the D-8 could have done more preliminary work, dishing out the crossing and laying back the sides. This would have expedited the remaining work.

In summary, I feel our heavy equipment work proceeded fairly efficiently. There was definitely room for improvement, however. The most important thing we learned was that D-8s can be extremely efficient dirt movers in both excavating and outsliping. An experienced, skilled and motivated operator is essential for all pieces of equipment. In the future I am sure there will be an increase in the use of large, powerful bulldozers on rehabilitation sites and I hope that "inexperienced", inefficient operators will continued to be weeded out!

### Labor Intensive Phase

#### Labor Intensive Application

Labor intensive work was completed by Redwood National Park laborers, Redwoods United, Inc. employees, and a C.E.T.A. and Y.C.C. crew. Redwoods United, C.E.T.A. and Y.C.C. were used entirely for mulch application. Redwood National Park laborers did a variety of tasks, though again the main treatment work was mulch distribution and application. Other secondary treatments included minor channel armoring adjustments, brushing stream channel crossings, travel between Orick and the site, job preparation, maintaining daily task worksheets, and other miscellaneous assignments.

#### Labor Intensive Costs

The distribution and application of straw mulch was the single largest cost (81 percent) of the labor intensive phase (Table 17). The total straw mulch cost was \$14,166.91. This includes the purchase and delivery cost for 1600 bales (\$4,400), the use of heavy equipment for distribution, and walking-in the straw on a short section of prairie road (\$881), and all labor intensive distribution and application costs (\$8,885.91). The area mulched totals 25.6 acres; unit cost was \$553.39/acre or \$8.85/bale (Table 18). Straw application rate averaged 3,750<sup>0</sup>/per acre.

TABLE 17.  
LABOR INTENSIVE COSTS  
82-1

|                                               | Work Types                    | Type of Laborers     | Person Hours | Cost         | Total Cost | Quantity   | Cost/Quantity | % of Total Cost | Remarks                                                                                                        |                          |
|-----------------------------------------------|-------------------------------|----------------------|--------------|--------------|------------|------------|---------------|-----------------|----------------------------------------------------------------------------------------------------------------|--------------------------|
| SECONDARY TREATMENT                           | Material Distribution (straw) | RNP                  | 193          | \$1590.04    | \$2086.23  | 1600 bales | \$1.30/bale   | 19%             | Includes moving straw with the park boom truck, a dump truck, and unloading the 18-wheel straw delivery truck. |                          |
|                                               |                               | RUI                  | 42           | 496.19       |            |            |               |                 |                                                                                                                |                          |
|                                               | Mulch Application (straw)     | RNP                  | 269½         | 2175.21      | 6799.68    | 1600 bales | 4.25/bale     | 62%             |                                                                                                                |                          |
|                                               |                               | RUI                  | 391½         | 4624.47      |            |            |               |                 |                                                                                                                |                          |
|                                               |                               | CETA                 | 42           | ---          |            |            |               |                 |                                                                                                                |                          |
|                                               |                               | YCC                  | 22½          | ---          |            |            |               |                 |                                                                                                                |                          |
|                                               | Rocking                       | RNP                  | 15           | 120.52       | 120.52     | 4 channels | 30.13/channel | 1%              |                                                                                                                |                          |
|                                               | TOTAL SECONDARY TREATMENT:    |                      |              | = \$9,006.43 |            | 82%        |               |                 |                                                                                                                |                          |
|                                               | MISCELLANEOUS                 | Travel and Job Prep. | RNP          | 145½         | 1176.35    | 1176.35    | ---           | ---             | 11%                                                                                                            |                          |
|                                               |                               | Brushing             | RNP          | 29           | 233.44     | 233.44     | 3 crossings   | 77.81/xing      | 2%                                                                                                             | Brushing road crossings. |
| Standby                                       |                               | RNP                  | 20           | 161.54       | 161.54     | ---        | ---           | 1%              |                                                                                                                |                          |
| Miscellaneous                                 |                               | RNP                  | 48½          | 392.07       | 392.07     | ---        | ---           | 4%              | Includes tasks such as changing flat tires, tool maintenance, safety meetings, and assisting archeologist.     |                          |
| TOTAL MISCELLANEOUS TREATMENT:                |                               |                      | = \$1,963.40 |              | 18%        |            |               |                 |                                                                                                                |                          |
| GRAND TOTAL LABOR INTENSIVE COST: \$10,969.83 |                               |                      |              |              |            |            |               |                 |                                                                                                                |                          |

TABLE 18.  
STRAW MULCH COSTS  
82-1

46

|                                                                    |                 |                    |
|--------------------------------------------------------------------|-----------------|--------------------|
| I. Purchase and delivery cost for 1600 Bales @ \$2.75/bale:        |                 | \$4,400.00         |
| II. Heavy equipment straw distribution cost:                       |                 |                    |
| A. Moving straw using a D-8 and 1450 bulldozers, and excavator;    | \$ 768.50       |                    |
| B. Walking in straw with the 1450 bulldozer on R-1;                | <u>112.50</u>   | 881.00             |
| III. Labor Intensive Costs:                                        |                 |                    |
| A. Distribution (using dump trucks, boom trucks, all labor costs); | 2,086.23        |                    |
| B. Application(RNP, RUI, CETA, YCC);                               | <u>6,799.68</u> | <u>8,885.91</u>    |
|                                                                    | TOTAL COST =    | <u>\$14,166.91</u> |

|                                    |                |
|------------------------------------|----------------|
| UNIT COSTS: Total Bales Used 1600  | \$8.85/bale    |
| Total Mulched Disturbed Acres 25.6 | \$553.39/acre  |
| Average applicate rate:            | 3,750 lbs/acre |

The second highest labor intensive cost was the category of travel time and job preparation (11 percent). Travel time between Orick and C-30/W-Line averaged 1 to 1 1/2 hours round-trip daily. Job preparation included acquiring equipment needed each day and keeping accurate daily records of work performed. Miscellaneous tasks (4 percent) included safety meetings, tool maintenance, changing many flat tires, dealing with truck (van) problems, and assisting the park archaeologists comb the hillside for artifacts.

All other tasks were a small percentage of this years labor intensive costs. Labor intensive channel rocking was one percent of the total labor intensive costs, and consisted of minor rock adjustments in crossings which were rocked by heavy equipment but needed flow course definition. Brushing stream channel crossings (2 percent) was performed on a few large crossings to help facilitate photo point documentation and volume surveys. Some brushing was also done in the spring; time for this work was not recorded but involved approximately 16 person-days.

#### Evaluation of the Labor Intensive Application

The main labor intensive treatment on the C-30 unit was the distribution of straw mulch on treated haul roads and stream crossings. This year a new technique was instituted for the distribution of straw. Instead of placing one bale above the cutbank every 10-25 feet (which is the most widely used technique), the bales were placed in pre-calculated quantities (stockpiles) at flagged locations on the site for later distribution by the heavy equipment. This method greatly reduces the labor cost and only .9 percent of our total heavy equipment cost went towards distributing straw.

This mulch distribution method is simple to plan and institute. The first step is to estimate the disturbed acreage for each road reach (linear feet by estimated finished width, eg. 250' x 75') and stream crossing (between .15-.50 acres depending upon volume). Depending upon the desired mulch application rate (lbs/acre, eg. 3000 lbs/acre) for each individual site location, the number of bales required is calculated using a 60 lb per bale average. The next step is to locate and flag sites in the field that have the capacity for the desired number of bales, such as landings, pull-outs, and outboard edges of the roads (on long road reaches >500 feet, it is best to split the stockpile into several locations). The laborers can then deliver straw quickly and efficiently. If stockpiles are planned for 50-60 bales each, the boom truck can simply dump an entire load of bales on the flagged location and no further moving of bales by hand is required. Efficiency is maximized when the number of bales in a stockpile is a multiple of the bale capacity of whatever truck is used. Dumping trucks are obviously preferable.

During the heavy equipment phase, the bales are distributed along finished areas usually by the bulldozers. Once a road reach is outloped to the desired completeness and to within a close distance (eg. 50') of a straw stockpile, the bulldozer distributes the straw either by pushing or carrying the bales (stacked behind the blade) along the road reach. As the bales are being pushed in front of the cat's blade, they will spill out on either side, thus being spaced for immediate application by the laborers. If a bale breaks open, it becomes partially spread by the bulldozer.

This mulch distribution method seems to be more efficient and cost effective, though we were unable to compare costs to our 1980 and 1981 sites because of the varying conditions and locations straw was distributed. All those involved agreed this was the best method used so far in the evolution of the rehabilitation program.

All in all, we were very pleased with this years labor intensive work performed and cost effectiveness. Jinkie Boyce and Gary Dasher were in charge of the actual organization and supervision of all labor intensive work on our site. Once the project goals were established and prioritized, we left it up to them to schedule their work and make arrangements for additional help when needed (other RNP workers, Redwoods United, CETA and YCC). They made sure that all materials were in place before the heavy equipment arrived at a given site, and that strawing was completed almost as soon as the equipment left. Jinkie kept accurate daily task sheets which greatly helped our record-keeping and final analysis of the work performed. We would like to thank all the laborers who worked on our site this year for a job well done.

APPENDIX TABLE 1: COMPLETE INVENTORY OF SKID TRAIL CROSSINGS, EREKALA CREEK

YEAR: 19XX AREA: XXX acres

DATION:

152

| Extra variable | Eroded   |
|----------------|----------|
| Volume 1       | Volume 2 |

| Fill Erosion | Expected <sup>3</sup> |
|--------------|-----------------------|
| 1            | 1                     |
| 2            | 2                     |
| 3            | 3                     |
| 4            | 4                     |
| 5            | 5                     |
| 6            | 6                     |
| 7            | 7                     |
| 8            | 8                     |
| 9            | 9                     |
| 10           | 10                    |
| 11           | 11                    |
| 12           | 12                    |
| 13           | 13                    |
| 14           | 14                    |
| 15           | 15                    |
| 16           | 16                    |
| 17           | 17                    |
| 18           | 18                    |
| 19           | 19                    |
| 20           | 20                    |
| 21           | 21                    |
| 22           | 22                    |
| 23           | 23                    |
| 24           | 24                    |
| 25           | 25                    |
| 26           | 26                    |
| 27           | 27                    |
| 28           | 28                    |
| 29           | 29                    |
| 30           | 30                    |
| 31           | 31                    |
| 32           | 32                    |
| 33           | 33                    |
| 34           | 34                    |
| 35           | 35                    |
| 36           | 36                    |
| 37           | 37                    |
| 38           | 38                    |
| 39           | 39                    |
| 40           | 40                    |
| 41           | 41                    |
| 42           | 42                    |
| 43           | 43                    |
| 44           | 44                    |
| 45           | 45                    |
| 46           | 46                    |
| 47           | 47                    |
| 48           | 48                    |
| 49           | 49                    |
| 50           | 50                    |
| 51           | 51                    |
| 52           | 52                    |
| 53           | 53                    |
| 54           | 54                    |
| 55           | 55                    |
| 56           | 56                    |
| 57           | 57                    |
| 58           | 58                    |
| 59           | 59                    |
| 60           | 60                    |
| 61           | 61                    |
| 62           | 62                    |
| 63           | 63                    |
| 64           | 64                    |
| 65           | 65                    |
| 66           | 66                    |
| 67           | 67                    |
| 68           | 68                    |
| 69           | 69                    |
| 70           | 70                    |
| 71           | 71                    |
| 72           | 72                    |
| 73           | 73                    |
| 74           | 74                    |
| 75           | 75                    |
| 76           | 76                    |
| 77           | 77                    |
| 78           | 78                    |
| 79           | 79                    |
| 80           | 80                    |
| 81           | 81                    |
| 82           | 82                    |
| 83           | 83                    |
| 84           | 84                    |
| 85           | 85                    |
| 86           | 86                    |
| 87           | 87                    |
| 88           | 88                    |
| 89           | 89                    |
| 90           | 90                    |
| 91           | 91                    |
| 92           | 92                    |
| 93           | 93                    |
| 94           | 94                    |
| 95           | 95                    |
| 96           | 96                    |
| 97           | 97                    |
| 98           | 98                    |
| 99           | 99                    |
| 100          | 100                   |

Diversion  
Potential<sup>4</sup>

version  
rosion  
expected's

| 15 year term flow |
|-------------------|
|-------------------|

|           |  |
|-----------|--|
| stability |  |
|-----------|--|

REMARKS

Footnotes

- ~~Estimated~~ Volume that would be excavated, estimated in the field. In general these estimates are lower than what is actually removed (surveyed) by rehab.
2. Volume estimated in field, often not measured.
  3. Estimated volume of fill that will erode before crossing stabilizers
  4. Probability of flow diverting out of natural channels
  5. Estimated volume of original ground that will erode if diversion occurs.

year: Pre - 1962 Acres: Undetermined, select cuts

Location: Elk Camp Prairie and Lane's Ranch

8-1

| SITE<br>Number                                                    | Excavatable<br>Volume <sup>1</sup> | Eroded<br>Volume <sup>2</sup>                      | Fill erosion<br>expected <sup>3</sup> | Diversion<br>Potential <sup>4</sup>     | Diversion<br>Erosion<br>Expected <sup>5</sup><br>or<br>Existing | 25 yr<br>storm flow                                                                                         | Stability        | REMARKS                                                                                                                                                                |
|-------------------------------------------------------------------|------------------------------------|----------------------------------------------------|---------------------------------------|-----------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 Xings<br>on ranch<br>and at<br>base of<br>Elk Camp<br>Prairie. | all < 25 cy                        | 10-25%<br>except<br>SX-11A = 10cy<br>SX-21A = 10cy | 1-5 cy each                           | Low,<br>except:<br>diverted<br>diverted | Rills,<br>except<br>10cy *<br>10cy **                           | Not calculated<br>but similar<br>to values<br>calculated<br>for W-Line<br>(see culvert<br>capacities table) | Fairly<br>stable | These are all small<br>fords. The road<br>itself has numerous<br>cut bank springs.<br>Flow from these and<br>other springs are<br>causing CB failures<br>on the W-Line |
| SX-11A                                                            | 75 cy                              | 2 cy                                               | 10cy                                  | Mod.                                    | 20cy                                                            | 6 cfs                                                                                                       | stable           | *causing small prairie gully -- active<br>**causing small prairie gully and cut bank failures on W-Line --- active.                                                    |
| Pre 62 - Ranch Area:                                              |                                    |                                                    |                                       |                                         |                                                                 |                                                                                                             |                  |                                                                                                                                                                        |
| SX-13B                                                            | } < 25cy                           | < 2cy                                              | < 5cy                                 | Low                                     | —                                                               |                                                                                                             | v. stable        | small fords                                                                                                                                                            |
| SX-13C                                                            |                                    |                                                    |                                       |                                         |                                                                 |                                                                                                             |                  |                                                                                                                                                                        |
| SX-13D                                                            | 30cy                               | 5cy                                                | 10cy                                  | Low                                     | —                                                               |                                                                                                             | v. stable        | mostly logs, subsurf. flow                                                                                                                                             |
| SX-13E<br>(built in '66)                                          | 400cy                              | —                                                  | 200cy                                 | Low                                     | —                                                               |                                                                                                             | stable →         | culvert maintenance necessary                                                                                                                                          |
| SX-13F                                                            | 200cy                              | rills.                                             | rills                                 | Low                                     | —                                                               |                                                                                                             | stable →         | culvert maintenance necessary                                                                                                                                          |
| Merced Lake                                                       | 300cy                              | —                                                  | 100cy                                 | Mod.                                    | could<br>gully prairie                                          |                                                                                                             | stable →         | culvert maintenance necessary                                                                                                                                          |

Pre-1962 Area: Below K&K, adjacent to Dobson Prairie - 29 acre tractor clear cut  
 Above K&K, below Bald Hills Road - 44.3 acre tractor clear cut 82-1

| SITE Number                           | Excavatable Volume <sup>1</sup> | Volume eroded <sup>2</sup> | Future erosion <sup>3</sup> | Diversion Potential <sup>4</sup> | Diversion Gro section <sup>5</sup> | 25 y Runoff                           | stability | REMARKS                                                             |
|---------------------------------------|---------------------------------|----------------------------|-----------------------------|----------------------------------|------------------------------------|---------------------------------------|-----------|---------------------------------------------------------------------|
| SX-5D                                 | 150cy                           | 2cy                        | 5cy                         | Low                              | —                                  | 25cfs                                 | v.stable  | Humboldt - surface flow                                             |
| SX-4C                                 | 50cy                            | Ø                          | minimal                     | Low                              | —                                  | 6cfs                                  | v.stable  | Humboldt - surface flow                                             |
| 5 possible SXs (air photo interp TPC) | small                           | unknown                    | minimal                     | ?                                | —                                  | 3 → <6cfs<br>1 → <2cfs<br>1 → ~2.5cfs | stable*   | *assume stable from degree of revegetation & position high on slope |
| SX-10I                                | 100cy                           | 37cy                       | minimal                     | Low                              | —                                  | 2cfs                                  | v.stable  | Humboldt.                                                           |
| Totals                                | 300cy                           | 39cy                       | 5cy                         |                                  | 0cy                                |                                       |           |                                                                     |

1965 Area: Below K.K., adjacent to Elk Camp Prairie - tractor, select 82-1  
46.2 acres

| SITE Number        | Exrav. Volume <sup>1</sup> | Volume Eroded <sup>2</sup> | future erosion <sup>3</sup> | Diver <sup>4</sup> Pot | Diversion Eros <sup>5</sup> | 25yr Runoff | Stability                     | REMARKS                                                  |
|--------------------|----------------------------|----------------------------|-----------------------------|------------------------|-----------------------------|-------------|-------------------------------|----------------------------------------------------------|
| SX-11D             | 150cy<br>(seems low)       | minimal                    | 50cy                        | Low                    | —                           | 14 cfs      | mod. to unstable <sup>2</sup> | Hum - surface flow<br>+ subsurface flow<br>Re-used in 77 |
| 2 SXs<br>below 11D | 10cy<br>10cy               | <20cy                      | minimal                     | no                     | —                           | 14 cfs      | v. stable                     | washed out hum. logs<br>only. AOK.                       |
| Totals             | 170cy                      | 20cy                       | 50cy                        |                        |                             |             |                               |                                                          |

| 1969 Area: below K&K, "Z" Deck Tractor-long line - clear cut - 6 acres 82-1 |                           |                          |                             |                        |                         |              |              |                                 |
|-----------------------------------------------------------------------------|---------------------------|--------------------------|-----------------------------|------------------------|-------------------------|--------------|--------------|---------------------------------|
| Site Number                                                                 | Excau Volume <sup>1</sup> | Vol. Eroded <sup>2</sup> | Future Erosion <sup>3</sup> | Diver Pot <sup>4</sup> | Diver Eras <sup>5</sup> | 25 yr Runoff | Stability    | REMARKS                         |
| SX 10C                                                                      | 150                       | 37                       | 25                          | no                     | —                       | 18cfs        | v. stable    | Blown out humboldt              |
| SX 10E                                                                      | 148                       | 41                       | 75                          | yes                    | 75cy                    | 16cfs        | temp stable  | surface flow Hum.               |
| SX 10G                                                                      | 150                       | minimal                  | minimal                     | no                     | —                       | 12cfs        | v. stable    | low gradient channel. Humboldt  |
| SX 10D                                                                      | 150                       | 10                       | 75                          | no                     | —                       | 16cfs        | v. stable    | surface flow, rocky fill        |
| SX 10F                                                                      | 218                       | 76                       | 150                         | no                     | —                       | 15cfs        | unstable     | subsurf. flow, cracks           |
| SX 10H                                                                      | 280                       | 42                       | 175                         | no                     | —                       | 13cfs        | temp. stable | subsurf. flow, gully across top |
| SX 9B                                                                       | 150                       | 50                       | minimal                     | no                     | —                       | 17cfs        | v. stable    | logs only, surf. flow           |
| SX 9C                                                                       | 308                       | minimal                  | 150                         | yes                    | 75                      | 9cfs         | temp         | subsurf. flow, cracks           |
| SX 8A                                                                       | 412                       | 5                        | 70                          | no                     | —                       | 16cfs        | temp         | subsurf. flow                   |
| SX 8B                                                                       | 278                       | 83                       | 50?                         | no                     | —                       | 11cfs        | temp         | surface                         |
| SX 8C                                                                       | 620                       | 67                       | 60?                         | no                     | —                       | 8cfs         | temp         | surface                         |
| SX 8D                                                                       | 250                       | 1                        | 50?                         | no                     | —                       | 6cfs         | temp         | subsurf.                        |

1969 to 11 cont

82-1

| SITE Number | Excav Vol.         | Eroded Vol. <sup>2</sup> | future <sup>3</sup> eros | Diver <sup>4</sup> Pot | Diver <sup>5</sup> eros | 25 yr runoff | stability | REMARKS                                                  |
|-------------|--------------------|--------------------------|--------------------------|------------------------|-------------------------|--------------|-----------|----------------------------------------------------------|
| SX-5E       | 100                | 2                        | minimal                  | no                     | —                       | 10 cfs       | v. stable | low grad. stream, rocky fill + logs surface flow, weaged |
| SX-5F       | 311                | 14                       | diverts                  | yes                    | 180                     | 7 cfs        | temp      | surface flow                                             |
| SX-5G       | 126                | minimal                  | 45                       | no                     | —                       | 5 cfs        | stable    | subsurf. flow                                            |
| Totals      | 3651 <sup>cy</sup> | 1255 <sup>cy</sup>       | 925 <sup>cy</sup>        |                        | 330 <sup>cy</sup>       |              |           |                                                          |

1972

Area: Above & below C-30, West of Emerald Cr.  
 Tractor clear cut 47.7 acres  
 select cut 7.8 acres } 55.5 ac.

82-

| SITE Number                                             | Excav Vol. <sup>1</sup> | Eroded Vol <sup>2</sup> | future eros <sup>3</sup> | Diver Pot <sup>4</sup> | Diver Eros <sup>5</sup> | 25 <sup>yr</sup> Runoff | Stability                          | REMARKS                                              |
|---------------------------------------------------------|-------------------------|-------------------------|--------------------------|------------------------|-------------------------|-------------------------|------------------------------------|------------------------------------------------------|
| SX-9A <sup>not on map</sup><br>(above Emerald Cr. Xing) | 80                      | 5                       | minimal                  | no                     | —                       | ?                       | v. stable                          | well capped.                                         |
| SX-12A                                                  | 32                      | 4                       | minimal                  | no                     | —                       | 14                      | v. stable                          | rocky fill                                           |
| SX-12B                                                  | 50                      | minimal                 | 10                       | mod.                   | 10                      | 14 cfs                  | temp                               | rocky fill<br>SBF above -<br>240 cy gone, more to go |
| SX-13A                                                  | 20                      | minimal                 | minimal                  | yes                    | minimal                 | 14 cfs                  | v. stable                          |                                                      |
| SX-13A <sup>1/2</sup><br>(off cr. (quies))              | 100                     | 10                      | minimal                  | no                     | —                       | 14 cfs                  | stable                             | mostly logs                                          |
| SX-13B                                                  | 85                      | 5                       | minimal                  | yes - do               | minimal                 | 14 cfs                  | <sup>v</sup> / <sub>2</sub> stable | rills only                                           |
| RX-13's<br>Log Jam<br>R-13                              | 525                     | ~5                      | ~250                     | no                     | —                       | 14 cfs                  | temp stab.                         | rotting logs                                         |
| Below Log Jam                                           | 35                      | 10                      | 1.5                      | yes                    | 16                      | 14 cfs                  | temp.                              | mostly logs                                          |
| Totals                                                  | 927 cu                  | 39 cu                   | 275 cu                   |                        |                         |                         |                                    |                                                      |

\* ←  
mean  
rehab

1975 Area: Slopes above C-30 - t. or clearcut  
 - NO xings = cable clearcut

191.5 acre

36.2 acres

82-1

| SITE Number                | Excav Vol         | Eroded Vol | future eros | Diver Pot | Diver Eros | 25yr runoff | Stability | REMARKS                                                  |
|----------------------------|-------------------|------------|-------------|-----------|------------|-------------|-----------|----------------------------------------------------------|
| SV-3A<br>(C-30)<br>SX-5A   | 610               | 5          | 300         | no        | —          | 30cfs       | UNstab    | subsurf. flow *<br>means<br>rehab.                       |
| SX-5A<br>(C-30)<br>SX-7A   | 815               | 56         | 150         | yes       | 200        | 45cfs       | v. UNstab | subsurf., cracked<br>large <sup>pot</sup> bank failure * |
| SX-7A<br>(C-30)            | 150               | 22         | ~50#?       | no        | —          | 9           | temp      |                                                          |
| SX-8A<br>(C-30)            | 150               | 75         | minimal     | no        | —          | 52          | v. stable | mostly logs                                              |
| SX-8B<br>(C-30)            | —                 | 100        | minimal     | no        | —          | 52          | v. stable | logs only = blown out                                    |
| SX-3A<br>(W-Line)<br>SX-1A | 250               | 14         | ?           | yes       | 200        | 6cfs        | unstable  | diversion is preventing<br>eros of xing *                |
| SX-4A (2)<br>(W-Line)      | 100<br>100        | minimal    | 5<br>5      | yes       | 20         | 20cfs       | temp.     | surface flow                                             |
| SX-4B (3)                  | 100<br>100<br>100 | minimal    | minimal     | no        | —          | 12cfs       | v. stable | surface flow                                             |

1975 cont

82-1

| SITE Number                | Excav. Vol. | Eroded vol | future eros | Diver Pot | Diver Gros | 25 yr Runoff | Stability | REMARKS                                   |
|----------------------------|-------------|------------|-------------|-----------|------------|--------------|-----------|-------------------------------------------|
| SX-5A<br>(wline)<br>SX-3A  | 250         | 60         | ~60         | no        | —          | 35           | unstab.   | Large area of the RB= unstable, sliding * |
| SX-5C<br>(wline)           | 150         | 65         | minimal     | no        | —          | 28           | v stable  | log nick points, well veged.              |
| SX-9A<br>(wline)<br>62?    | 200         | 10         | minimal     | yes       | minimal    | 19cfs        | temp      | surface flow                              |
| SX-10A/B<br>(wline)<br>62? | 400         | 15         | 250         | no        | —          | 37cfs        | temp      | surf. flow, slushy                        |
| SX-11A<br>(wline)          | 400         | 20         | 50?         | no        | —          | 32cfs        | temp      | lots of logs                              |
| SX-11B<br>(wline)<br>62?   | 250         | 17         | 50?         | yes       | 10         | 27cfs        | temp      | slushy + loggy                            |
| Totals                     | 425cy       | 443cy      | 920cy       |           | 430cy      |              |           |                                           |

1970

Area: Below Wline Archie <sup>bridge</sup> : cable clear cut - 33.5 ac <sup>(includes 71 tractor cut around land)</sup>  
 Below Wline adjacent to Delason Prairie - Tractor clear cut 16.9 acres <sup>No Kings</sup>

| SITE Number | Excav vol                                                                                                                 | eroded vol            | future erosion             | diver Pot | diver eros | 25 yr Runoff        | stability | REMARKS 82-1           |
|-------------|---------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------------|-----------|------------|---------------------|-----------|------------------------|
| SX-1AE      | 50<br>50<br>50<br>50<br>50                                                                                                | 5<br>5<br>5<br>5<br>5 | 10<br>10<br>10<br>10<br>10 | no        | —          | 6-10 cfs            | v. stable | subsurf. flow or rills |
| Totals      | 250                                                                                                                       | 25                    | 50                         |           |            |                     |           |                        |
| 1973        | Area: Below L&K, adjacent to Elk. Camp Prairie<br>Re-entered 1966 tractor select cut ... 46.2 ac<br><br>No new crossings. |                       |                            |           |            |                     |           |                        |
|             |                                                                                                                           |                       |                            |           |            | Total acres = 508.7 |           |                        |

C-30

| SITE Number | Old Number (unrehabbed) | <sup>25</sup> yr discharge <sup>1</sup> | culvert diameter | Culvert inlet depth | Actual Hw/D <sup>2</sup> | Required Hw/D <sup>2</sup> |            | REMARKS                                        |
|-------------|-------------------------|-----------------------------------------|------------------|---------------------|--------------------------|----------------------------|------------|------------------------------------------------|
| —           | RX-2                    | 10 cfs                                  | —                | —                   | —                        | —                          |            | Flow directed to RX-5 via IBD                  |
| RX-5        | RX-3                    | (10+31 cfs)<br>41 cfs                   | 48"              | 5.5'                | 1.3                      | .74                        | OK         | Could divert<br>Flow directed to RX-7 via IBD. |
| RX-6        | RX-4                    | 30 cfs<br>(30+47 cfs)                   | —                | —                   | —                        | —                          | →          |                                                |
| RX-7        | RX-5                    | 77 cfs                                  | 48"              | 9.5'                | 2.4                      | 1.2                        | OK         | Could divert                                   |
| RX-8        | RX-6                    | 54 cfs                                  | 48"              | 8.0'                | 2.0                      | 0.9                        | OK         | Could divert                                   |
| RX-9        | RX-7                    | 11 cfs                                  | 24"              | 6.0'                | 3.0                      | 1.0                        | OK         | Could divert                                   |
| RX-10       | RX-8                    | 58 cfs                                  | 36"              | 9.5'                | 3.2                      | 2.0                        | OK         | No diversion potential                         |
| RX-11       | RX-9                    | 122 cfs                                 | 48"              | 15.0'               | 3.75                     | 1.7                        | OK         | No diversion potential                         |
| R-12        | RX-10                   | 7 cfs                                   | 12" ?            | 24" ?               | 2.0                      | 6.0                        | undersized | Has diverted in past                           |
|             |                         | ↑<br>MOVE                               |                  | UP !                | ↑                        |                            |            |                                                |
| RX-12       | RX-12                   | 14 cfs                                  | 18"              | 4.0'                | 2.67                     | 3.4                        | undersized | Minor D.P.                                     |
| RX-13       | RX-13                   | 14 cfs                                  | 18" ?            | 4.5'                | 3.0                      | 3.4                        | undersized | Minor D.P.                                     |

1 Calculated using Rational Formula (see Table — : Drainage Area & Runoff in Appendix)

2 Hw/D = Headwater depth ÷ culvert diameter = headwater depth in diameters

Actual Hw/D = culvert inlet depth below road surface ÷ culvert diameter

Required Hw/D = obtained from "Chart 5—Headwater Depth for C.M. Pipe Culverts with Inlet Control" (using projecting entrance<sup>type</sup>), Bureau of Public Roads, Jan 1963.

# 82-1: CULVERT CAPACITIES (cont)

W-LINE

| SITE<br>Number | Old<br>Number<br>(unrehabbed) | 25 yr<br>Discharge | culvert<br>diameter | culvert<br>inlet<br>depth | Actual<br>HW/D | Required<br>HW/D        | REMARKS    |
|----------------|-------------------------------|--------------------|---------------------|---------------------------|----------------|-------------------------|------------|
| -              | RX-1                          | 2cfs               | 24"                 | N.M. <sup>4</sup>         | -              | no depth<br>requirement | Minor D.P. |
| -              | RX-2                          | 5cfs               | 24"                 | N.M. <sup>4</sup>         | -              | .6                      | Minor D.P. |
| RX-1           | RX-3                          | 6cfs               | 24"                 | 2.0'                      | 1.0            | .65                     | Minor D.P. |
| RX-2           | RX-4                          | 23cfs              | 24"                 | 3.0'                      | 1.5            | 2.2                     | Minor D.P. |
| RX-3           | RX-5                          | 36cfs              | 36"                 | 7.0'                      | 2.33           | 1.1                     | Minor D.P. |
| -              | RX-6                          | 3cfs               | 24"                 | N.M. <sup>4</sup>         |                | NO DEPTH<br>REQUIREMENT | Minor D.P. |
| -              | RX-7                          | 9cfs               | 24"                 | N.M. <sup>4</sup>         |                | .8                      | Minor D.P. |
| -              | RX-8                          | 30cfs              | 36"                 | 6.5'                      | 2.17           | .95                     | Minor D.P. |
| -              | RX-9                          | 27cfs              | 36"                 | 9.0'                      | 3.6            | .9                      | Minor D.P. |
| -              | RX-10                         | 45cfs              | 36"                 | 11.5'                     | 3.84           | 1.3                     | Minor D.P. |
| -              | RX-11                         | 45cfs              | 36"                 | 10.5'                     | 3.5            | 1.3                     | Minor D.P. |
| -              | RX-13                         | 50cfs              | 36"                 | 7.5'                      | 2.5            | 1.5                     | Minor D.P. |

# CULVERT CAPACITIES (cont.)

W-LINE

| SITE number | Old Number (unrehabbed) | 25 yr discharge <sup>1</sup> | culvert diameter | culvert inlet depth | Actual HW/D <sup>2</sup> | Required HW/D <sup>2</sup> |    | REMARKS                              |
|-------------|-------------------------|------------------------------|------------------|---------------------|--------------------------|----------------------------|----|--------------------------------------|
| -           | RX-14                   | 25 cfs                       | 36"              | 4'                  | 1.3                      | .82                        | OK | Minor D.P.                           |
| -           | RX-15                   | 4                            | 18"              | 3'                  | 2                        | .65                        | OK | No channel here<br>Feeding land side |
| (Em. Cr.)   | RX-16                   | 15                           | 36"              | 5'                  | 1.7                      | .62                        | OK | Could divert                         |
| -           | RX-17                   | 7                            | 18"              | 4'                  | 2.7                      | 1.2                        | OK | Could divert                         |
| -           | RX-18                   | 7                            | 18"              | 4'                  | 2.7                      | 1.2                        | OK | Could divert                         |
| -           | RX-19                   | 8                            | 18"              | 4'                  | 2.7                      | 1.3                        | OK | Could divert                         |
| -           | RX-20                   | 1                            | No culvert       | -                   | -                        | -                          | -  | Diverts down IED                     |
| -           | RX-21                   | 10                           | 18"              | 4'                  | 2.7                      | 1.7                        | OK | Could divert                         |
| -           | RX-22                   | 2                            | No culv.         | -                   | -                        | -                          | -  | Diverts down IED                     |
|             |                         |                              |                  |                     |                          |                            |    |                                      |
|             |                         |                              |                  |                     |                          |                            |    |                                      |

**APPENDIX TABLE 3.  
B2-1 MISCELLANEOUS HEAVY EQUIPMENT COSTS**

| Category                           | Equipment  | Hours | Cost    | Site<br>Cost     |
|------------------------------------|------------|-------|---------|------------------|
| Moving straw                       | Excavator  | 1     | \$85.00 |                  |
|                                    | 1450       | 8½    | 637.50  |                  |
|                                    | D-8        | ¼     | 24.75   |                  |
|                                    | D-8        | ¼     | 21.25   | \$768.50         |
| Moving culverts                    | 1450       | 7½    | 543.75  | 543.75           |
| Miscellaneous time<br>paid in full | Excavator  | 1½    | 127.50  |                  |
|                                    | 1450       | 1     | 75.00   | 202.50           |
| Walking in straw                   | 1450       | 1½    | 112.50  | 112.50           |
| Miscellaneous work*                | Excavator  | ¼     | 42.50   |                  |
|                                    | Dump truck | 2     | 70.00   |                  |
|                                    | Dump truck | 2     | 68.64   | 181.14           |
| TOTAL                              |            |       |         | <u>\$1808.39</u> |

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\*Work for Technical Services on K & K sediment troughs.

**APPENDIX TABLE 4.**  
**82-1 STRAW DISTRIBUTION: ROAD REACHES**

| Site Number    | Area: Acres       | Number of Straw Bales* | lbs/Acre             | % Slope         | Road Width (Ft)      | Remarks         |
|----------------|-------------------|------------------------|----------------------|-----------------|----------------------|-----------------|
| R-1            | 3.1               | 160                    | 3087                 | 24%             | 88                   | Partial prairie |
| R-2            | .9                | 65                     | 4333                 | 20%             | 69                   |                 |
| R-3            | 1.3               | 70                     | 3231                 | 11%             | 96                   | Landing         |
| R-4            | 3.8               | 185                    | 2921                 | 21%             | 80                   |                 |
| R-5            | 1.8               | 145                    | 4833                 | 24%             | 204                  | W-Line Rockpit  |
| R-6            | .7                | 50                     | 4286                 | 22%             | 67                   |                 |
| R-7            | 1.0               | 85                     | 5100                 | 31%             | 89                   | Landing         |
| R-8            | 1.3               | 70                     | 3231                 | 18%             | 72                   |                 |
| R-9            | .3                | 20                     | 4000                 | 24%             | 50                   |                 |
| R-10           | 2.0               | 120                    | 3600                 | 35%             | 88                   |                 |
| R-11           | 1.6               | 110                    | 4125                 | 24%             | 62                   |                 |
| R-12           | 1.5               | 135                    | 5400                 | 26%             | 63                   | C-30 Rockpit    |
| R-13           | 1.8               | 135                    | 4500                 | 28%             | 150                  | Landslide       |
| R-14           | 1.4               | 65                     | 2786                 | 23%             | 121                  | Landing         |
| R-15           | .3                | 15                     | 3000                 | 13%             | 45                   |                 |
| <b>TOTALS:</b> | <b>22.8 Acres</b> | <b>1430 bales</b>      | <b>3763 lbs/acre</b> | <b>23% Avg.</b> | <b>90' wide Avg.</b> |                 |

\*Note: Calculated 60 lb/bale.



82-1 SOC PP3 Pre Heavy Equipment



82-1 SOC PP3, WA Post H.E.



82-1 SOC PP3 8/3/84 D.A.S



82-1 SOC PP8 Pre H.E.



82-1 SOC PP8 Post H.E.



82-1 SOC PP8 8/3/83



82-1 SOC PP9 RX-3 Pre H.E.



82-1 SOC PP9 RX-3 Post H.E.



82-1 SOC PP9 8/2/84 D.A.S.



82-1 SOC PP37a RX-12 Pre H.E.



82-1 SOC PP37A 8/3/83 DES.